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Inventive leadership styles and their impact for achieving sustainable development goals in education at secondary schools: a case study from Multan, Pakistan

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Globally, as we progress toward a more sustainable future, the sustainable development goals (SDGs) must be incorporated into various sectors, including education. This article explores the significant impact of inventive leadership styles on SDGs in education at the secondary school level in Pakistan. Based on this study, four hypotheses were developed using leadership variables such as empowerment of leadership, inspiring learners, resilient visions, and lead transformation. A quantitative survey method was utilized in this study. The researchers selected convenient sampling to collect data from 288 teachers, including heads of schools and administrators from 89 institutions. The data collection process included using a survey questionnaire to collect data on leadership styles and their relationship regarding SDGs within the field of education. In order to analyze the given data, two software programs were used, namely SPSS and Smart PLS 4.0. Several statistical methods were used to examine the collected data, such as confirmatory factor analysis (CFA) and structural equation modeling (SEM), which were implemented to confirm the measurement model. Additionally, path analysis was conducted to determine the relationship between independent and dependent variables. The findings revealed that overall leadership styles have a great positive impact on SDGs in education. Based on results, it has been found that it would be beneficial if leaders/teachers enhance their struggle using inventive leadership styles for achieving SDGs, fostering transformative education, and ensuring that learners and societies benefit from a more equitable and resilient future. Additionally, the need for more resources, resistance to change, and a need for leaders'/teachers' professional development have been identified as potential obstacles. To overcome these challenges, a collaborative approach among stakeholders, policy support, and innovative practices are recommended.

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Introduction

The 2030 Agenda for Sustainable Development Goals in Education (SDGsE) lays forth an ambitious plan to improve the world’s economic, social, and ecological systems. The 193 UN member states approved it in September 2015. They will lead the organization toward success for the next 15 years (Sachs et al., 2019). Improvements in critical thinking and the capacity to make more responsible judgments and contribute to developing sustainable societies are essential outcomes of education for SDGs (Ferrer-Estévez & Chalmeta, 2021; Hák et al., 2016).

A decade of sustainable development goals in education (SDGsE) was declared between 2005 and 2014 by the United Nations (UN) and a global action program (Beynaghi et al., 2016). Global action program reports that education for education for sustainable development (ESD) is increasingly known as a primary element of eminence education (Zguir et al., 2021). SDGsE proposes a new approach to education focused on inspiring leaders and management to take responsibility for creating and enjoying a sustainable future (Kolb et al., 2017).

Moreover, implementing this new educational model/approach, which focuses on using education to achieve SDG, poses a challenge for leadership and management as it requires a reorientation of curriculum, policy programs, and practices (Ferrer-Estévez & Chalmeta, 2021). Educational institutions’ management and educators, as well as the content and methodology of education, are all affected by this challenge (Alm et al., 2022). As a result, people all across the globe are paying attention to the UN’s education strategy for sustainable development (Leal Filho et al., 2022). Educating society about the ecosystem’s vitality and changing the social behavior of leaders and management is one of the vital goals of SD (Kleespies & Dierkes, 2022). Numerous initiatives have been taken by the United Nations, among which education has been identified as an essential means for transforming people’s behaviors and creating awareness (Leithwood et al., 2008; Massari et al., 2022).

However, it is admitted that education plays a vital role in shaping today’s leaders and innovators. The United Nations has emphasized the importance of education as a catalyst for sustainable development, and it has also formulated a set of sustainable development goals (SDGs) to guide global efforts toward a more inclusive, equitable, and sustainable future. Integrating innovative leadership styles at secondary schools is one of the essential aims: empowering leaders, inspiring learners, fostering resilient visions, leading transformation, and aligning with the overall SDGs (Sachs et al., 2019; Saxena et al., 2021).

Since the education system in Pakistan is tasked with producing responsible citizens and the human potential to achieve national education goals (NEGs), strong school leadership and administration are essential to the country’s progress (Maqbool et al., 2023). According to the analysis of educational policy documents, significant examples of sustainability activism are related to leadership and management (Greer et al., 2023). When

considering educators’ points of view, the study on sustainable development education for secondary school leaders stands out as especially significant (Kalkan et al., 2020).

Incorporating the SDGs, “Education for all,” into the millennium development goals has elevated the right to education to the forefront of national policy discussions (Khan & Hassan, 2019). A leadership approach to education generally examines the extra subtle effects of SDGs of unique management of various significant student outcomes (Fry & Egel, 2021). Leadership in education consists of problem-solving and facilitation; excellent teaching facilities are required to offer superior education (Chen et al., 2022).

Furthermore, in Pakistan, schools, colleges, and universities contribute to accomplishing the millennium development goals (MDGs). At the same time, secondary schools are the ultimate sub-level of education that builds learners’ foundation and the basis of the entire pyramid of education (Asadullah et al., 2020). However, leadership styles play an essential role in the development and success of schools. Educational movements must be renewed to keep pace with changing times (Franco & Matos, 2015). The above introduction provides an impression of the SDGs and their educational significance. It also emphasizes inventive leadership styles and their role in empowering leadership, inspiring learners, fostering a resilient vision, leading transformation, and aligning with SDGsE. The explanation of variables can be seen in Table 1.

Theoretical underpinning

SHRM has been approached theoretically from several angles, including institutional theory (Das & Kodwani, 2018), stakeholder theory (De Gooyert et al., 2017), paradox theory (Cunha & Putnam, 2019), risk society theory (Beck, 2015), organizational development theory (Zacher & Rosing, 2015), system theory (Jia et al., 2017), and signaling theory (Alsos & Ljunggren, 2017). However, the ability, motivation, and opportunity theory is the most widely used (Bos-Nehles et al., 2023) since it gives a conceptual model that elucidates the strategies and consequences of the HR functions that foster long-term success (Gholami et al., 2016; Li et al., 2022; Malik et al., 2021; Rizvi & Garg, 2021; Yu et al., 2020). Based on the following lines, the theories address the connections between leadership styles and sustainability.

In addition, SDGs have been included in classroom discussions about leadership and management strategies by (Wolff et al., 2020). Practicing sustainability is tending to immediate wants without undermining the requirements of future generations (Bibri & Krogstie, 2017). Leaders’ leadership style is how they interact with and influence their followers. The finest leaders can mobilize their followers to effect political and social change. They may inspire others to raise their output, originality, and innovation. Furthermore, sustainability is the action of satisfying present demands without endangering future

Table 1 Variables explanations.

Variables	Explanation
Empowerment of leaders	Wherein authority is delegated from superiors to employees so they may act autonomously (Van Dierendonck & Dijkstra, 2012).
Inspiration for learner	Inspiration for learners is defined by its capacity to motivate followers to follow its example and improve themselves through education and experience (Chopra & Kanji, 2010).
Lead transformation	The goal of the management philosophy known as “lead transformation” is to motivate and inspire workers to create and implement novel strategies for the future development of an organization (Cetin & Kinik, 2015).
Resilient vision	Leaders and teachers with resilient vision can maintain enthusiasm in adversity, roll with unexpected twists and turns, and make necessary adjustments (Maulding et al., 2012).

generations’ requirements. Consequently, there has been much debate and study of this idea in the academic community (Geissdoerfer et al., 2017).

Conceptual model and sustainable development goals in educational integration in Pakistan

Sustainability advocacy is present, according to the examination of educational policy documents (Boeve-de Pauw et al., 2015; Laurie et al., 2016). Studies of teacher preparation have received the most attention (Batool, Habiba, 2021; Best & MacGregor, 2017; Kalsoom & Khanam, 2017; Siew et al., 2015; Yalcin Arslan, 2019). In particular, regarding leadership styles, the research on leadership at the secondary school level (9–10 grades) from an SDGs perspective needs to be revised (Leithwood, 2016). Hence, the question of how leadership and management styles influence SDGs in education can act as an influential approach. A requisite exists to take surveys from secondary school teachers regarding leadership styles to SDGs in school education.

However, as per the concept of this study, SDGsE contribute significantly to the design of educational frameworks and curricula. Bringing the SDGsE into secondary education (grades 9–10) allows students to become aware of global challenges and develop a sense of responsibility as global citizens. In this way, innovative leadership styles are promoted, focusing on sustainable development, which has been shown in Fig. 1 with the dependent variable (DV) that is SDGs in education, and independent variables (ID) such as empowering of leadership, inspiration for the learner, resilient vision, and lead transformation. Based on the literature review, four hypotheses were formulated. The significance of education as a driver of human capital and economic growth is shown by this research. Therefore, politicians, academics, researchers, and administrative heads of educational institutions would benefit from this study’s findings while formulating policies and establishing methods to enhance Pakistan’s educational system.

Literature review and hypothesis development

ESD has expanded worldwide via UNESCO’s programs in both the North and the South, although ESD has only sometimes been a priority in national programs. The desire of teacher education institutions to include ESD in teacher training programs is still a major limiting factor in the adoption of ESD. Literature frequently combines leadership and management styles with SDGs in education, which may be partially attributed to how the term is understood and used (Rapsikevičius et al., 2022). Leadership plays a significant role in determining students’ learning success (Mun et al., 2021).

Moreover, leadership is the ability to inspire others to work toward a common goal or vision with the necessary skills and

dedication to make it a reality (Hallinger, 2018). leadership based on participatory decision-making can positively impact teachers’ organizational performance (Torlak et al., 2022). Leadership is predictive of the performance of individuals and organizations (Zacher & Rosing, 2015). An empirical study has demonstrated that employees who develop better relationships with their leaders feel empowered, ultimately motivating them to perform effectively and contribute to the organization’s success (Lin, 2023).

Due to school administrators’ increased responsibilities and accountability-focused climate, educational leadership is frequently in the spotlight (Muijs, 2015; Sun & Leithwood, 2015). Effective school management is essential for public administration. Education accounts for 13% of public spending in OECD nations (Kim, 2013). According to previous research, leadership, and administration have been shown to significantly impact a school’s performance. Further, leadership for SDGsE” has rarely been the topic of empirical research. However, research on the effectiveness of schools has shown that a school’s leadership directly impacts the quality and performance of the school per se (Pietsch et al., 2020).

Empowerment of leadership and SDGsE. The presence of empowering leadership is essential for both individual and organizational success. As defined by past research, empowering leadership is the delegation of authority and responsibility to subordinates, teams, or groups to increase employee enthusiasm and productivity (Amundsen & Martinsen, 2015; Fong & Snape, 2015; Konan, Tayyar Çelik (2018); Sharma & Kirkman, 2015; Vrhovnik et al., 2018). Positive research has inspired the evolution of empowering leadership (Lee et al., 2017), and Consequently, it is argued that empowering leadership yields generally positive, empathetic, and moral results regarding sustainable development (Chen et al., 2011; Erkutlu & Chafra, 2015; Zhang & Jin, 2019).

Furthermore, within management theory, two primary mechanisms exist for bestowing leaders with more authority. The rational construct model is characterized by delegating authority from superiors to subordinates, enabling them to exercise initiative and make independent work choices (O’Donoghue & van der Werff, 2022). Leadership is the act of persuading others. Empowering leaders delegate authority to their followers, enabling them to modify the behavior of their subordinates. The second strategy characterizes empowerment as a motivational construct with four subcomponents (Birdi et al., 2016; Conger, 2017). The first component is the worker’s self-assurance in his or her ability to do the task (Li et al., 2015). The second component is workers’ sense of significance and appreciation for their contributions to the company (Wang & Xu, 2019). The third is self-determination, or allowing workers

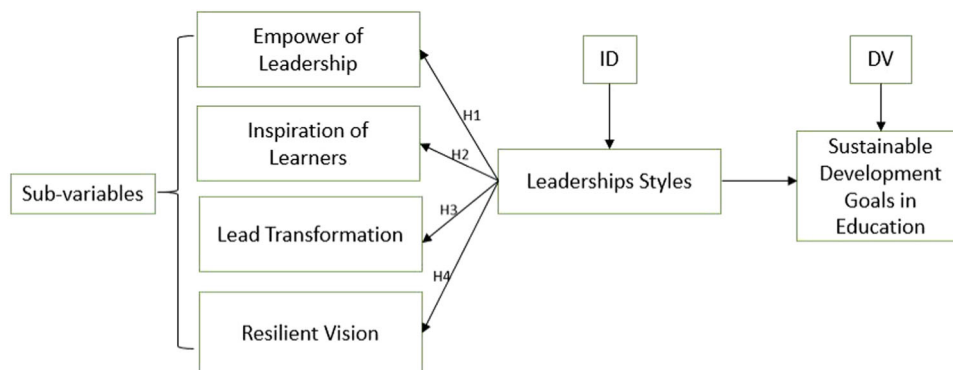


Fig. 1 Conceptual representation of the present study based on literature review.

some say in what they do and how they do it (Groen et al., 2017). Last, “impact” reveals the employee’s level of sway inside the company/institution (Kang & Sung, 2017). Therefore, we hypothesize that empowering leadership has a significant impact on SDGsE.

H₁: Empower of leadership will have a positive impact on sustainable development goals in Education.

Inspiration for learner and SDGsE. Inspiration for the Learner defines the leader’s ability to inspire the learner to learn and move forward (Day et al., 2016). Students retain more of what they learn when actively involved in the process. Learning results improve when a learner is interested in what they are doing. Teachers should strive to make their classrooms as exciting and motivational as possible (Froiland & Worrell, 2016).

Moreover, studies have demonstrated various methods that instructors can use to engage and inspire learners in the learning process, encouraging more sophisticated critical thinking and improving concentration spans (Granjeiro, 2019). Some of them are mentioned, asking open-ended questions because it (a) prompts students to think more critically and creatively, (b) helps students form their hypotheses and explanations, (c) expands their lexicon, (d) instills in them the habit of constantly coming up with something novel and unique, and (e) improves their ability to solve problems (Sammons et al., 2016). Group activities greatly facilitate collaborative learning. Students learn more effectively and enjoy teamwork (DeLozier & Rhodes, 2017). Students may generate unique ideas via presentations. Presentations allow students to showcase their knowledge and enhance their skills in public speaking. When students Present work before others, it encourages learning, cooperation, brainstorming, and problem-solving (Hospel & Galand, 2016). Teachers who put their students first are more likely to spark their imaginations, which benefits everyone’s ability to master the subject matter (Czajka & McConnell, 2019). Hence, we assumed that inspiration for learners positively impacts SDGsE.

H₂: Inspiration for learners will have a positive impact on sustainable development goals in education.

Lead transformation and SDGsE. James MacGregor Burns, a leadership expert and presidential biographer, first introduced the concept of lead transformation. According to Burns, transformational leadership is exhibited when leaders and adherents elevate each other’s moral and motivational standards (Andersen, 2018). Four criteria were also found in lead transformation experiments. (a) Mental exercise: transformational leaders challenge the status quo and encourage creativity in their followers. The leader encourages people to take fresh approaches to address issues and learn new things. (b) One aspect of transformative leadership is showing care for others individually. To cultivate supportive relationships, transformational leaders maintain open communication channels so that listeners feel free to share their ideas and their contributions are promptly acknowledged. (c) Inspirational motivation: Influential leaders share a compelling vision with their employees that inspires them. These leaders may inspire their adherents to share the same determination and zeal (d) Idealized influence: The transformative leader inspires those who follow him or her. Because they venerate and respect the leader, followers assume the leader’s beliefs and actions (Al-Husseini & Elbeltagi, 2018; Bakker et al., 2022; Çekmecelioğlu & Özbağ, 2016; Cetin & Kinik, 2015). Thus, we expect that lead transformation positively impacts SDGE.

H₃: Lead transformation will have a positive impact on sustainable development goals in education.

Resilient vision and SDGsE. Resilient vision is the quality in which leaders/educators can maintain their energy level under duress, cope with disruptive changes, and adapt (Mansfield et al., 2016). A resilient leader adapts to change and capitalizes on opportunities. They overcome obstacles, solve problems creatively, and encourage others to share their work and organizational vision. Most importantly, they respond quickly to challenges and prepare the group for the next phase (Malik & Garg, 2020). Moreover, businesses can grow with resilient leaders who inspire their followers to adopt a new strategy in the face of hardship. With a lack of this leadership, consequences include (a) lost chances for development and efficiency, (b) disengaged and uninspired staff, and (c) constrained productivity, creativity, and invention (Jakobsen et al., 2023).

However, many professional and contextual teacher resilience methods have been found via study, and suggestions have been put forward at the individual, school, and system levels (Day & Gu, 2014), more research needs to be done to pinpoint how exactly teacher training might help teachers become resilient. Several recommendations have been given about what teachers should study and how to gain knowledge. As there is a dearth of research on teacher resilience during the pre-service years, it is generally agreed that teacher leadership can play a crucial part in the resilience process, even if their life experience and professional level impact the teachers’ resources and employed to support resilience (Richards et al., 2016). Gu (2014) recommends teacher resilience to enhance teaching quality and student learning outcomes. Therefore, using proven leadership styles will positively impact the achievement of education’s SDGs.

H₄: Resilient vision will have a positive impact on sustainable development goals in education.

Methodology

Study method and participants. The research was carried out utilizing the quantitative survey method. Because the survey technique is defined as the collecting of information from a sample of persons via their replies to questions (Schutt, 2019), multiple stages are involved in this method, including the collection and analysis of quantitative data to test the hypotheses for knowing the impact concerning leadership styles and SDGs in education (Shafqat et al., 2023).

The research participants are secondary school instructors specializing in teaching various natural and social sciences courses. An in-depth study was undertaken, including a sample size of 288 individuals comprised of teachers, school principals, and administrators. They were all educators in secondary schools in Multan, Punjab, Pakistan. The Board of Intermediate and Secondary Education (BISE) Multan encompasses a total of 306 secondary schools situated in several smaller localities within the Multan region. This study’s participants were selected using a convenient sampling strategy, explicitly targeting 89 secondary schools (Peterson & Merunka, 2014).

Moreover, educators were met at their respective educational institutions on specific days during the process of data collecting. Teachers were given survey sheets along with an invitation letter for participation. It included the fundamental components of the study as well as detailed directions for the successful completion of the survey questionnaire. Teachers participated voluntarily after receiving permission from their principals and signing consent forms. Furthermore, participants were assured that their personal information would be maintained in strict confidentiality, and they were also informed of their right to withdraw from the study at any point before the analysis phase.

A pilot investigation was conducted, with a sample of 55 participants, to assess the reliability of the survey questionnaire.

Cronbach’s alpha (CA) statistics were then used to assess the internal consistency of the questionnaire. The obtained alpha value demonstrated a substantial level of internal consistency, hence affirming the questionnaire’s high reliability for collecting formal data. The alpha value of 0.88 aligns with the findings reported in the prior research (Zafeer et al., 2023).

Questionnaire and analysis settings. In this survey, one questionnaire was developed to assess the empowerment of leadership, inspiration for learners, lead transformation, resilient vision, and SDGs in education. The questionnaire consisted of 25 statements, and each variable consisted of 5 statements. A 5-point Likert scale with five levels of agreement, ranging from 1 (strongly disagree) to 5 (strongly agree), was used to evaluate the participant’s responses. Two statistical tools/software, including a statistical package for social science (SPSS) and Smart (PLS-SEM), were utilized for data analysis.

A dataset review was conducted to determine whether it met the measurement model specifications and would be suitable for further analysis. The loadings of the indicators were examined as the first step of the evaluation process. Confirmatory factor analysis (CFA) is used to validate the measurement model. Several types of validity can be measured in measurement models (Hair et al., 2020).

Moreover, partial least squares structural equation modeling (PLS-SEM) was utilized to assess the proposed model. This method is effective with small sample sizes and intricate models (Hair et al., 2017). Multivariate statistical analysis using PLS-SEM is conducted in two stages: first, the measurement model is evaluated, then the structural model is evaluated through SmartPLS 4.0, and 10,000 bootstrap samples were used to ensure accuracy (Ali et al., 2018).

Findings. Table 2 summarizes the participants’ demographics, which include five variables such as gender, age, educational qualifications, professional qualifications, and experiences, which have been analyzed by frequency, percentage, mean, and standard deviation. Both males and females were present, male ($f = 115$, $\% = 39.9$) female ($f = 173$, $\% = 60.1$) with ($M = 1.60$ and $SD = 0.491$). Among the participants, the age range was 26–30 ($f = 136$, $\% = 47.2$), 31–35 ($f = 107$, $\% = 37.2$), 36–40 ($f = 28$, $\% = 9.7$), and 41above ($f = 17$, $\% = 5.9$), with ($M = 1.74$ and $SD = 0.861$). A classification of academic qualifications was made B.A/B.Sc. ($f = 182$, $\% = 63.2$), M.A/M.Sc. ($f = 95$, $\% = 33.0$), M.Phil. ($f = 11$, $\% = 3.8$), with ($M = 1.41$ and $SD = 0.565$). In addition, professional qualifications were categorized into B.Ed. ($f = 207$, $\% = 71.9$), M.Ed. ($f = 41$, $\% = 14.2$), do not have ($f = 40$, $\% = 13.9$) with ($M = 1.42$ and $SD = 0.723$). As a final consideration, experience is divided into 1–5 ($f = 52$, $\% = 18.1$), 6–10 ($f = 170$, $\% = 59.0$), and 11–15 ($f = 40$, $\% = 13.9$) and 16 above ($f = 26$, $\% = 9.0$) with ($M = 2.14$ and $SD = 0.815$).

Measurement model assessment. A CFA is the first step to test the reliability and validity of the measurement variables and lay the foundation for subsequent structural analysis. After the hypothesis is proposed or the causal relationships between latent constructs are explored, the PLS-SEM is applied to test the hypothesis. Internal consistency reliability was assessed using CA and composite reliability (CR) because previous studies indicated that CR estimates tend to produce more accurate reliability coefficients (Kalkbrenner, 2023). According to empirical evidence, CA and CR coefficients should always be greater than 0.7 for a good and reliable instrument.

Table 3 shows that all CA coefficients after analyzing formal data and CR coefficients are above 0.70, meaning the responses

Table 2 Participant demographic statistics.

Variables	F	(%)	M	SD
Gender				
Male	115	39.9	1.60	0.491
Female	173	60.1		
Total	288	100.0		
Age				
25-30	136	47.2	1.74	0.861
31-35	107	37.2		
36-40	28	9.7		
41above	17	5.9		
Total	288	100.0		
Academic qualifications				
B.A/B.Sc	182	63.2	1.41	0.565
M.A/M.Sc	95	33.0		
M.phill	11	3.8		
Total	288	100.0		
Professional qualifications				
B.Ed	207	71.9	1.42	0.723
M.Ed	41	14.2		
Don't have	40	13.9		
Total	288	100.0		
Experience				
1-5	52	18.1	2.14	0.815
6-10	170	59.0		
11-15	40	13.9		
16 above	26	9.0		
Total	288	100.0		

Note: *f* frequency, % percentage, *M* mean, *SD* standard deviation.

Table 3 Factors loading and assessment of the indicators.

Indicators	Factor loading	VIF	Cronbach's alpha	Cr	AVE
EOL	0.738	1.637	0.839	0.886	0.611
EOL	0.891	3.040			
EOL	0.804	2.186			
EOL	0.689	1.555			
EOL	0.771	1.702			
IFL	0.707	1.576	0.829	0.881	0.600
IFL	0.824	1.906			
IFL	0.608	1.273			
IFL	0.826	2.339			
IFL	0.878	2.973			
LT	0.861	2.180			
LT	0.591	1.285	0.792	0.859	0.555
LT	0.638	1.381			
LT	0.857	2.231			
LT	0.737	1.676			
RV	0.836	2.248	0.868	0.905	0.655
RV	0.828	2.504			
RV	0.797	1.949			
RV	0.803	1.855			
RV	0.781	2.159			
SDGE	0.840	2.329	0.872	0.907	0.661
SDGE	0.757	1.804			
SDGE	0.824	2.181			
SDGE	0.836	2.160			
SDGE	0.807	1.941			

Note: *EOF* empower of leadership, *IFL* inspiration for learner, *LT* lead transformation, *RV* resilient vision, *SDGE* sustainable development goals in education, *VIF* variance inflation factor, *CA* cronbach's alpha, *CR* composite reliability, *AVE* average variance extracted, all loadings were significance.

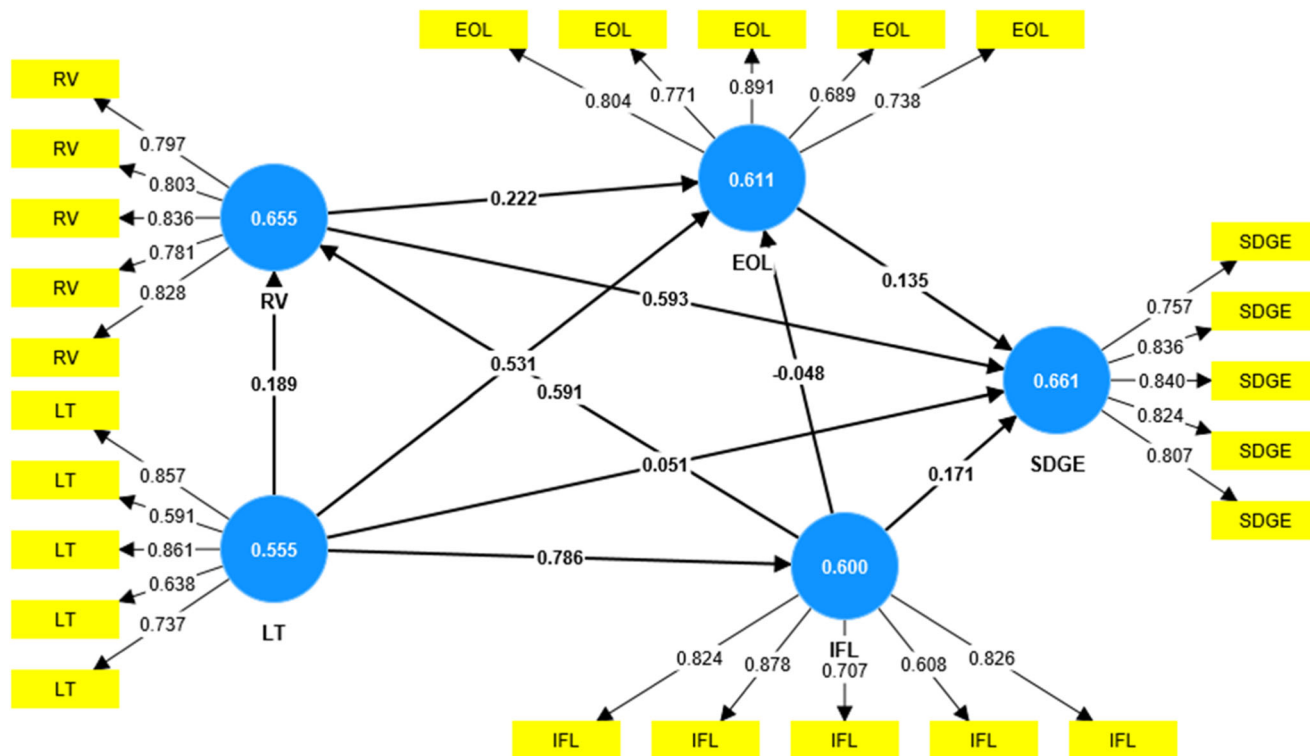


Fig. 2 Measurement (path analysis) model.

are highly related (Taber, 2018). A convergent validity test was conducted using average variance explained (AVE) for each construct across all items (Cheah et al., 2018). Findings indicate that all AVE values meet the minimum acceptable threshold of 0.5, confirming convergence (Shah, 2019). As a result, the variance inflation factor (VIF) values were used. A multicollinearity problem exists when VIF values exceed 5. Based on the results, the highest outer VIF value was 3.040, which falls within the acceptable range (Johnston et al., 2018).

The path analysis model shows that measurement items loading less than 0.50 should be discarded (Baby & Kannammal, 2020). In the present study, all measurement items had a loading range higher than 0.50 (Ki & Hon, 2008; Zafeer et al., 2022). Such as empower of leadership factor loading ranges from 0.891 to 0.689, inspiration for learners from 0.878 to 0.608, lead transformation from 0.861 to 0.591, resilient vision from 0.836 to 0.781, and SDGs in education from 0.840 to 0.757. Leadership empowerment has the highest, and Lead Transformation has the lowest factor loading (Fig. 2).

The Heterotrait-Monotrait (HTMT) technique was used to test the discriminant validity of the constructs. Literature indicated the criteria for an HTMT ratio of less than 0.85 (strictly speaking) or less than 0.90 (acceptable) (Henseler et al., 2015). Table 4 demonstrates that all HTMT values are less than the cutoff value of 0.90, proving that discriminant validity has been established. Moreover, after ensuring the validity and reliability of the measurement model, the next stage is to build the structural model, investigate the possible directions, and put forth hypotheses for testing.

Structural model assessment and hypothesis testing. Table 5 displays the Confidence Intervals for Hypothesis Testing and path analysis. It also presents each indicator’s leadership style and impact on the education SDGs. The indicators were explained by path coefficients, beta-values, *T*-statistics, *p*-values, and *f*-squared

Variables	EOL	IFL	LT	RV	SDGE
EOL	0.782				
IFL	0.533	0.775			
LT	0.638	0.786	0.745		
RV	0.533	0.740	0.653	0.809	
SDGE	0.574	0.721	0.658	0.824	0.813

EOF empower of leadership, *IFL* inspiration for learners, *LT* lead transformation, *RV* resilient vision, *SDGE* sustainable development goals in education.

as follows. According to H₁, empowerment of leadership will positively impact SDGs in education. EOL → SDGsE (H1: β = 0.044, t = 3.071, p < 0.002). H₂, inspiration for learners will positively impact SDGs in education. IFL → SDGsE (H2: β = 0.080, t = 2.136, p < 0.033). H₃, lead transformation will positively impact SDGs in education. LT → SDGsE (H3: β = 0.076, t = 0.663, p < 0.507). H₄, resilient vision will positively impact SDGs in education. RV → SDGsE (H4: β = 0.055, t = 10.722, p < 0.000). It was found that the decision to accept H₁, H₂, and H₄ substantially impacted empowerment leadership, inspiration for learners, and resilient vision on SDGsE. Meanwhile, H₃ is rejected because no statistical evidence supports the proposed significant impact of lead transformation on SDGsE.

In Fig. 3, it is demonstrated that three hypotheses have been accepted concerning SDGs in education, including the empowerment of leadership, inspiration for learners, and the resilient vision. Meanwhile, lead transformation has been rejected concerning the SDGs in education.

The measurement model is created in Smart (PLS-SEM) based on partial least squares analysis. The research model indicated an adequate data fit. The final model was acceptable because all fit

Table 5 Hypothesis testing through path analysis.

Relationship	Path coefficients	B	T	P	f-squared (f2)	2.5%	97.5%	Decision
EOL → SDGE	0.135	0.044	3.071	0.002	0.037	0.049	0.223	Accepted
IFL → SDGE	0.171	0.080	2.136	0.033	0.031	0.021	0.331	Accepted
LT → SDGE	0.051	0.076	0.663	0.507	0.003	0.105	0.195	Rejected
RV → SDGE	0.593	0.055	10.722	0.000	0.536	0.475	0.694	Accepted

EOL empower of leadership, IFL inspiration for learner, LT lead transformation, RV resilient vision, SDGE sustainable development goals in education. $P < 0.001$, PC path coefficients, β beta-value, $t = t$ -Statistics.

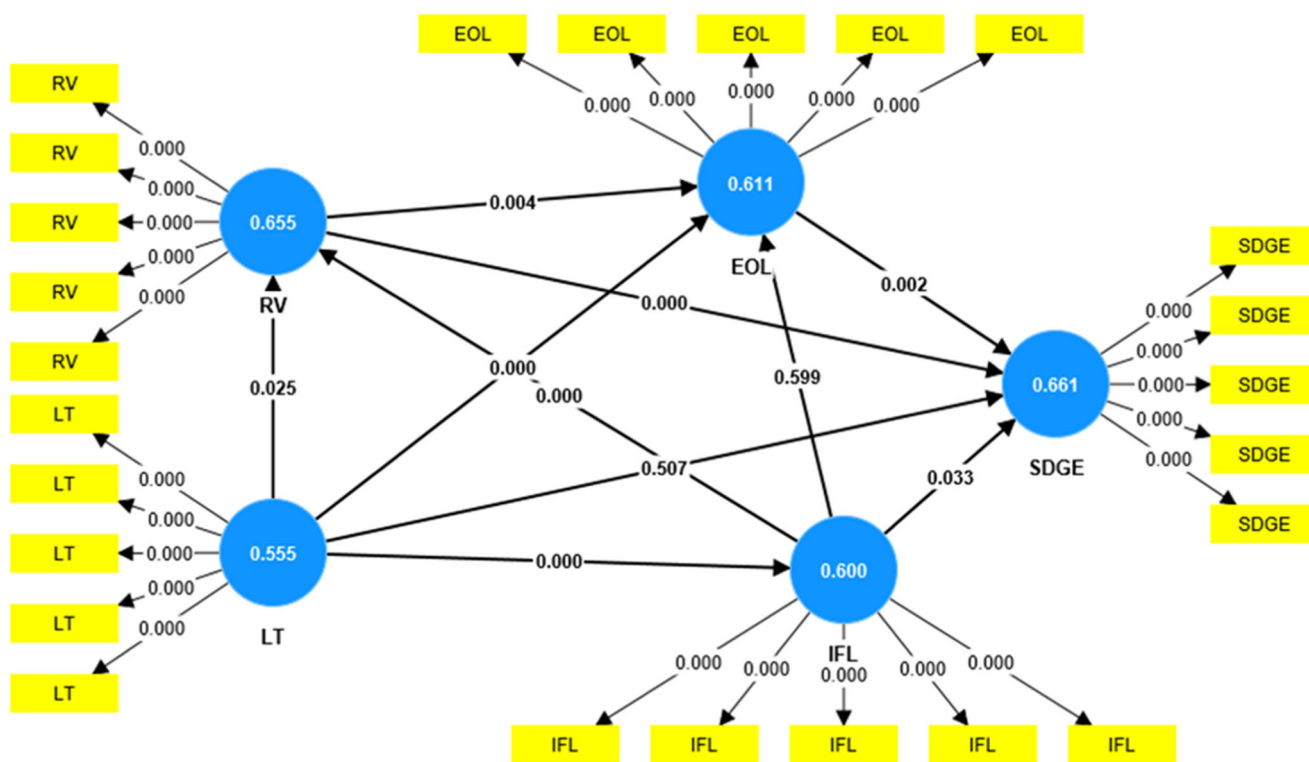


Fig. 3 Bootstrap image for path analysis.

Table 6 Goodness of fit indices.

Fit indices	EM
SRMR	0.055
χ^2	827.724
NFI	0.921

Note: SRMR standardized root mean square residual, χ^2 chi-square, NFI Normed Fit Index, EM estimated. Model

indices fulfilled this criterion. It was the product of several iterations before a satisfactory model was achieved (Asparouhov et al., 2018). The model with the best fit showed an inter-correlation between the scales, or latent factors, as illustrated in Fig. 3. It is assessed using several criteria, which include standardized root mean square residual (SRMR), Chi-square, and Normed Fit Index (NFI). The goodness of fit indices shown in Table 6, such as SRMR = 0.055, Chi-square = 827.724, and NFI = 0.921, indicate that the final model is well-fitted.

Discussion

Since the announcement of the 2030 education plan, substantial educational research has been dedicated to sustainable development integration (Agbedahin, 2019). This study explored inventive leadership styles to integrate and expand SDGs in education. First, four hypotheses were formulated; second, secondary school teachers were used as participants to collect data; third, data were analyzed through various statistical methods.

Further, leadership is the capacity to motivate others to perform toward a shared goal for the future of one’s institution. Leaders express the vision to rally employees and stakeholders behind the school’s aspiration for a brighter future for the school, stakeholders, and its students. Furthermore, Bush and Glover (2016) Bush and Glover (2003) present the three facets of leadership as follows: (1) leadership is an impact process that designs and coordinates the processes of an organization; (2) leadership is correlated with organizational values and people’s commitment to these values; and (3) vision is an indispensable element of effective leadership. Education leadership is not a position but a strategy for impacting the beliefs of one’s colleagues.

However, due to the influence process, the administrative procedures of the institution have changed (including, but not limited to, tracking the teaching process, controlling personnel, and assigning resources) and are more likely to be successful and be valued by all parties involved (students, teachers, parents, society). Nonetheless, the connection between leadership and sustainable development is crucial, as there can only be progress with leadership, especially in the education, social, human, and cultural dimensions. Innovative management and leadership approaches are crucial to sustaining performance and maximizing output (Stafford-Smith et al., 2017).

As the results of the present study show, leadership styles significantly impact the achievement of SDGs in education at the secondary school level. Schools can create a collaborative and inclusive learning environment (Gutberlet, 2021). A strong leadership team can promote innovative approaches, encourage participatory decision-making, and promote a sense of ownership among teachers and students, thus enhancing the overall effectiveness of the education system (Zguir et al., 2021).

Moreover, the UN has established a series of 17 new SDGs to end inequality, hunger, and poverty, battle climate change, and the environment, build effective institutions and partnerships, and increase access to health care and education by 2030 (Keitsch, 2018). Education should emphasize sustainability so future leaders can adapt to a changing world (Acuti et al., 2020).

Previous studies also discussed the importance of inspiring learners (Laurie et al., 2016). So, leaders/educators can foster global awareness, empathy, and critical thinking in students by incorporating the SDGs into secondary education (Harris & De Bruin, 2018). Students can be motivated to become active agents of change and contribute to the sustainable development of their communities by participating in this program (Estrada et al., 2021). Furthermore, integrating real-world issues and engaging students in projects linked to the SDGs makes education more relevant and meaningful, preparing students to meet future challenges (Nguyen et al., 2020).

In addition, the researchers emphasize the significance of developing a resilient vision within the context of the SDGs in education (Gupta & Vegelin, 2016). Through integrating sustainability into educational programs, students and educators develop a forward-thinking perspective that acknowledges and adapts to challenges as they arise. The resilience vision allows us to address social, economic, and environmental obstacles proactively (Xue et al., 2018).

Another significant aspect explored is the potential for integrating the SDGs to have transformative effects (Berrone et al., 2023). By adopting innovative leadership styles aligned with the SDGs, educational institutions can drive systematic change and foster an environment of continuous improvement (Palau-Pinyana et al., 2023). This transformative leadership approach encourages innovation, collaboration, and experimentation within the education system, improving outcomes and longer-term sustainability (Agrawal et al., 2022).

However, SDGs in education can bring about significant changes in secondary schools, mainly leadership. This discussion has highlighted the impact of various inventive leadership styles and their contribution to achieving SDGs in education (Axford et al., 2022).

Limitations and future studies. However, the research has several limitations. First, the sample size is small, consisting of only 89 public secondary schools from Multan, Punjab. The participants were selected from four districts, whereas the province of Punjab consisted of 36 districts. Therefore, the findings cannot be applied nationwide. Future studies can be conducted on a larger

scale to include participants and institutions from additional districts or provinces. Second, only four leadership approaches were selected. An in-depth study can be conducted by investigating alternative leadership styles for accomplishing education's sustainable development objectives.

Conclusion and recommendations

Education must be used to cultivate future leaders and innovators for sustainable development. The SDGs of the UN provide a comprehensive structure for addressing global issues. This study aimed to explore inventive leadership styles and their impact on attaining SDGs in education. The findings elaborated that the four inventive leadership styles (empowerment of leadership, inspiration for the learner, lead transformation, and resilient vision) are vital and significantly impact achieving SDGs in education at the secondary school level. Furthermore, as evident the benefits of integrating SDGs into secondary education, the studies also highlight challenges that must be addressed. The lack of resources, resistance to change, and a need for leaders'/teachers' professional development have been identified as potential obstacles. To overcome these challenges, a collaborative approach among stakeholders, policy support, and innovative practices are recommended. The leaders'/teachers' perspicacity allows them to fathom the suggested strategies for reforming education in order to achieve the goals of the UN 2030 education plan. Such kind of initiative can provide all-encompassing aspects, strategies, and advantages to attaining goals.

Data availability

All data generated or analyzed during this study are contained in the manuscript. Additionally, the rest of the information regarding data has been attached in a supplementary file.

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Author contributions

Samra M: conceptualization, data curation, validation, interpretation, and writing-original draft. HMIZ and ZD: provided valuable insights into the theoretical framework conceptualization, resources, and proofreading. ZPF: supervision, review, and editing. SJ and Sufyan M: actively participated in the manuscript revising for scientific accuracy and ensuring clarity in the methodology section. All authors read and approved the final manuscript.

Competing interests

The authors declare no competing interests.

Ethical approval

This study was approved by the Ethics Committee of Zhejiang Normal University, Jinhua, Zhejiang, China, with ethics approval number “ZSRT2024129”. The research team strictly followed the ethical rules and principles established by the institution throughout the study in order to ensure the responsible and respectful treatment of all participants.

Informed consent

Informed consent was obtained from all participants before data collection. The duration of data collected was four months from November 2022 to March 2023. We approached the participants and elaborated each participant about the purpose of the study, and also ensured that their privacy and personal information would be kept secret. And they would be free to withdraw at any time if they do not want to take part in this survey.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1057/s41599-024-03086-2>.

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