



Perceived Curriculum–Textbook Alignment and Curriculum Implementation Fidelity: The Serial Mediating Roles of Textbook Pedagogical Usability and Teacher Curriculum Self-Efficacy among Middle-School General Science Teachers in Gwadar, Balochistan

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ABSTRACT

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Curriculum reform efforts often face obstacles in classrooms within education systems that are still developing, while theoretical explanations of how curriculum materials translate into classroom implementation remain underdeveloped in developing countries (Alvarado & Galigao, 2024; Dheivamani, 2022). Based on the theory of curriculum alignment, the perspective of participatory use of curriculum, and social cognitive theory, this research empirically investigates a serial mediation model in which perceived curriculum-textbook alignment (PCTA) affects curriculum implementation fidelity (CIF) through textbook pedagogical usability (TPU) and teacher curriculum self-efficacy (TCSE). Data on perceptions of curriculum alignment, textbook usability, teachers' self-efficacy in implementing the curriculum and the degree of its classroom implementation fidelity were collected cross-sectionally through surveys administered to 200 middle school General Science teachers (Grades 6-8) in Gwadar District, Balochistan, Pakistan from both public ($n=200$) schools using the National Curriculum of Pakistan 2022-23 and textbooks of the Balochistan Textbook Board. Structural equation modelling with partial least squares in SmartPLS 4 was performed using 5,000 bootstrapping subsamples. The measurement model showed adequate reliability ($\alpha=.868-.887$; $\rho=.900-.914$) and discriminant validity ($HTMT \leq .666$). PCTA had significant effects on TPU ($\beta=.402$) and TCSE ($\beta=.448$); TPU affected TCSE ($\beta=.361$), and TCSE positively predicted CIF ($\beta=.393$); however, the direct effects of PCTA ($\beta=-.044$) and TPU ($\beta=.021$) on CIF were insignificant. Indirect-only (full) mediation analysis indicated that TCSE mediated the effects of both PCTA ($\beta=.176$) and TPU ($\beta=.142$) on CIF; the serial pathway PCTA $\rightarrow$ TPU $\rightarrow$ TCSE $\rightarrow$ CIF was significant ($\beta=.057$), while TPU alone mediated neither. The model accounted for 46.1% and 14.5% of the variances in TCSE and CIF (SRMR = .054), respectively. This indicates that the alignment and usability of pedagogically appropriate textbooks affect curriculum implementation fidelity via increasing teachers' efficacy in implementing the specific curriculum. Thus, teachers' psychology is shown to be the main mechanism enabling material-related reforms.

Introduction

Any reforms in the curriculum can be deemed important only to the extent to which they are implemented within the classrooms. In all educational systems, the difference between the intended curriculum, embedded in the system's policies, and

the enacted curriculum students experience is perhaps one of the greatest challenges of educational change (Fullan, 2016; Remillard & Heck, 2014). This problem of the intended-enacted gap becomes especially pronounced in developing educational systems where the textbooks become not only one of the possible resources of teaching but, indeed, an operational curriculum: they dictate the order of teaching, set limits for what can be taught and assessed, and sometimes become the curriculum framework itself for teachers' work (Ball & Cohen, 1996; Bhatti et al., 2015). In such cases, when the textbook operationalizes the SLOs of the curriculum framework, it can help implement the framework. Otherwise, it will divert teachers from the intended curriculum.

Indeed, Pakistan provides an important context to study such phenomena. It has launched a series of reforms based on the development of standards, including the National Curriculum 2006, the Single National Curriculum (SNC) 2020, and the National Curriculum of Pakistan (NCP) 2022-23, which uses the outcomes-based approach to organization of the curriculum through progression grids and SLOs (Government of Pakistan, 2023; Shaikh & Benedetti, 2024). Balochistan is known to experience many educational problems, which include low-quality learning results, insufficient resources at school, and implementation issues (Bhutto et al., 2022; Hashmi et al., 2018). In this regard, the Balochistan Textbook Board (BTBB) has created a new Grade 6 General Science textbook, which complies with the National Curriculum of Pakistan for 2022-2023 and was launched as a pilot version at middle schools in Balochistan Province (Bano et al., 2024). However, it has already been demonstrated in previous research on curriculum-textbook alignment in Pakistan that there are many discrepancies between intentions of the national curriculum and the actual content of provincial textbooks (Bano et al., 2024; Bhutto et al., 2022). While implementation studies report that the reform cascading process fragments experiences and lacks resources and support. District Gwadar in the Makran Division of the south coast of Balochistan represents the described phenomenon well enough because its middle schools work with the scattered population on the coastline and in the countryside; science teachers usually work with several grades and have no laboratories, and the textbook is the only accessible tool for instruction in most cases.

In light of the foregoing considerations, the issue of what factors affect curriculum implementation fidelity, or the level of teachers' ability to implement the curriculum according to its intentions regarding adherence, comprehensiveness, quality, and assessment (Carroll et al., 2007; Dusenbury et al., 2003; O'Donnell, 2008), becomes of considerable theoretical and empirical significance. As implementation science has shown, fidelity is the proximal variable that influences the outcome of implementation in achieving its intended effects (Century & Cassata, 2016; Durlak & DuPre, 2008). At the same time, research on curriculum materials has shown that certain characteristics, such as their standardization and pedagogical supportiveness, influence their use by teachers (Davis & Krajcik, 2005; Dröse et al., 2025; Remillard, 2005). Moreover, there exists a separate strand of research, based on social cognitive theory (Bandura, 1977, 1997), proving that teacher self-efficacy is one of the most consistent predictors of the quality of instruction, openness to innovations, and enactment of reforms (Guskey, 1988; Klassen & Tze, 2014; Zee & Koomen, 2016). Recent studies confirm that self-efficacy operates as a key mediating mechanism linking contextual and organizational conditions to teachers' commitment to curriculum implementation (Boudouaia et al., 2024; Xu et al., 2025).

What remains underexplored is the integrative question that sits at the junction of these literatures: through what psychological and pedagogical mechanisms does teachers' perception of curriculum-textbook alignment translate into, or fail to translate into, implementation fidelity? Three gaps motivate the present study. First, Pakistani alignment research has been overwhelmingly document-analytic, mapping SLO coverage between curricula and textbooks (Bano et al., 2024; Hashmi et al., 2018), but it has rarely modeled teachers' perceptions of alignment as a predictor of their implementation behavior, even though it is the perceived rather than the documented curriculum-textbook relationship that operates in teachers' pedagogical reasoning (Remillard, 2005). Second, although textbook quality frameworks identify pedagogical usability, that is, clarity of explanation, activity and inquiry support, and visual design serviceable for classroom use (Cunningsworth, 1995; Leacock & Nesbit, 2007; Tomlinson, 2011), usability has seldom been positioned as an intervening mechanism between alignment and enactment in quantitative models. Third, while individual links such as self-efficacy to fidelity have been documented (Boudouaia et al., 2024; Guskey, 1988), no study to our knowledge has tested a serial mediation chain in which alignment perceptions enhance perceived usability, usability builds curriculum-specific self-efficacy, and self-efficacy in turn drives fidelity, within a single structural model in a South Asian public-school context (Rafaq et al., 2025).

The present study addresses these gaps by developing and testing a serial mediation model among 200 middle-school General Science teachers from public schools in District Gwadar. Specifically, the study pursues three objectives: (a) to examine the direct effects of perceived curriculum-textbook alignment (PCTA), textbook pedagogical usability (TPU), and teacher curriculum self-efficacy (TCSE) on curriculum implementation fidelity (CIF); (b) to test the simple mediating roles of TPU and TCSE in the relationship between PCTA and CIF; and (c) to test the serial mediation pathway $PCTA \rightarrow TPU \rightarrow TCSE \rightarrow CIF$. Correspondingly, the study asks: To what extent does perceived alignment predict usability, self-efficacy, and fidelity? Do usability and self-efficacy transmit the effect of alignment on fidelity individually and in sequence? Furthermore, what is the relative magnitude of these direct and indirect pathways?

The study makes four contributions. Theoretically, it integrates curriculum alignment theory (Porter, 2002; Webb, 1997), the participatory perspective on teacher–curriculum interaction (Remillard, 2005), and social cognitive theory (Bandura, 1997) into a unified psychological-process model of implementation, and it adjudicates empirically between materials-centred and teacher-centred accounts of fidelity. Methodologically, the paper uses PLS-SEM with bootstrapped serial mediation (Hair et al., 2022; Nitzl et al., 2016), which is not feasible in an alignment study based on document analysis. Contextually, the paper provides scarce evidence from the province of Balochistan, particularly the district of Gwadar, a region that is virtually invisible in the international literature on curriculum implementation. In practice, the finding that self-efficacy is the only mediator on the pathway from curriculum material quality to implementation fidelity calls for rethinking policies related to textbook production. It is not enough to produce aligned and usable textbooks; investment in reform should deliberately build teachers' self-efficacy in the process.

The rest of the paper is structured as follows. The next section discusses the theoretical framework and formulates 10 hypotheses, including 3 simple mediation hypotheses and 1 serial mediation hypothesis.

Literature Review and Hypothesis Development

Theoretical Foundations

The study's conceptual model rests on three complementary theoretical traditions. The first is curriculum alignment theory. Porter (2002) conceptualized alignment as the degree of correspondence between the content and cognitive demand of instructional artefacts, curricula, textbooks, instruction, and assessments, and demonstrated that alignment indices predict instructional content coverage. Webb (1997, 1999) elaborated criteria for judging alignment, including categorical concurrence, depth-of-knowledge consistency, range of knowledge, and balance of representation, which have since anchored alignment analyses internationally, including recent applications to Pakistan's SNC and NCP frameworks (Bano et al., 2024; Bhutto et al., 2022). Alignment theory holds that when textbooks operationalize curricular SLOs coherently across content, sequence, cognitive demand, activities, and assessment, the textbook becomes a fidelity-supporting scaffold rather than a competing curriculum (Schmidt et al., 2001). Crucially, however, in the classroom it is the teacher's perception of that alignment which enters pedagogical decision-making; document-level alignment that teachers do not perceive cannot guide their planning (Remillard & Heck, 2014).

The second tradition is the participatory or teacher–curriculum interaction perspective (Remillard, 2005; Stein et al., 2007). This perspective conceptualizes curriculum use as a dynamic transaction between teacher resources (knowledge, beliefs, and efficacy) and material resources (structure, supports, and educative features). Ball and Cohen (1996) argued that curriculum materials could contribute substantially to instructional improvement if designed with teachers' learning in mind, and Davis and Krajcik (2005) formalized this insight in design heuristics for educative curriculum materials. Contemporary evidence confirms that the explicitness and pedagogical supportiveness of materials shape the completeness and depth of teachers' enactment of instructional innovations (Dröse et al., 2025). Within this perspective, textbook pedagogical usability, the clarity of its explanations, the classroom utility of its activities and inquiry supports, and the instructional serviceability of its visuals (Cunningsworth, 1995; Leacock & Nesbit, 2007; Tomlinson, 2011) constitute the material-side mechanism through which alignment becomes practically consequential.

Thirdly, the tradition of social cognitive theory (Bandura, 1977, 1997) provides the mechanism from the teacher's side. Self-efficacy, an individual's belief in his or her ability to organize and carry out actions needed to achieve certain accomplishments, determines the choice of activities, effort allocation, and perseverance in the face of difficulties. In the context of teaching, self-efficacy was operationalized as instructional strategies, student engagement, and classroom management (Tschannen-Moran & Woolfolk Hoy, 2001) and was meta-analytically shown to predict teacher instructional effectiveness and well-being (Klassen & Tze, 2014; Zee & Koomen, 2016). Bandura (1997) identified mastery experiences, vicarious experiences, verbal persuasion, and physiological states as sources of efficacy. Well-designed curriculum materials can nourish the two former efficacy sources through providing success stories and modelling effective teaching practices. Efficacious teachers have been shown by Guskey (1988) to be the most open to adopting new instructional practices, a finding replicated in modern curriculum implementation research (Boudouaia et al., 2024). Teacher curriculum self-efficacy (TCSE) in the current study refers to teacher efficacy beliefs concerning implementing the General Science curriculum: teaching its SLOs, using various teaching strategies, engaging students, and conducting assessment consistent with the curriculum.

Lastly, the dependent construct, curriculum implementation fidelity (CIF), is based on the implementation science approach proposed by Dusenbury et al. (2003), Carroll et al. (2007), and O'Donnell (2008), where fidelity is analyzed from the perspectives of adherence to the desired program, exposure or coverage, delivery quality, and participant responsiveness. The importance of these fidelity aspects in determining the outcomes of educational interventions has been demonstrated by Century and Cassata (2016) and Durlak and DuPre (2008). As a result, by combining these three traditions, the following

research hypothesis emerges: perceived fit (theory of curriculum) works via material fit (participatory tradition) and curriculum-specific efficacy (social cognitive theory) to form implementation fidelity (implementation science). The corresponding theoretical model is provided in Figure 1 below.

Perceived Curriculum–Textbook Alignment and Textbook Pedagogical Usability (H1)

Any textbook that reflects the sequence of the SLOs in the curriculum, follows the same sequence as the curriculum, requires the same level of cognitive engagement in the classroom as the curriculum expects, and has activities and exercises aligned with the curricular objectives would inevitably make teaching from the textbook much easier. Alignment reduces the need for teachers to translate the framework into the lesson, since everything has already been done. Conversely, misaligned materials impose adaptation burdens, forcing teachers to supplement, resequence, or reinterpret content, which degrades the perceived practical usability of the book (Remillard, 2005). Empirically, alignment analyses in Pakistan have repeatedly linked misalignment to teacher-reported difficulties in using textbooks for lesson planning and outcome-based instruction (Bhatti et al., 2015; Bhutto et al., 2022; Hashmi et al., 2018), while research on standards-aligned instructional materials indicates that teachers rate aligned materials as more classroom-serviceable and draw on them more extensively (Dröse et al., 2025; Remillard & Heck, 2014). Perceptually, teachers who judge their textbook to be well aligned should also judge its explanations, examples, activities, and visuals as more pedagogically useful, because alignment is itself a component of instructional utility in outcomes-based systems. Accordingly:

H1. Perceived curriculum–textbook alignment has a significant positive effect on textbook pedagogical usability.

Textbook Pedagogical Usability and Teacher Curriculum Self-Efficacy (H2)

Social cognitive theory specifies the mechanism linking usable materials to efficacy beliefs. Mastery experiences are the most potent source of self-efficacy (Bandura, 1997); textbooks with clear explanations, worked examples that help teachers explain difficult concepts, classroom-ready activities, inquiry supports, and instructive visuals increase the frequency with which lessons succeed, thereby increasing the accumulation of mastery experiences during curriculum enactment. Educative features of materials also provide vicarious experience and cognitive modelling, showing teachers how the curriculum can be taught (Ball & Cohen, 1996; Davis & Krajcik, 2005). Empirical work supports this pathway: teachers supported by explicit, pedagogically elaborated materials enact innovations more completely and report greater confidence in doing so (Dröse et al., 2025), and professional resources that operationalize curricula have been shown to strengthen implementation-related efficacy (Darling-Hammond et al., 2017; Penuel et al., 2007). In low-resource contexts such as Balochistan, where the textbook is often the primary or sole instructional support and professional development is scarce, the textbook's pedagogical quality plausibly carries disproportionate weight in shaping teachers' confidence that they can teach the curriculum as intended. Hence:

H2. Textbook pedagogical usability has a significant positive effect on teacher curriculum self-efficacy.

Teacher Curriculum Self-Efficacy and Curriculum Implementation Fidelity (H3)

Self-efficacy theory predicts that efficacious teachers set more ambitious enactment goals, persist through implementation difficulties, and remain receptive to prescribed innovations rather than retreating to familiar routines (Bandura, 1997; Guskey, 1988). A substantial body of evidence supports the efficacy–fidelity link. Efficacious teachers implement reform curricula more faithfully and adapt less destructively (Zee & Koomen, 2016); early childhood teachers with higher efficacy for instructional strategies and student engagement report higher fidelity to mandated curricula, and self-efficacy has emerged as a consistent individual-level predictor of implementation dosage and responsiveness in curriculum intervention research (Century & Cassata, 2016; Durlak & DuPre, 2008). Most directly, Boudouaia et al. (2024) found that self-efficacy significantly transmitted school-context effects onto teachers' commitment to curriculum implementation among 533 middle-school teachers, and recent PLS-SEM studies confirm efficacy's role as a proximal driver of instruction-related outcomes (Arthur et al., 2025; Wang et al., 2024; Zhi et al., 2024). In the present context, teachers confident in teaching to SLOs, varying strategies, engaging students, and assessing against outcomes should adhere more closely to the intended General Science curriculum, cover its content within planned time, use recommended methods, and assess in curriculum-consistent ways. Therefore:

H3. Teacher curriculum self-efficacy has a significant positive effect on curriculum implementation fidelity.

Perceived Curriculum–Textbook Alignment and Teacher Curriculum Self-Efficacy (H4)

Alignment not only affects curriculum enactment efficacy indirectly by influencing usability but may also directly provide an additional boost to teachers' self-efficacy related to curricular implementation. If teachers perceive the textbook and curriculum as integrated into a coherent system, then implementing this curriculum appears more feasible to them. The goals are clear, the resources match the goals, and the evaluation process is predictable. All these reduce ambiguity in the task and improve teachers' self-assessments of their abilities to achieve it (Bandura, 1997). At the same time, verbal persuasion and system signals

are of great importance. Alignment research notes that incoherent intended–enacted–assessed systems undermine teachers’ sense of instructional control (Porter, 2002; Webb, 1999), and implementation studies of Pakistan’s recent reforms report that perceived incoherence among curriculum documents, textbooks, and examinations erodes teachers’ confidence in outcome-based teaching (Jan et al., 2023). Thus:

H4. Perceived curriculum–textbook alignment has a significant positive effect on teacher curriculum self-efficacy.

Perceived Curriculum–Textbook Alignment and Curriculum Implementation Fidelity (H5)

Alignment theory’s central practical claim is that aligned instructional systems produce instruction closer to the intended curriculum (Porter, 2002; Schmidt et al., 2001; Webb, 1997). If the textbook is the operational curriculum, then a teacher who follows an aligned textbook is, ipso facto, implementing the intended curriculum with greater adherence and coverage. Perceived alignment should therefore exhibit a positive total association with fidelity, and prior cross-sectional evidence links coherent materials to standards-consistent instruction (Remillard & Heck, 2014). Whether this association survives as a direct effect once the intervening pedagogical and psychological mechanisms (TPU, TCSE) are modeled is precisely the theoretical question the serial mediation design adjudicates: a materials-determinist account predicts a residual direct path, whereas a process account predicts that alignment’s influence is fully carried by usability and efficacy. Consistent with alignment theory’s baseline expectation, we hypothesize:

H5. Perceived curriculum–textbook alignment has a significant positive direct effect on curriculum implementation fidelity.

Textbook Pedagogical Usability and Curriculum Implementation Fidelity (H6)

Usable materials lower the cost of faithful enactment. Clear explanations reduce preparation load, ready-made activities enable the delivery of prescribed pedagogy, and aligned exercises make curriculum-consistent assessment convenient; teachers should therefore find it easier to achieve adherence, coverage, and quality of delivery with pedagogically usable textbooks (Cunningsworth, 1995; Davis & Krajcik, 2005; Tomlinson, 2011). Implementation research views the quality and supportiveness of the program’s material resources as an implementation facilitator linked to greater fidelity (Century & Cassata, 2016; Durlak & DuPre, 2008), whereas enactment research finds more comprehensive implementation in the presence of high-quality material resources (Dröse et al., 2025). On the other hand, the participatory paradigm reminds us that materials cannot instruct but must be used by teachers, with efficacy and beliefs guiding enactment (Remillard, 2005), implying that the influence of usability will largely operate through efficacy. Keeping the direct proposition for empirical testing:

H6. Textbook pedagogical usability has a significant positive direct effect on curriculum implementation fidelity.

The Mediating Role of Textbook Pedagogical Usability (H7)

Given that alignment facilitates usability (H1) and that usability facilitates fidelity (H6), TPU is bound to mediate some of the effect of PCTA on CIF. The mediation model above illustrates the materiality-based path, as alignment is crucial to implementation because it enhances the book’s usability as a pedagogical instrument. The materiality-based logic is consistent with the theory of educative materials, which claims that the instructional impact of curriculum material stems from their utility as teaching materials (Ball & Cohen, 1996; Davis & Krajcik, 2005; Dröse et al., 2025). Thus:

H7. Textbook pedagogical usability mediates the relationship between perceived curriculum–textbook alignment and curriculum implementation fidelity.

The Mediating Role of Teacher Curriculum Self-Efficacy Between Alignment and Fidelity (H8)

The teacher-level mechanism suggests that alignment increases fidelity by improving curriculum self-efficacy (H4), which, in turn, leads to fidelity (H3). Social Cognitive Theory states that the effects of the structures of the environment on behavior mainly take place through their effect on personal agency of the individual – his/her self-efficacy (Bandura, 1997). The literature on mediation research consistently emphasizes that self-efficacy is an intermediate variable between contextual factors and implementation and instructional behaviours (Boudouaia et al., 2024; Li & Liu, 2022; Xu et al., 2025). Thus, it can be argued that:

H8. Teacher curriculum self-efficacy mediates the relationship between perceived curriculum–textbook alignment and curriculum implementation fidelity.

The Mediating Role of Teacher Curriculum Self-Efficacy Between Usability and Fidelity (H9)

Further to the above, the factor of usability promotes fidelity through efficacy: it leads to mastery and modelling experiences, thereby enabling the confidence to sustain fidelity (H2-H3). It is for this reason that the claim about the participatory perspective, wherein the instructional value of material affordances can only be realized with enough resources to enable them, comes to fruition (Remillard, 2005; Stein et al., 2007). Hence:

H9. Teacher curriculum self-efficacy mediates the relationship between textbook pedagogical usability and curriculum implementation fidelity.

The Serial Mediation Hypothesis (H10)

Complete theoretical integration is manifested through a three-step process. First, when perception of alignment is greater, the textbook's pedagogical usability improves accordingly—alignment theory being an addition and an enrichment to the participatory perspective on learning and education. Second, this greater usability increases self-efficacy in the curriculum because the materials become a source of efficacy from a social cognitive theory perspective. Third, increased efficacy results in fidelity driven by agency beliefs in the enactment, as defined in implementation science. Serial mediation models, in which an environmental/material antecedent acts through a proximal resource and then through a psychological capability to impact behaviour, are widely recognized constructs in modern educational research. Such studies typically use PLS-SEM/bootstrap methods to estimate indirect effects (Arthur et al., 2025; Boudouaia et al., 2024; Xu et al., 2025). Testing the three-path indirect effect PCTA → TPU → TCSE → CIF against simple mediations will allow us to establish whether the mediation sequence from alignment to fidelity is inherent, with the quality of the materials as the first step and teachers' confidence as the second. Our hypothesis is:

H10. Textbook pedagogical usability and teacher curriculum self-efficacy serially mediate the relationship between perceived curriculum-textbook alignment and curriculum implementation fidelity (PCTA → TPU → TCSE → CIF).

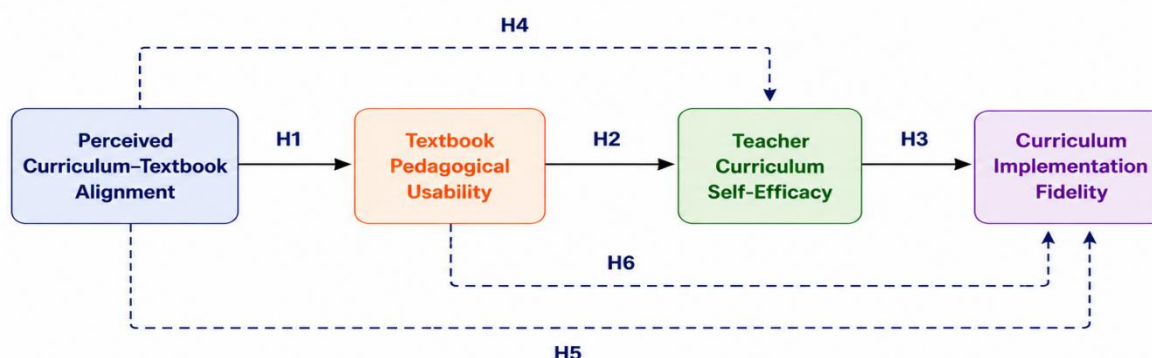
Conceptual Framework

Figure 1 illustrates the elaborated version of the suggested theoretical model. Under this scheme, PCTA will be treated as an exogenous variable, whereas TPU and TCSE will serve as serial mediators between PCTA and the endogenous variable, CIF. The main serial paths in the suggested theoretical model are shown in solid lines, reflecting backbone hypotheses H1, H2, and H3 that describe the process of mediation in question. Dashed lines are used to represent additional direct relationships, reflecting hypotheses H4, H5, and H6. In addition, hypotheses H7 to H10 refer to the specific indirect effects observed in the model under consideration.

The suggested model is analyzed in the unified analysis, so the influence of each path is assessed relative to all others. Such an approach helps decompose the total effect of PCTA on CIF into direct and mediated components, as presented in the literature (Nitzl et al., 2016; Zhao et al., 2010).

Figure 1: Research Conceptual Framework

Research Conceptual Framework



Methodology

Research Design and Philosophical Orientation

The study followed a quantitative, cross-sectional, correlational survey design, grounded in a postpositivist perspective, suitable for evaluating theory-based relationships among latent constructs (Kline, 2023). Since the purpose of the study was to determine a predictive serial mediation model using latent variables and to obtain optimal statistical power of the indirect effects in a limited population sample, PLS-SEM was chosen as the analysis method (Hair et al., 2019, 2022). It is suggested to use PLS-SEM when the purpose of research involves modeling a structural theory using composites, when there is a need to have multiple mediations in the model, and when it is critical to have maximum variance explained in the endogenous constructs (Becker et al., 2023; Sarstedt et al., 2021).

Research Context

This research was carried out in District Gwadar, one of the coastal districts in the Makran Division of Balochistan, Pakistan, which includes four tehsils: Gwadar, Pasni, Jiwani, and Ormara. Middle Schools in the said district are following the General Science curriculum for Grades 6-8 as per the National Curriculum of Pakistan 2022-23, using books provided by the Balochistan Textbook Board, according to the NCP progression grid and SLOs. The pilot edition of the book is also being used as part of ongoing reforms. The textbooks approved by the Board are used in public schools in this district.

Population, Sample, and Procedure

The target population consisted of general science teachers in the District Gwadar who had been teaching grades 6, 7, or 8 during the 2025-26 school year in public schools that use the sanctioned curriculum and books. With the help of the District Education Office and the school administrations, a list of eligible teachers was prepared, and then eligible teachers in all four tehsils were contacted. Questionnaire data were collected in person by the researcher and trained assistants during school visits and cluster meetings. The questionnaire was conducted in English, with verbal clarification on request. Among the questionnaires distributed, 200 completed and valid responses were retained for analysis.

A total of 200 cases in the achieved sample exceed all relevant adequacy criteria. According to the power analysis conducted with G*Power 3.1 (Faul et al., 2009), a sample of 119 is sufficient to detect a small-to-moderate effect ($f^2 = .15$) with power = .95 and $\alpha = .05$ when there are at most three predictors for any endogenous variable in the model; similarly, the inverse square root approach shows that with $N = 200$, the study is adequately powered to detect standardized path coefficients of at least .18 (Hair et al., 2022), which is less than any substantively interesting path proposed in the research model. The achieved sample size also comfortably meets the ten-times rule.

As shown in Table 1, participants were predominantly from public schools ($n = 200$, 100%). The sample included 117 male (58.5%) and 83 female (41.5%) teachers. Ages were distributed across 25-30 years ($n = 68$, 34.0%), 31-35 years ($n = 76$, 38.0%), and 36-40 years ($n = 56$, 28.0%). Teachers taught Grade 6 ($n = 53$, 26.5%), Grade 7 ($n = 47$, 23.5%), Grade 8 ($n = 46$, 23.0%), or multiple grades ($n = 54$, 27.0%). Academic qualifications were B.Sc ($n = 113$, 56.5%) or B. A ($n = 87$, 43.5%), and most held a B.Ed professional qualification ($n = 163$, 81.5%), with the remainder reporting other professional credentials ($n = 37$, 18.5%). All respondents taught General Science.

Table 1: Demographic Profile of Respondents (N = 200)

Characteristic	Category	n	%
School type	Public	200	100
Gender	Male	117	58.5
	Female	83	41.5
Age (years)	25-30	68	34.0
	31-35	76	38.0
	36-40	56	28.0
Grade taught	Grade 6	53	26.5
	Grade 7	47	23.5
	Grade 8	46	23.0
	Multiple grades	54	27.0

Characteristic	Category	n	%
Academic qualification	B.Sc	113	56.5
	B.A	87	43.5
Professional qualification	B.Ed	163	81.5
	Other	37	18.5

Note. All respondents were General Science teachers in District Gwadar (Grades 6–8).

Instrumentation

Data were collected using a researcher-adapted, 24-item, structured questionnaire measuring the four constructs, each with six items, on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). All constructs were specified as reflective composites. Perceived curriculum–textbook alignment (PCTA) items covered SLO and content alignment, sequence and cognitive-demand alignment, and activity and assessment alignment, adapted from the alignment frameworks of Porter (2002) and Webb (1997, 1999) and the EQUIP science rubric (Achieve, 2014); a sample item is “The General Science textbook content reflects the curriculum Student Learning Outcomes (SLOs).” Textbook pedagogical usability (TPU) items covered clarity and explanation quality, teaching-activity and inquiry support, and visual design and practical classroom use, adapted from Cunningsworth (1995), Tomlinson (2011), and the Learning Object Review Instrument criteria of Leacock and Nesbit (2007); a sample item is “The textbook supports inquiry-based and hands-on science teaching.” Teacher curriculum self-efficacy (TCSE) items covered instructional-strategy, student-engagement, and assessment-and-adaptation efficacy, adapted from Bandura (1997) and Tschannen-Moran and Woolfolk Hoy (2001) to the curriculum-specific referent; a sample item is “I can teach General Science according to the curriculum learning outcomes.” Curriculum implementation fidelity (CIF) items covered adherence to the intended curriculum, exposure and quality of delivery, and student responsiveness with aligned assessment, adapted from Dusenbury et al. (2003), Carroll et al. (2007), and O'Donnell (2008); a sample item is “I follow the prescribed curriculum learning outcomes while teaching science lessons.”

The adapted instrument underwent expert review by three specialists in curriculum studies and educational measurement for content validity and contextual appropriateness, followed by pilot testing with a small group of teachers from the adjoining Kech District to confirm clarity; minor wording refinements were made. Psychometric adequacy in the main study was subsequently established through the PLS-SEM measurement model assessment reported below.

Common Method Bias

As all constructs were measured using self-reports by the same individuals within the same sitting, both procedural and statistical methods to address common method variance were employed (Podsakoff et al., 2003; Podsakoff et al., 2024). From a procedural point of view, respondent anonymity was ensured, distinct instructions separated blocks of questions, and questions were framed in concrete terms in relation to the particular curriculum and textbook to minimize evaluation apprehension and ambiguity. From a statistical perspective, a full collinearity test was carried out (Kock, 2015). All internal variance inflation factors ranged from 1.000 to 1.855, well below the conservative cut-off point of 3.3, indicating that common-method bias does not threaten the results.

Ethical Considerations

The institution's ethical guidelines were strictly followed throughout the research process. Before conducting the research, permission from the district education authorities, the administrations, and the principals of the participating schools was obtained. Moreover, informed consent of each participant was obtained in writing following a thorough explanation of the aims and objectives of the research study. It was completely voluntary, with participants receiving no monetary benefits and the right to withdraw at any stage of the research process. The most important aspect is that no personal data were collected in the study.

Data Analysis Strategy

The analysis followed the two-step procedure recommended for PLS-SEM (Hair et al., 2022) in SmartPLS 4 (Ringle et al., 2024). The measurement model was checked for the reliability of indicators (loadings $\geq .708$), consistency (Cronbach's α , ρ_A , $pc > .95$), convergent validity (AVE $\geq .50$), and discriminant validity (Fornell–Larcker criterion, Fornell & Larcker, 1981; HTMT $< .85$, Henseler et al., 2015; Dijkstra & Henseler, 2015). Next, the structural model was examined for collinearity (VIF), path significance with bootstrapping with 5,000 samples and percentile confidence intervals, explanatory power (R^2 , f^2 ; Cohen, 1988), and goodness-of-fit (SRMR; Henseler et al., 2015). Mediation was established by the bootstrap distribution of the particular indirect effect, not by the causal-steps procedure (Preacher & Hayes, 2008; Zhao et al., 2010) in accordance with

PLS-SEM mediation recommendations (Nitzl et al., 2016) and mediating role typology (complementary, competitive, or indirect-only) (Hayes, 2022; Zhao et al.,

Results

Descriptive Statistics

The construct-level descriptive statistics have been provided in Table 2. The mean scores were centered at the middle of the range for the scale with textbook pedagogical usability scoring the highest ($M = 3.04$, $SD = 0.67$) and curriculum implementation fidelity the lowest ($M = 2.95$, $SD = 0.60$) suggesting that the science teachers of Gwadar perceive moderate level of alignment, usability, and efficacy but only moderate level of fidelity, which is indicative of an early-stage reform setting. Both skewness (0.04 to 0.27) and kurtosis (-0.33 to 0.43) were far below 2 and 7, respectively, suggesting no violation of the normality assumption. However, PLS-SEM is inherently distribution-free due to its use of nonparametric bootstrapping (Hair et al., 2022).

Table 2: Construct Descriptive Statistics (N = 200)

Construct	M	SD	Skewness	Kurtosis
Perceived curriculum–textbook alignment (PCTA)	3.01	0.60	0.27	0.43
Textbook pedagogical usability (TPU)	3.04	0.67	0.04	−0.33
Teacher curriculum self-efficacy (TCSE)	3.01	0.62	0.25	0.15
Curriculum implementation fidelity (CIF)	2.95	0.60	0.16	−0.11

Note. Constructs scored as the mean of six items on a 1–5 scale.

Measurement Model Assessment

Table 3 reports the reflective measurement model results. All 24 indicator loadings ranged from .729 (CIF2) to .831 (TCSE2), exceeding the .708 benchmark and demonstrating that each construct explains more than half of every indicator's variance. Internal consistency was satisfactory throughout: Cronbach's α ranged from .868 (CIF) to .887 (TCSE), ρ_A from .887 to .888, and composite reliability ρ_c from .900 to .914, values comfortably within the recommended .70 to .95 band and free of the redundancy concerns associated with excessively high reliabilities (Hair et al., 2019). Convergent validity was established with AVE values of .600 (CIF), .635 (PCTA), .636 (TPU), and .640 (TCSE), all above the .50 criterion (Fornell & Larcker, 1981).

Table 3: Measurement Model: Loadings, Reliability, and Convergent Validity

Construct	Items	Loadings range	α	ρ_A	ρ_c	AVE
PCTA	6	.763–.818	.885	.887	.912	.635
TPU	6	.765–.815	.885	.887	.913	.636
TCSE	6	.772–.831	.887	.888	.914	.640
CIF	6	.729–.814	.868	.888	.900	.600

Note. All loadings significant at $p < .001$ (bootstrap $t \geq 15.83$). α = Cronbach's alpha; ρ_A and ρ_c = composite reliability; AVE = average variance extracted.

Discriminant validity was assessed with the Fornell–Larcker criterion and the HTMT ratio. As Table 4 shows, the square root of each construct's AVE (diagonal) exceeded its correlations with all other constructs. Table 5 shows that all HTMT values, from .212 (PCTA–CIF) to .666 (TCSE–PCTA), fell below even the conservative .85 threshold (Henseler et al., 2015), and bootstrap confidence intervals excluded 1. The four constructs are therefore empirically distinct.

Table 4: Discriminant Validity: Fornell–Larcker Criterion

Construct	CIF	PCTA	TCSE	TPU
CIF	.774			
PCTA	.198	.797		
TCSE	.378	.593	.800	
TPU	.216	.402	.541	.797

Note. Diagonal values are square roots of AVE; off-diagonal values are latent variable correlations.

Table 5: Discriminant Validity: Heterotrait–Monotrait Ratio (HTMT)

Construct pair	HTMT
PCTA – CIF	.212
TCSE – CIF	.414
TCSE – PCTA	.666
TPU – CIF	.233
TPU – PCTA	.447
TPU – TCSE	.608

Note. All values below the conservative .85 criterion (Henseler et al., 2015).

Structural Model Assessment

Collinearity diagnostics preceded path evaluation: inner VIF values ranged from 1.000 (PCTA → TPU) to 1.855 (TCSE → CIF), far below 3, indicating no collinearity concerns and, per the full collinearity logic, no evidence of method bias contamination (Hair et al., 2019; Kock, 2015). Overall model fit was acceptable, with SRMR = .054 for both the saturated and estimated models, comfortably under the .08 benchmark (Henseler et al., 2015); the accompanying descriptive fit statistics were $d_{ULS} = .866$, $d_G = .305$, and NFI = .868, the last approaching the .90 guideline typically cited for covariance-based indices and reported here for completeness.

The model explained meaningful variance in the mediators and outcome: $R^2 = .162$ for TPU (adjusted $R^2 = .158$), $R^2 = .461$ for TCSE (adjusted $R^2 = .455$), and $R^2 = .145$ for CIF (adjusted $R^2 = .132$), representing respectively weak-to-moderate, moderate-to-substantial, and weak-to-moderate explanatory power by conventional standards (Cohen, 1988; Hair et al., 2022). Effect sizes (f^2) showed that PCTA exerted a medium-to-large effect on TCSE ($f^2 = .312$) and a medium effect on TPU ($f^2 = .193$), TPU a medium effect on TCSE ($f^2 = .203$), TCSE a small-to-medium effect on CIF ($f^2 = .097$), and PCTA and TPU essentially null direct effects on CIF ($f^2 = .001$ and $.000$).

Hypothesis Testing: Direct Effects

Table 6 presents the bootstrap results for the six direct paths, and Figure 2 displays the estimated model. Four direct hypotheses were supported. PCTA strongly predicted TPU ($\beta = .402$, $t = 6.841$, $p < .001$, 95% CI [.288, .520]), supporting H1. TPU significantly predicted TCSE ($\beta = .361$, $t = 7.008$, $p < .001$, 95% CI [.258, .460]), supporting H2. TCSE significantly predicted CIF ($\beta = .393$, $t = 4.464$, $p < .001$, 95% CI [.221, .563]), supporting H3, and constituted the only significant proximal predictor of fidelity. PCTA also directly predicted TCSE ($\beta = .448$, $t = 8.037$, $p < .001$, 95% CI [.334, .556]), supporting H4.

In contrast, the direct path from PCTA to CIF was near zero and nonsignificant ($\beta = -.044$, $t = 0.608$, $p = .544$, 95% CI [-.189, .095]), so H5 was not supported as a direct effect, although PCTA's total effect on CIF was positive and significant ($\beta = .198$, $t = 3.222$, $p = .001$, 95% CI [.078, .321]). Likewise, the direct path from TPU to CIF was nonsignificant ($\beta = .021$, $t = 0.251$, $p = .802$, 95% CI [-.139, .192]), so H6 was not supported, although TPU's total effect on CIF was significant ($\beta = .163$, $t = 2.211$, $p = .027$, 95% CI [.018, .312]). The divergence between null direct effects and significant total effects foreshadows the mediation findings.

Table 6: Structural Model: Direct Effects (5,000 Bootstrap Subsamples)

Hypothesis	Path	β	SE	t	p	95% CI	Decision
H1	PCTA → TPU	.402	.059	6.841	< .001	[.288, .520]	Supported
H2	TPU → TCSE	.361	.052	7.008	< .001	[.258, .460]	Supported
H3	TCSE → CIF	.393	.088	4.464	< .001	[.221, .563]	Supported
H4	PCTA → TCSE	.448	.056	8.037	< .001	[.334, .556]	Supported
H5	PCTA → CIF	-.044	.072	0.608	.544	[-.189, .095]	Not supported
H6	TPU → CIF	.021	.084	0.251	.802	[-.139, .192]	Not supported

Note. β = standardized path coefficient; CI = percentile bootstrap confidence interval.

Hypothesis Testing: Mediation and Serial Mediation

Table 7 reports the specific indirect effects. The total indirect effect of PCTA on CIF was significant ($\beta = .241$, $t = 4.916$, $p < .001$, 95% CI [.157, .348]), accounting for the entirety of PCTA's total effect (.198) under the null, with a slightly negative direct path. Decomposition showed three significant specific pathways and one nonsignificant pathway. The simple mediation through TPU alone (PCTA $\rightarrow$ TPU $\rightarrow$ CIF) was nonsignificant ($\beta = .008$, $t = 0.242$, $p = .809$, 95% CI [-.054, .084]); H7 was therefore not supported. The simple mediation through TCSE (PCTA $\rightarrow$ TCSE $\rightarrow$ CIF) was significant ($\beta = .176$, $t = 3.832$, $p < .001$, 95% CI [.094, .272]), supporting H8 and constituting the largest single conduit of alignment's influence. TCSE also significantly mediated the TPU-CIF relationship (TPU $\rightarrow$ TCSE $\rightarrow$ CIF: $\beta = .142$, $t = 3.590$, $p < .001$, 95% CI [.073, .227]), supporting H9. Critically, the hypothesized serial pathway PCTA $\rightarrow$ TPU $\rightarrow$ TCSE $\rightarrow$ CIF was significant ($\beta = .057$, $t = 3.064$, $p = .002$, 95% CI [.027, .100]), supporting H10; the two-step chain PCTA $\rightarrow$ TPU $\rightarrow$ TCSE feeding this pathway was likewise significant ($\beta = .145$, $t = 4.712$, $p < .001$, 95% CI [.092, .212]).

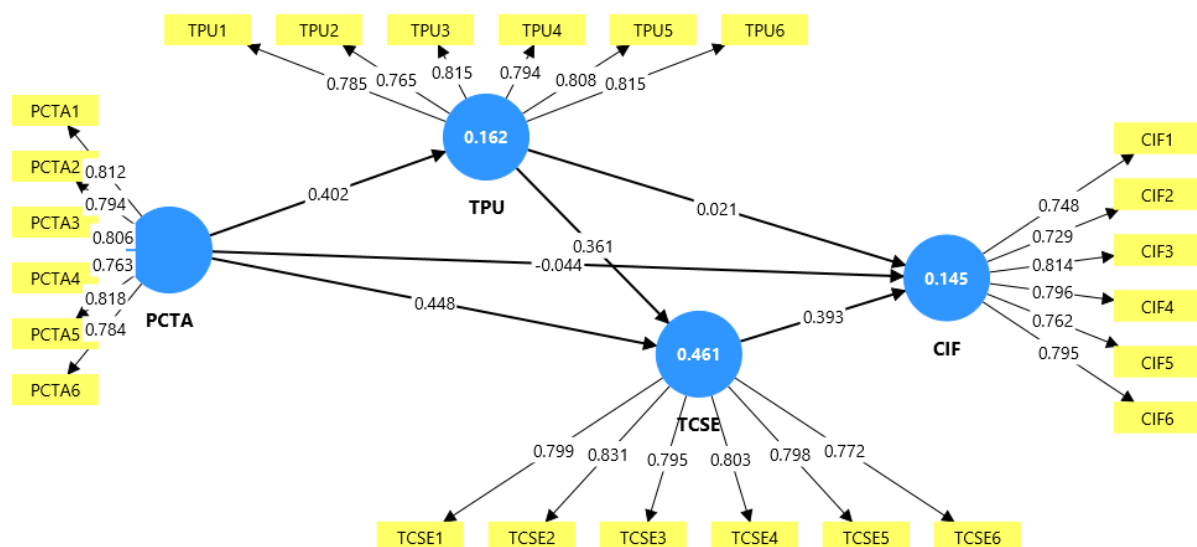
Since the direct effects of both PCTA and TPU on CIF were insignificant, but the indirect effect through TCSE was significant, the model falls under the indirect-only mediation model of Zhao et al. (2010), in which TCSE entirely mediates the effects of both alignment perceptions and textbook usability on implementation fidelity. Almost 72.9% of the mediated effect of PCTA was channelled through TCSE, 23.6% through the serial TPU-TCSE mediation path, and an insignificant proportion via the TPU-only path.

Table 7: Mediation Analysis: Specific and Total Indirect Effects (5,000 Bootstrap Subsamples)

Hypothesis	Indirect path	β	SE	t	p	95% CI	Decision
H7	PCTA $\rightarrow$ TPU $\rightarrow$ CIF	.008	.035	0.242	.809	[-.054, .084]	Not supported
H8	PCTA $\rightarrow$ TCSE $\rightarrow$ CIF	.176	.046	3.832	< .001	[.094, .272]	Supported
H9	TPU $\rightarrow$ TCSE $\rightarrow$ CIF	.142	.040	3.590	< .001	[.073, .227]	Supported
H10	PCTA $\rightarrow$ TPU $\rightarrow$ TCSE $\rightarrow$ CIF	.057	.019	3.064	.002	[.027, .100]	Supported
—	PCTA $\rightarrow$ TPU $\rightarrow$ TCSE	.145	.031	4.712	< .001	[.092, .212]	Significant
—	Total indirect: PCTA $\rightarrow$ CIF	.241	.049	4.916	< .001	[.157, .348]	Significant

Note. Given nonsignificant direct effects of PCTA and TPU on CIF, significant indirect effects indicate indirect-only (full) mediation (Zhao et al., 2010).

Figure 2: Estimated Structural Model with Outer Loadings, Path Coefficients, and R² Values



Summary of Hypothesis Tests

Ten hypotheses were examined throughout the research process, and seven proved valid. First, the theoretical model's sequential structure (H1, H2, and H3) was confirmed, indicating that the sequence was correct. Second, the alignment-efficacy relationship (H4), along with the two other mediations centred around the concept of efficacy (H8 and H9), was confirmed. Third, the serial mediation hypothesis (H10) was also correct.

However, some direct relationships failed to hold up empirically: H5 (alignment-fidelity direct relationship) and H6 (usability-fidelity direct relationship), as well as H7 (the mediating role of usability). Although these results may seem unexpected at first glance, the text below provides an extensive explanation of how they are consistent with the theory.

Discussion

In District Gwadar, the current study sought to explicate how the perceptions of General Science teachers in middle schools regarding curriculum-textbook alignment influence implementation fidelity, employing a serial mediation model via textbook pedagogical usability and teacher curriculum self-efficacy. Findings produce a cohesive and theoretically meaningful narrative whereby alignment is extremely important for implementation but only through teachers' perception: perceptions of alignment affect both the usability of teachers' textbook and their curriculum self-efficacy; usability affects self-efficacy too; and only self-efficacy leads to implementation fidelity, which is not affected by alignment or usability when self-efficacy is controlled.

A strong path from PCTA to TPU (H_1 , $\beta = .402$) validates the tenet of alignment theory that the coherence of the curriculum and textbook is a usability characteristic, not mere documentation (Porter, 2002; Webb, 1997). Perceiving the BTBB General Science textbook as reflecting SLOs, having logical sequencing of contents, meeting cognitive demands, and being in line with activities with respect to assessment criteria translated into teachers' substantial evaluation of the book as more serviceable for explanation, activity generation, and lesson planning, with alignment accounting for approximately a sixth of the variability in usability ($R^2 = .162$). This perceptual relationship goes beyond Pakistani document-analytic evidence (Bano et al., 2024; Bhutto et al., 2022; Hashmi et al., 2018) in proving that alignment was also important to teachers as a property of the textbook material.

Results on efficacy formation (H_2 and H_4) are fully consistent with Bandura's (1997) source framework. PCTA and TPU together accounted for almost half of the variability in teachers' curriculum self-efficacy ($R^2 = .461$), with alignment ($\beta = .448$) and usability ($\beta = .361$) producing medium-to-large independent effects ($f^2 = .312$ and $.203$). In terms of sources of efficacy, a coherent curriculum-textbook system makes an enactment task sensible and feasible, serving as an environmental signal, whereas a pedagogically usable textbook generates mastery experiences and offers models of effective teaching – these are the exact mechanisms discussed in relation to educative materials in the relevant literature (Ball & Cohen, 1996; Davis & Krajcik, 2005; Dröse et al., 2025). The high explanatory power of these material characteristics in this context can be attributed to the resource ecology in Gwadar, where professional development occurs episodically, and laboratories are rare, making textbooks the predominant efficacy-related artefact in teachers' professional environment.

Confirming H_3 (TCSE $\rightarrow$ CIF, $\beta = .393$) adds to the evidence from implementation studies on the association between efficacious teachers and higher fidelity levels (Boudouaia et al., 2024; Guskey, 1988; Zee & Koomen, 2016). Confidence in teaching to SLOs, varied instructional strategies, engaging students, and assessing in relation to SLOs led teachers to report higher levels of adherence, coverage, delivery quality, and aligned assessment. The moderate R^2 for CIF (.145) appears theoretically justified, as fidelity also depends on structural limitations, time, class size, supervision, and exam pressure, which were not controlled in the present model; other psychological models of implementation produced similar estimates (Boudouaia et al., 2024).

The most distinctive contribution lies in the mediation architecture. The nonsignificant direct paths from PCTA (H_5) and TPU (H_6) to CIF, combined with significant efficacy-routed indirect effects (H_8 , H_9) and a significant serial pathway (H_{10}), establish indirect-only, or full, mediation (Zhao et al., 2010). Alignment's significant total effect on fidelity ($\beta = .198$) is carried entirely by mediated channels (total indirect $\beta = .241$), of which the TCSE-only route is dominant ($\beta = .176$) and the serial TPU $\rightarrow$ TCSE route substantial ($\beta = .057$), while the TPU-only route is null (H_7 , $\beta = .008$). Three interpretive conclusions follow. First, the findings adjudicate against a materials-determinist reading of alignment theory: a well-aligned, highly usable textbook does not, by itself, discipline classroom enactment. This aligns with the participatory perspective's insistence that curriculum use is a transaction in which teacher resources are decisive (Remillard, 2005; Stein et al., 2007), and with enactment evidence that material affordances require teacher uptake to become instructional realities (Dröse et al., 2025). Second, self-efficacy is not just another mediator among others but rather the mandatory step connecting the material system to fidelity; alternative routes around it, through alignment, through usability, or through usability alone as the single mediator, fail to connect to the result. The recent discoveries about mediation in curriculum implementation studies (Boudouaia et al., 2024; Xu et al., 2025) are advanced by the fact that, within this one theory, the psychological mediator absorbs all the impact that can be gained from the material mediators. Finally, the important sequential chain shows the process's sequence: alignment's effectiveness gains some of its value via an indirect route, first improving the textbook's usability and thereby raising confidence. Alignment thus acts on fidelity twice indirectly, by usability and efficacy sequentially, and once indirectly, by efficacy alone, never directly.

In this context, the direct path from the null TPU to CIF warrants special consideration, given policy interest in the textbook's quality as a channel for implementation. One such explanation is that usability and its behavioural implications are incorporated into efficacy because usability affects fidelity only to the extent that it influences teachers' beliefs about what they can accomplish; a usable but unconvincing textbook offers ease of use without adherence. Alternatively, the explanation may be

measurement-based: CIF, as measured in this case, stresses curricula-referenced behaviours (adherence to SLOs, recommended instructional methods, assessment), which are agency- and belief-based, whereas usability, being mechanical in its time savings, could affect unmeasured aspects of practice. In either case, the implication is that textbook improvements should not be expected to yield any improvements in fidelity metrics in situations such as those of Balochistan.

Lastly, the profile described – mean levels of all constructs near the midpoint, fidelity lowest ($M = 2.95$) – in and of itself provides valuable diagnostic information for the NCP rollout in 2022–2023. Gwadar science teachers are neither alienated from nor fully committed to the existing curriculum-textbook set; their perceptions lie at an ambivalent midpoint, consistent with implementation problems in Pakistan's reform cascade (Jan et al., 2023; Shaikh & Benedetti, 2024). Given the model's logic, this ambivalence creates a multiplier effect: moderate alignment beliefs constrain usability perceptions and, through them and directly, the efficacy required for full fidelity.

Implications

Theoretical Implications

First, the paper makes theoretical contributions by combining curriculum alignment theory, the participatory approach to curriculum use, and social cognitive theory in one testable process model and proving that it is the intersection between these traditions, not any of them alone, that leads to implementation: the alignment theory gives the specification of input, the participatory approach of material transformation, and social cognitive theory of the psychological mechanism. Second, through the indirect-only mediation, the paper shifts the locus of causal power from behaviour to belief; it is better to see textbook characteristics as information sources about effectiveness (mastering facilitation, modelling, system-coherence persuasion) rather than as scaffolds for direct behaviour. Third, the paper provides a validated series of steps to be adopted by future models of curriculum implementation in developing countries, extended with moderators (for example, professional development and supervision) or challenged with longitudinal design: material coherence → material usability → teacher capability belief → implementation. The model makes a construct-level contribution, showing the empirical distinction and good psychometric performance of teacher curriculum-specific self-efficacy (TCSE) compared to general teaching efficacy, as called for by Tschannen-Moran & Woolfolk Hoy (2001) and Zee & Koomen (2016).

Practical and Policy Implications

In terms of developing textbooks, especially for the Balochistan Textbook Board in the case of completion of NCP-aligned editions, the findings suggest designing books in two ways—firstly, for alignment, as described above, and secondly, for usability for increased efficacy by using explicit SLO tags in each chapter, worked examples that help in explaining difficult concepts to teachers, inquiry activities suitable to be conducted even without laboratory facilities, and instructionally useful graphics. Because perceptions of alignment have been shown to influence both usability and self-efficacy, conveying information about the textbook's alignment through curriculum mapping matrices in the book's introduction and in teacher guides qualifies as an intervention in itself. For professional development programs, the concept of full mediation is critical—the provision of better textbooks should be combined with professional development aimed at increasing efficacy, practice with the new material, modeling, and guidance in initial implementation of the textbooks because fidelity improvement comes only through improved self-efficacy (Darling-Hammond et al., 2017; Desimone, 2009; Penuel et al., 2007). Education authorities in Gwadar and other similar districts should treat teacher efficacy audits as leading indicators of implementation, and school supervision should enhance rather than reduce efficacy, focusing on formative processes rather than mere compliance checks. Inspection systems that decrease efficacy, according to the current model, result in decreased fidelity. From a policy standpoint, curriculum developers should understand that the NCP's success in peripheral districts will be limited by the weakest link in the chain of alignment-usability-efficacy-fidelity, and provide the corresponding resources to create a coherent curriculum-textbook-training-assessment nexus (Jan et al., 2023; Porter, 2002).

Limitations and Future Research

Some restrictions exist for this study. Firstly, as a cross-sectional approach was used in this study, causality cannot be established despite the theory-driven structural model and bootstrapping of the indirect effect. Longitudinal or intervention studies, such as testing effectiveness and fidelity over time during textbook implementation, are needed to test the temporal precedence hypothesis (Kline, 2023). Secondly, all variables were self-reported, and in particular, fidelity might be biased due to social desirability. Even though there were methodological corrections to address the issue and a full collinearity analysis showed no issues (Kock, 2015; Podsakoff et al., 2024), further studies should use classroom observation, lesson logs, or other methods to measure fidelity (Century & Cassata, 2016; O'Donnell, 2008). Finally, the sample was purposively restricted to middle school teachers of General Science within one school district in Balochistan, thereby increasing contextual validity but decreasing statistical generalizability. Replication across Makran Division, other Balochistan districts, other provinces, private-sector samples, and other subjects would establish boundary conditions. Fourth, the model omits plausible moderators and

additional mediators, professional development support, instructional leadership, workload, examination pressure, and language-of-instruction factors salient in Balochistan, whose inclusion could raise the explained variance in fidelity and qualify the mediation pattern; moderated serial mediation designs are a natural extension (Arthur et al., 2025; Boudouaia et al., 2024). Fifth, although the adapted instrument displayed excellent psychometrics, its six-item scales compress multidimensional constructs; full-length fidelity batteries capturing adherence, dosage, quality, and responsiveness separately could yield finer-grained pathway estimates. Finally, predictive-validity extensions linking the model to student learning outcomes would complete the causal chain that ultimately justifies alignment reform.

Conclusion

Drawing on 200 middle-school General Science teachers from public schools in District Gwadar, this study modeled the journey from perceived curriculum–textbook alignment to curriculum implementation fidelity under Pakistan’s NCP 2022–23 reform. Serial mediation analysis yields a definitive conclusion: perceptions of alignment significantly augment both textbook Pedagogical Usability and Curriculum Self-Efficacy; pedagogical usability, in turn, augments self-efficacy, while self-efficacy on its own ensures the actualization of material factors such as faithfulness in implementation. No direct paths from material factors to fidelity can be demonstrated. The significance of the serial path alignment → usability → efficacy → fidelity, along with the dominance of indirect effects mediated via efficacy and the absence of effects that bypass efficacy at all, demonstrates that curriculum self-efficacy is the critical mediator of material-based reforms. For Balochistan and similar low-resource settings, the implications are harsh but practical: ensure that your textbooks are well-aligned and pedagogically usable, help teachers see that alignment, and then work specifically on transforming material qualities into teacher self-efficacy, since it is teachers who will implement the curricula.

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