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Transforming Teaching Practices: A Two-Year Analysis Of Reformed Teacher Observation Protocol Implementation In Primary Education

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Abstract: This study examines the implementation and impact of the Reformed Teacher Observation Protocol (RTOP) at Shantiniketan School's primary section (grades 1-5) over a two-year period (2023-2024). The research tracks the transformation of teaching practices from traditional methodologies toward more facilitative approaches using Understanding by Design (UbD) frameworks. Quantitative analysis of RTOP scores across 31 teachers reveals a significant overall improvement (mean score increase from 61.0 to 70.3), with the greatest gains in Classroom Culture domains. Despite progress, challenges persist in Procedural Knowledge and student-directed learning. The study identifies exemplary practitioners, teachers requiring intervention, and domain-specific trends. These findings contribute to the understanding of teacher development in constructivist educational settings and offer insights into effective professional development strategies for primary education transformation. The paper concludes with recommendations for sustaining and accelerating progress in pedagogical transformation.

Keywords: Reformed Teacher Observation Protocol (RTOP), teacher development, constructivist teaching, primary education, Understanding by Design, classroom observation

1. Introduction

Educational reform efforts worldwide have increasingly emphasised the shift from traditional, teacher-centred instruction toward constructivist, student-centred approaches (Bybee et al., 2006; Sawada et al., 2002). This paradigm shift requires substantial changes in teaching practices, beliefs, and classroom dynamics. However, implementing such changes presents significant challenges, particularly in educational contexts with deeply embedded traditional instructional methods (Fullan, 2007).

The Reformed Teacher Observation Protocol (RTOP) represents one of the most comprehensive and validated instruments for measuring the degree to which classroom instruction aligns with constructivist principles (Piburn et al., 2000). Originally developed for science and mathematics education, RTOP has been adapted for use across various subjects and grade levels (Sawada et al., 2002). The instrument evaluates teaching practices across five domains: Lesson Design and Implementation, Content (Propositional Knowledge), Content (Procedural Knowledge), Classroom Culture (Communicative Interactions), and Classroom Culture (Student/Teacher Relationships).

This paper presents a longitudinal analysis of RTOP implementation at Shantiniketan School, a primary educational institution in India. The school initiated a systematic transformation process in 2023, adopting Understanding by Design (UbD) frameworks (Wiggins & McTighe, 2005) and implementing RTOP as both an assessment tool and a guide for professional development. By comparing RTOP scores and qualitative feedback across two years (2023-2024), this study seeks to identify patterns of change, areas of success, persistent challenges, and effective strategies for pedagogical transformation.

The significance of this research lies in its contribution to understanding the practical implementation of educational reform at the classroom level, particularly in primary education settings. While numerous studies have examined RTOP implementation in secondary and higher education (Adamson et al., 2003; Sawada et al., 2002), fewer have focused on primary grades. Additionally, this study provides insights into the effectiveness of UbD as a framework for supporting constructivist teaching practices.

2. Literature Review

2.1 Reformed Teacher Observation Protocol (RTOP)

The RTOP was developed as part of the Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT) project, funded by the National Science Foundation (Piburn et al., 2000; Sawada et al., 2002). It was designed specifically to measure "reformed" teaching—instruction that aligns with constructivist principles and student-centred approaches advocated by national educational standards (National Research Council, 1996, 2000).

The RTOP instrument consists of 25 items organised into five subscales, each containing five items:

1. Lesson Design and Implementation
2. Content: Propositional Knowledge
3. Content: Procedural Knowledge
4. Classroom Culture: Communicative Interactions
5. Classroom Culture: Student/Teacher Relationships

Each item is scored on a scale from 0 (not observed) to 4 (very descriptive), yielding a maximum possible score of 100. Studies have demonstrated strong psychometric properties for the RTOP, with high inter-rater reliability ($r > 0.90$) when used by trained observers (Sawada et al., 2002). Furthermore, research has established significant correlations between RTOP scores and student learning outcomes, particularly in conceptual understanding and scientific reasoning (Lawson et al., 2002; MacIsaac & Falconer, 2002).

2.2 Understanding by Design (UbD) and Teacher Development

Understanding by Design, developed by Wiggins and McTighe (2005), represents a framework for curriculum design that emphasises "backwards planning" from desired understandings and learning outcomes. The approach centres on essential questions, enduring understandings, and authentic assessment. While UbD does not prescribe specific teaching methodologies, its emphasis on conceptual understanding, transfer of learning, and authentic performance aligns closely with constructivist principles embedded in the RTOP (McTighe & Seif, 2003).

Research on UbD implementation has demonstrated its effectiveness in improving curriculum coherence (Brown & Wiggins, 2004), assessment quality (Childre et al., 2009), and conceptual understanding (McTighe & Thomas, 2003). However, studies specifically examining the relationship between UbD implementation and transformation of teaching practices, particularly as measured by instruments like RTOP, remain limited.

2.3 Teacher Development and Pedagogical Change

The literature on teacher professional development emphasises that significant pedagogical change requires sustained effort, typically spanning multiple years (Desimone, 2009; Guskey, 2002). Effective professional development programs share several characteristics, including focus on content knowledge, active learning opportunities, coherence with school goals, sufficient duration, and collective participation (Desimone, 2009).

Studies of teacher change processes indicate that shifts in practice often precede changes in beliefs (Guskey, 1986), suggesting the importance of supporting teachers through initial implementation challenges. Change is facilitated by classroom-embedded coaching, peer collaboration, and formative feedback (Darling-Hammond et al., 2017). The use of structured observation protocols, such as RTOP, can provide both guidance for desired practices and objective feedback on progress (Sawada et al., 2002).

2.4 Research Gap and Study Relevance

While existing literature provides strong theoretical foundations for understanding teacher development and reformed teaching practices, several gaps remain. First, most RTOP studies have focused on secondary and higher education, with fewer investigations at the primary level. Second, the integration of UbD frameworks with RTOP assessment represents an under-explored approach to pedagogical transformation. Finally, longitudinal studies tracking teacher development through systematic RTOP implementation remain relatively scarce, particularly in non-Western educational contexts.

This study addresses these gaps by examining a two-year implementation of RTOP in conjunction with UbD frameworks in an Indian primary school context. By doing so, it contributes to understanding the processes and challenges of pedagogical transformation in diverse educational settings.

3. Methodology

3.1 Research Context

This study was conducted at Shantiniketan School, a primary educational institution in India serving students in grades 1-5. The school initiated a systematic transformation process in 2023, adopting Understanding by Design frameworks for curriculum development and implementing the Reformed Teacher Observation Protocol (RTOP) as both an assessment tool and a guide for professional development. The study encompasses two academic years: 2023 and 2024.

3.2 Participants

The participants included 31 primary school teachers across multiple subject areas, including English, Hindi, Marathi, Environmental Studies (EVS), Mathematics, and co-curricular subjects such as Art. In 2023, 29 teachers were assessed, while in 2024, the number increased to 31 with the addition of two art teachers. Teacher experience ranged from new teachers (freshers) to experienced educators with multiple years in the profession.

3.3 Instruments and Data Collection

The primary instrument used in this study was the Reformed Teacher Observation Protocol (RTOP), a validated classroom observation tool consisting of 25 items organised into five subscales:

1. **Lesson Design and Implementation** (Items 1-5)
2. **Content: Propositional Knowledge** (Items 6-10)
3. **Content: Procedural Knowledge** (Items 11-15)
4. **Classroom Culture: Communicative Interactions** (Items 16-20)
5. **Classroom Culture: Student/Teacher Relationships** (Items 21-25)

Each item was scored on a scale from 0 (not observed) to 4 (very descriptive), yielding a maximum possible score of 100.

Observations were conducted by trained administrators who observed full lessons taught by each teacher. In addition to numerical scores, observers provided qualitative comments on teacher performance, noting specific strengths and areas for improvement. Each teacher was observed once per academic year as part of the formal evaluation process.

3.4 Data Analysis

The analysis involved both quantitative and qualitative approaches. Quantitative analysis included:

1. Calculation of descriptive statistics (mean, median, range) for overall RTOP scores and subscale scores for each year
2. Comparison of 2023 and 2024 scores to identify changes in overall performance and specific domains
3. Identification of the highest and lowest-performing teachers and domains
4. Analysis of score distributions to determine patterns of improvement

Qualitative analysis involved:

1. Thematic analysis of observer comments to identify common strengths and challenges

2. Comparison of comments between years to track changes in teaching approaches
3. Identification of exemplary practices among high-performing teachers
4. Analysis of persistent challenges among lower-performing teachers

3.5 Limitations

Several limitations should be acknowledged. First, each teacher was observed only once per year, which may not capture the full range of their teaching practices. Second, despite training, there may be some observer variability in RTOP scoring. Third, as a case study of a single school, the findings may not be generalizable to all educational contexts. Finally, confounding variables beyond the professional development interventions (such as teacher turnover, changes in student population, or other school initiatives) may have influenced the results.

4. Results

4.1 Overall Performance Trends

Analysis of RTOP scores revealed substantial improvement in teaching practices from 2023 to 2024. Table 1 presents summary statistics for both years.

Table 1: Overall RTOP Score Statistics (2023-2024)

Metric	2023	2024	Change
Average Total Score	61.0	70.3	+9.3
Median Score	58.0	72.0	+14.0
Highest Score	100	100	0
Lowest Score	33	40	+7
Number of Teachers Evaluated	29	31	+2
Teachers Scoring ≥75	6 (20.7%)	13 (41.9%)	+21.2%

The data indicate a clear positive trend, with the average RTOP score increasing by 9.3 points. More notably, the median score improved by 14 points, suggesting that the improvement was not driven solely by a few outliers. The percentage of teachers scoring 75 or above (generally considered the threshold for "reformed" teaching) doubled from 20.7% to 41.9%, indicating substantial progress toward constructivist teaching practices.

4.2 Domain Performance Analysis

Analysis of subscale scores revealed varying degrees of improvement across the five RTOP domains, as shown in Table 2.

Table 2: Domain Performance Analysis (Average Scores)

Domain	2023	2024	Change
Lesson Design & Implementation (Items 1-5)	12.0	13.8	+1.8
Propositional Knowledge (Items 6-10)	12.2	13.9	+1.7
Procedural Knowledge (Items 11-15)	10.0	11.5	+1.5
Communicative Interactions (Items 16-20)	12.2	14.4	+2.2
Student/Teacher Relationships (Items 21-25)	14.7	16.7	+2.0

The most significant improvements were observed in the Classroom Culture domains, particularly Communicative Interactions (+2.2 points) and Student/Teacher Relationships (+2.0 points). This suggests that teachers made substantial progress in creating more interactive classroom environments with positive teacher-student dynamics. Content domains showed moderate improvement, with Procedural Knowledge remaining the lowest-scoring domain despite an increase of 1.5 points.

4.3 Item-Level Analysis

Examination of individual RTOP items revealed specific strengths and persistent challenges in teaching practices. Table 3 presents the average scores for each item across both years.

Table 3: Average Item Scores (2023-2024)

Item	Description	2023	2024	Change
1	Respected students' prior knowledge	3.0	3.3	+0.3
2	Engaged students as a learning community	3.1	3.4	+0.3
3	Student exploration preceded formal presentation	2.8	3.2	+0.4
4	Encouraged alternative modes of investigation	1.8	2.5	+0.7
5	Lesson direction is determined by student ideas	1.9	2.4	+0.5
6	Involved fundamental concepts	3.0	3.2	+0.2
7	Promoted coherent conceptual understanding	2.3	2.6	+0.3
8	The teacher had a solid grasp of the subject matter	2.7	3.0	+0.3
9	Elements of abstraction encouraged	2.0	2.3	+0.3
10	Connections with other disciplines/real world	2.1	2.8	+0.7
11	Students used various means to represent phenomena	1.6	2.0	+0.4
12	Students made predictions/hypotheses	1.9	2.2	+0.3
13	Students engaged in a thought-provoking activity	2.0	2.3	+0.3
14	Students were reflective about learning	2.7	3.2	+0.5
15	Intellectual rigour and challenging ideas are valued	1.7	2.3	+0.6
16	Students communicated ideas through various means	2.4	2.9	+0.5
17	Teacher questions triggered divergent thinking	2.3	2.7	+0.4
18	High proportion of student talk	2.3	2.9	+0.6
19	Student questions determined discourse direction	1.7	2.2	+0.5
20	Climate of respect for others' ideas	2.8	3.4	+0.6
21	Active participation is encouraged and valued	3.1	3.5	+0.4
22	Students generated conjectures/interpretations	2.2	2.5	+0.3
23	The teacher was patient with the students	3.2	3.5	+0.3
24	The teacher supported student investigations	2.9	3.1	+0.2
25	"Teacher as listener" characteristic of the classroom	2.6	3.1	+0.5

The largest improvements were observed in items related to encouraging alternative modes of investigation (+0.7), making connections with other disciplines and real-world phenomena (+0.7), and promoting a high proportion of student talk (+0.6). Items with the highest absolute scores in 2024 included "Active participation encouraged and valued" (3.5), "Teacher was patient with students" (3.5), and "Climate of respect for others' ideas" (3.4).

Despite improvements, several items remained challenging, particularly "Students used various means to represent phenomena" (2.0), "Student questions determined discourse direction" (2.2), and "Students made predictions/hypotheses" (2.2). These items, predominantly in the Procedural Knowledge domain, represent areas for continued development.

4.4 Individual Teacher Analysis

The data revealed significant variation in individual teacher performance and improvement. Table 4 presents the teachers with the most substantial score changes between 2023 and 2024.

Table 4: Most Improved Teachers (2023-2024)

Teacher	2023 Score	2024 Score	Improvement
Amruta Shinde	51	98	+47
Pradip Jathar	56	91	+35
Kiran Jagtap	58	86	+28
Deepadevi Kalugade	65	93	+28
Arjun Vadrale	59	79	+20
Kavita Kagale	58	78	+20
Sakshi Kamate	50	70	+20
Alok Singh	47	67	+20
Shubhangi Hujare	44	67	+23

Qualitative comments provided insight into the nature of these improvements. For Amruta Shinde, observers noted a dramatic transformation from a teacher with adequate baseline skills to one who "is passionate and committed" with "a very good rapport with her students" and who "creates interest, curiosity and fun in the class." Similar patterns were evident for other improved teachers, with comments highlighting enhanced student engagement, improved questioning techniques, and greater student agency.

Conversely, several teachers continued to struggle with reformed teaching practices, as shown in Table 5.

Table 5: Teachers with Persistent Challenges

Teacher	2023 Score	2024 Score	Change
Manjusha Kudturkar	33	40	+7
Uday Kage	45	42	-3
Aditee Kulkarni	49	43	-6
Swati Mohite	50	41	-9
Neha Chavan	N/A	41	N/A

Qualitative comments for these teachers consistently mentioned challenges with classroom management, lesson implementation, and student engagement. For example, comments for Uday Kage noted that despite being "sincere and committed," he "conducted a teacher-centric class" where "students were passive." Similarly, Aditee Kulkarni was described as having "good content knowledge but tends to mix up concepts and ideas, thus confusing learners."

One teacher, Anuradha Sankpal, achieved a perfect score of 100 in both years, representing exemplary reformed teaching practice. Observer comments described her class as "excellent" with "bonding with the children evident" and noted her effective use of humour, vocabulary, and body language.

5. Discussion

5.1 Patterns of Pedagogical Transformation

The two-year RTOP data from Shantiniketan School reveal a clear pattern of pedagogical transformation, with significant overall improvement in teaching practices. The increase in average RTOP scores from 61.0 to 70.3 represents substantial progress toward more constructivist, student-centred instruction. This finding aligns with previous research suggesting that meaningful pedagogical change typically requires sustained effort over multiple years (Desimone, 2009; Guskey, 2002).

The most pronounced improvements occurred in the Classroom Culture domains, particularly in Communicative Interactions and Student/Teacher Relationships. This pattern suggests that teachers first establish a positive and respectful classroom environment before tackling more challenging aspects of reformed teaching, such as facilitating student inquiry and promoting procedural knowledge. This sequence aligns with Maslow's hierarchy of needs as applied to educational settings (Maslow, 1943), where psychological safety precedes higher-order learning experiences.

The item-level analysis reveals that teachers made the greatest gains in areas that extend traditional practice rather than fundamentally transform it. For example, substantial improvements were seen in connecting content to the real world (+0.7) and encouraging student talk (+0.6), both of which can be incorporated into relatively structured lessons. In contrast, items requiring teachers to relinquish control, such as allowing student questions to determine lesson direction (+0.5) or encouraging students to generate conjectures (+0.3)—showed more modest gains. This pattern aligns with research on teacher change, which suggests that teachers often adopt surface-level aspects of reform before deeper structural changes (Cohen & Ball, 1990; Cuban, 1993).

5.2 Variability in Teacher Development

The substantial variation in individual teacher development suggests that teachers respond differently to the same professional development initiatives. While some teachers (e.g., Amruta Shinde, +47 points) demonstrated remarkable growth, others showed minimal improvement or even regression. This heterogeneity in response to professional development is consistent with previous research on teacher learning (Desimone et al., 2002; Garet et al., 2001).

Several factors may explain this variability. First, teachers' prior beliefs and experiences likely influenced their receptiveness to reformed teaching approaches (Pajares, 1992). Second, content knowledge differences may have affected teachers' confidence in implementing more student-centred approaches (Ball et al., 2008). Third, personal factors such as motivation, self-efficacy, and openness to change may have played significant roles (Tschannen-Moran & Hoy, 2001).

The success stories, particularly Amruta Shinde and Pradip Jathar, highlight the potential for substantial pedagogical transformation within a relatively short timeframe. Qualitative comments suggest that these teachers not only adopted specific reformed teaching techniques but also embraced the underlying philosophy of constructivist education. This transformation appears to reflect what Mezirow (1991) describes as "perspective transformation"—a fundamental shift in how teachers conceptualise their role and the nature of learning.

5.3 Domain-Specific Challenges

The persistent challenges in the Procedural Knowledge domain merit particular attention. Despite improvements, items related to student representation of phenomena, prediction-making, and critical assessment remained among the lowest-scoring across both years. This finding aligns with previous research suggesting that facilitating student inquiry and procedural knowledge development represents one of the most challenging aspects of reformed teaching (Anderson, 2002; Crawford, 2007).

Several factors may contribute to these challenges. First, developing procedural knowledge requires substantial instructional time, which teachers may feel conflicts with content coverage demands. Second, facilitating student inquiry requires sophisticated pedagogical content knowledge that may take years to develop (Crawford, 2007). Third, cultural expectations regarding teacher and student roles may create resistance to more student-directed learning approaches (Anderson, 2002).

The relatively stronger performance in the Propositional Knowledge domain suggests that teachers have maintained a focus on conceptual understanding while incorporating more interactive teaching methods. This balance is essential for effective science and mathematics education (Bransford et al., 2000) but appears more challenging to achieve in procedural aspects of learning.

5.4 Implications for Professional Development

The findings have several implications for professional development in schools undertaking similar pedagogical transformations. First, the overall improvement in RTOP scores validates the school's approach of combining UbD frameworks with systematic observation and feedback. This finding supports previous research on the effectiveness of coherent, sustained professional development programs (Desimone, 2009).

Second, the variability in teacher development suggests the need for differentiated professional development approaches. While some teachers thrived under the schoolwide initiative, others may require more intensive, individualized support. This aligns with research advocating adaptive rather than standardized professional development programs (Clarke & Hollingsworth, 2002).

Third, the persistent challenges in the Procedural Knowledge domain suggest the need for targeted professional development in facilitating student inquiry, prediction-making, and representation. Such professional development might include demonstration lessons, video analysis of exemplary practice, and collaborative planning focused specifically on these aspects of teaching (Borko, 2004).

Finally, the successful transformation of several teachers suggests the potential value of peer mentoring and collaborative learning communities. Teachers who have successfully implemented reformed teaching practices could serve as powerful models and mentors for colleagues still developing these skills (Borko, 2004; Little, 2002).

6. Conclusion and Recommendations

6.1 Summary of Findings

This study examined the implementation of the Reformed Teacher Observation Protocol (RTOP) at Shantiniketan School over two years (2023-2024). The analysis revealed significant overall improvement in teaching practices, with the average RTOP score increasing from 61.0 to 70.3. The most substantial gains occurred in the Classroom Culture domains, while the Procedural Knowledge domain remained challenging

despite modest improvement. Individual teacher performance varied considerably, with some teachers demonstrating remarkable growth while others continued to struggle with reformed teaching approaches.

6.2 Theoretical and Practical Implications

Theoretically, this study contributes to understanding the process of pedagogical transformation, particularly in primary education settings. The findings suggest that teachers typically establish positive classroom cultures before mastering more challenging aspects of reformed teaching, such as facilitating student inquiry and procedural knowledge development. This pattern aligns with theories of teacher change that emphasise the incremental nature of pedagogical transformation (Guskey, 1986; Hall & Hord, 2001).

Practically, the study validates the use of RTOP as both an assessment tool and a guide for professional development in primary education. The detailed analysis of domain and item-level performance provides valuable insights for targeting professional development efforts. Additionally, the identification of exemplary practitioners and common challenges offers concrete guidance for schools undertaking similar transformations.

6.3 Recommendations for Practice

Based on the findings, the following recommendations are proposed for Shantiniketan School and similar institutions:

Short-term Interventions (3-6 months)

1. **Peer Learning Partnerships**: Establish structured mentoring relationships between high-performing teachers and those needing support, with regular classroom observations and collaborative planning.
2. **Targeted Professional Development**: Focus on procedural knowledge development, particularly student representation of phenomena, prediction-making, and critical assessment.
3. **Individualized Improvement Plans**: Develop specific goals, resources, and support structures for the 5-7 lowest-scoring teachers.

Medium-term Strategies (6-12 months)

1. **Student-Directed Learning Workshops**: Implement a focused professional development program on techniques for empowering students to direct their learning.
2. **Model Classroom Observations**: Arrange for all teachers to observe classes taught by exemplary practitioners such as Anuradha Sankpal.
3. **Resource Development**: Create a repository of successful learning activities, questioning techniques, and classroom management strategies from high-performing teachers.

Long-term Initiatives (1-2 years)

1. **Comprehensive UbD Implementation**: Continue refining curriculum development with special attention to formative assessment and student reflection.
2. **Teacher Leadership Development**: Identify and develop teacher-leaders who can eventually lead professional development initiatives internally.
3. **Parent Education**: Develop programs to help parents understand and support the shift from traditional teaching to facilitation-based approaches.

6.4 Directions for Future Research

Several questions emerge from this study that warrant further investigation:

1. What factors explain the substantial variability in teacher development observed in this study?
2. How do RTOP scores correlate with student learning outcomes in primary education settings?
3. What specific professional development approaches are most effective for improving the Procedural Knowledge domain?

4. How do cultural contexts influence the implementation and effectiveness of reformed teaching practices?

5. What are the long-term effects of sustained RTOP implementation on teacher beliefs, practices, and student outcomes?

Longitudinal research addressing these questions would further enhance understanding of effective educational reform implementation in diverse contexts.

6.5 Concluding Thoughts

The transformation of teaching practices at Shantiniketan School represents a promising case study in educational reform implementation. The significant improvement in RTOP scores over two years demonstrates that meaningful pedagogical change is possible with sustained, systematic effort. At the same time, the persistent challenges and variable teacher performance highlight the complexity of educational transformation. By continuing to refine their approach based on RTOP data and emerging research, Shantiniketan School can further advance their journey toward fully reformed, student-centred teaching practices.

References

1. Adamson, S. L., Banks, D., Burtch, M., Cox, F., Judson, E., Turley, J. B., Benford, R., & Lawson, A. E. (2003). Reformed undergraduate instruction and its subsequent impact on secondary school teaching practice and student achievement. Journal of Research in Science Teaching, 40(10), 939-957.
2. Anderson, R. D. (2002). Reforming science teaching: What research says about inquiry. Journal of Science Teacher Education, 13(1), 1-12.
3. Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? Journal of Teacher Education, 59(5), 389-407.
4. Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. Educational Researcher, 33(8), 3-15.
5. Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). How people learn: Brain, mind, experience, and school. National Academy Press.
6. Brown, J., & Wiggins, G. (2004). Making the most of understanding by design. Association for Supervision and Curriculum Development.
7. Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). The BSCS 5E instructional model: Origins and effectiveness. BSCS.
8. Childre, A., Sands, J. R., & Pope, S. T. (2009). Backward design: Targeting depth of understanding for all learners. Teaching Exceptional Children, 41(5), 6-14.
9. Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. Teaching and Teacher Education, 18(8), 947-967.
10. Cohen, D. K., & Ball, D. L. (1990). Relations between policy and practice: A commentary. Educational Evaluation and Policy Analysis, 12(3), 331-338.
11. Crawford, B. A. (2007). Learning to teach science as inquiry in the rough and tumble of practice. Journal of Research in Science Teaching, 44(4), 613-642.
12. Cuban, L. (1993). How teachers taught: Constancy and change in American classrooms, 1890-1990 (2nd ed.). Teachers College Press.
13. Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). Effective teacher professional development. Learning Policy Institute.
14. Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualisations and measures. Educational Researcher, 38(3), 181-199.
15. Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S., & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. Educational Evaluation and Policy Analysis, 24(2), 81-112.
16. Fullan, M. (2007). The new meaning of educational change (4th ed.). Teachers College Press.
17. Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. American Educational Research Journal, 38(4), 915-945.
18. Guskey, T. R. (1986). Staff development and the process of teacher change. Educational Researcher, 15(5), 5-12.

19. Guskey, T. R. (2002). Professional development and teacher change. Teachers and Teaching, 8(3), 381-391.
20. Hall, G. E., & Hord, S. M. (2001). Implementing change: Patterns, principles, and potholes. Allyn and Bacon.
21. Lawson, A. E., Benford, R., Bloom, I., Carlson, M. P., Falconer, K. F., Hestenes, D. O., Judson, E., Piburn, M. D., Sawada, D., Turley, J., & Wyckoff, S. (2002). Evaluating college science and mathematics instruction: A reform effort that improves teaching skills. Journal of College Science Teaching, 31(6), 388-393.
22. Little, J. W. (2002). Locating learning in teachers' communities of practice: Opening up problems of analysis in records of everyday work. Teaching and Teacher Education, 18(8), 917-946.
23. MacIsaac, D., & Falconer, K. (2002). Reforming physics instruction via RTOP. The Physics Teacher, 40(8), 479-485.