



Teacher Creativity and Innovative Classroom Practices in Secondary Schools

Dr. Juhi Peter

Assistant Professor

Agrasen College Dhanora, Durg, Chhattisgarh



<http://www.gjirp.org/> || Vol. 2 No. 3 (2026): Special August Issue

Date of Submission: 15-07-2026

Date of Acceptance: 31-07-2026

Date of Publication: 20-08-2026

Abstract— Teacher creativity has become increasingly consequential as secondary schools respond to heterogeneous learners, digital transformation, generative artificial intelligence, and demands for higher-order thinking. This study addresses a specific research gap: existing scholarship frequently measures teachers' creativity, digital competence, or innovative behavior separately, but rarely examines how creative capacity is translated into observable and sustainable classroom innovation. The proposed study conceptualizes this translation as a Creativity-to-Practice Translation Framework, integrating creative self-efficacy, pedagogical adaptability, digital/AI agency, collaborative school climate, and instructional experimentation. Particular attention is given to whether teachers who perceive themselves as creative actually implement differentiated tasks, inquiry-oriented activities, multimodal resources, AI-assisted lesson design, collaborative problem solving, and formative experimentation in secondary classrooms. **Keywords—** Teacher Creativity, Innovative Classroom Practices, Creative Self-Efficacy, Secondary Education, Artificial Intelligence in Education, Pedagogical Innovation

Introduction

Creativity in teaching has moved from being considered an optional professional quality to becoming a central component of adaptive educational practice. Secondary-school teachers now work in classrooms characterised by substantial variation in prior knowledge, language proficiency, motivation, digital access, learning pace, and preferred modes of participation. At the same time, curricular

expectations increasingly emphasise critical thinking, collaboration, problem solving, communication, and the production of original ideas. The OECD's first large-scale PISA assessment of creative thinking, conducted as part of PISA 2022 and reported in 2024, reinforced the educational importance of enabling students to generate, evaluate, and improve ideas rather than merely reproduce established information.

Such expectations place considerable demands on teachers. Creativity in professional teaching practice involves more than presenting an entertaining lesson or introducing an unfamiliar technological application. It requires the teacher to recognise an instructional problem, formulate multiple possible responses, select an appropriate approach, adapt available resources, and evaluate whether the resulting practice improves the learning process. Consequently, teacher creativity is best understood as contextually useful novelty: an instructional response must be sufficiently original to depart from routine practice while remaining pedagogically appropriate for specified learners, content, and educational objectives.

This distinction is especially important in the contemporary digital environment. The period following the COVID-19 disruption accelerated experimentation with online platforms, multimedia resources, blended learning, collaborative applications, digital assessment, and flexible instructional arrangements. More recently, generative artificial intelligence has expanded the range of tools available for lesson planning, resource generation, differentiation, feedback design, simulations, questioning, and content adaptation. UNESCO's guidance on generative AI nevertheless stresses that technological availability alone does not guarantee



educational value; human-centred design, privacy protection, age appropriateness, validation of outputs, and preservation of human agency remain necessary conditions for responsible educational use.

The same principle is reflected in UNESCO's AI Competency Framework for Teachers, which identifies human-centred thinking, AI ethics, AI foundations and applications, AI pedagogy, and AI-supported professional development as interconnected areas of teacher competence. Importantly, the framework progresses beyond basic technological use toward a "create" level in which teachers become agents capable of exploring innovative pedagogical practices with AI while retaining professional responsibility for instructional decisions. This development creates a significant conceptual shift: innovative classroom practice can no longer be defined simply by whether technology is present. A conventional worksheet automatically generated through an AI system may involve sophisticated technology but little pedagogical creativity, whereas a low-technology inquiry activity redesigned around students' misconceptions may demonstrate considerable professional creativity.

Research conducted before and during this technological transition indicates that creative teaching is shaped by both individual and environmental conditions. Huang et al. (2021), analysing data from 7,187 teachers, reported that teacher enthusiasm and metacognition were associated with teaching for creativity, while collaboration among teachers, colleague innovation, and access to resources were important school-level conditions. More recent research has strengthened the importance of teachers' internal beliefs. Zielińska et al. (2024) demonstrated that creative self-beliefs and self-regulatory processes contribute to teachers' creative activity, indicating that producing innovative outcomes requires both confidence in one's creative capability and the ability to plan, monitor, and adjust creative work.

Evidence also suggests that digital professional learning can provide inputs for instructional creativity. Mulyono et al. (2024), studying Indonesian EFL teachers, found that participation in informal digital learning significantly predicted teaching creativity, although the statistical models left substantial variance unexplained. Similarly, research on secondary teachers implementing differentiated instruction has shown that creativity becomes visible through motivation, originality, elaboration, brainstorming, instructional flexibility, adaptation of materials, and the ability to respond to learner diversity. These findings collectively suggest that teacher creativity is not an isolated psychological characteristic. It operates through interactions among professional beliefs, self-regulation, pedagogical knowledge, school conditions, learning from peers, digital competence, and opportunities for experimentation.



Fig. 1: Enhancing Teachers' Creativity with an Innovative Training Model and Knowledge Management

Source: <https://www.mdpi.com/2227-7102/14/12/1381>

Research Gap

A significant limitation remains in this literature. Much existing research measures **creative self-efficacy, teaching for creativity, digital competence, differentiated instruction, or innovative behavior as separate constructs**. Other studies depend primarily on self-report questionnaires, making it difficult to determine whether teachers who describe themselves as creative consistently translate those beliefs into identifiable classroom practices. Reviews of K–12 creativity research have also identified persistent constraints involving teachers' creativity beliefs, environmental limitations, time pressures, professional preparation, and the continuation of conventional instructional routines.

The emerging use of generative AI widens this gap. Research increasingly discusses teachers' AI competence and responsible technology use, yet comparatively little work connects **creative self-belief → instructional experimentation → observable innovative practice → responsible digital/AI integration** within a unified analytical model for secondary schools. Studies also frequently assume linear relationships, although teachers may exhibit heterogeneous innovation profiles. For example, one teacher may demonstrate strong pedagogical creativity with limited technology use, another may use many digital tools without substantially modifying instructional design, while a third may combine high creative agency, differentiation, student-centred learning, and purposeful AI-supported experimentation.

The present study therefore introduces the concept of a **Creativity-to-Practice Translation Gap (CPTG)**: the potential discrepancy between a teacher's creative capacity or creative self-perception and the extent to which that capacity

becomes visible in recurring classroom practice. This approach shifts the central question from “*Are teachers creative?*” to “*Under what individual, technological, and organisational conditions does teacher creativity become pedagogically meaningful innovation?*”

Accordingly, the study has four interconnected objectives: to examine the relationship between creative self-efficacy and observable innovative classroom practices among secondary-school teachers; to determine how pedagogical adaptability, digital/AI agency, and collaborative school climate influence the conversion of creativity into practice; to distinguish pedagogically meaningful innovation from technology use that merely reproduces conventional instruction; and to develop a machine-learning-supported classification framework capable of detecting teacher innovation profiles from multidimensional educational data.

This framing is particularly suitable for contemporary secondary education because it recognises teachers as professional designers rather than passive users of prescribed methods or emerging technologies. It also permits innovation to encompass technology-rich and technology-light practices, thereby avoiding the assumption that classroom modernisation is synonymous with digitisation.

Literature Review

2.1 Teacher Creativity as Professional Agency

Educational creativity involves the production of ideas, activities, resources, explanations, or learning arrangements that combine novelty with instructional usefulness. For teachers, creativity operates within constraints: curriculum requirements, assessment schedules, available time, classroom size, student readiness, institutional expectations, and access to resources. Creative teaching therefore represents situated professional problem solving rather than unrestricted originality.

Recent empirical evidence suggests that creative agency depends partly on teachers’ beliefs about their own creative capability. Zielińska et al. (2024) found that creative self-beliefs increase the likelihood of producing creative professional outcomes and that self-regulation provides an important mechanism through which teachers organise creative work. This finding is theoretically important because a teacher may possess imaginative ideas yet fail to convert them into classroom practice without planning, persistence, iterative adjustment, and confidence in managing uncertainty.

Creative self-efficacy must therefore be distinguished from demonstrated innovation. Self-efficacy concerns perceived capability, whereas innovative classroom practice involves enacted behavior. The distinction provides the theoretical foundation for the CPTG proposed in this study.

2.2 From Creative Teaching to Innovative Classroom Practice

Creative teaching and teaching for creativity overlap but are not identical. Creative teaching concerns the originality and effectiveness of a teacher’s instructional actions, while teaching for creativity deliberately creates conditions through which learners generate ideas, explore alternatives, tolerate uncertainty, make decisions, and develop creative competence. Bullard and Bahar’s (2023) K–12 literature review highlights barriers including teachers’ creative self-efficacy and beliefs, environmental constraints, and professional preparation that may perpetuate established instructional practices.

Innovative classroom practice can therefore be conceptualised as the behavioural expression of pedagogical creativity. Examples include problem- and project-based learning, inquiry sequences, interdisciplinary tasks, differentiated pathways, student-generated content, collaborative problem solving, flexible formative assessment, multimodal explanation, peer teaching, simulation, and iterative lesson redesign. Innovation does not necessarily require an entirely new teaching method; adapting an established strategy intelligently to a specific classroom problem may also constitute innovative professional behavior.

Research on differentiated instruction illustrates this principle. Hidayat, Basthomi, and Afrilyasanti (2024) observed secondary-school teachers demonstrating creativity through originality, elaboration, brainstorming, flexibility, motivation, adaptation, and purposeful use of materials. Their findings also revealed difficulties in particular dimensions, including learner autonomy, illustrating that creativity may vary across components of teaching rather than existing as a uniform teacher characteristic.

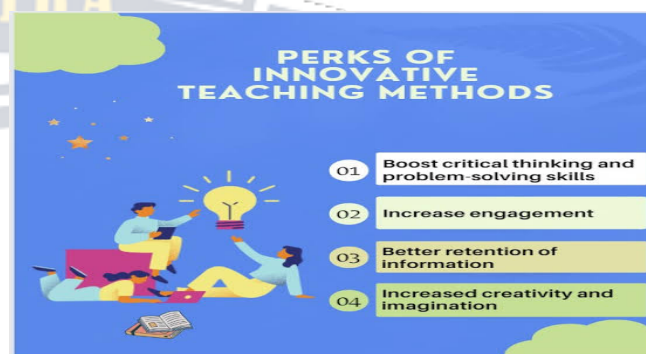


Fig. 2: Perks of Innovative Teaching Techniques

Source: <https://www.themanthanschool.co.in/blog/innovative-teaching-techniques-for-kids/>

2.3 School Climate and the Social Ecology of Teacher Innovation

Teacher creativity develops within organisational environments. Schools determine how much experimentation is tolerated, whether teachers exchange ideas, whether professional learning is sustained, and whether new approaches can be tested without excessive fear of failure.

Huang et al. (2021) provided large-scale evidence that collaborative teaching and colleague innovation are strongly associated with teaching for creativity. Their findings indicate that creativity is partly socially distributed: interaction with innovative colleagues can expose teachers to alternative strategies, encourage reflection, and normalise experimentation.

This perspective challenges models that explain innovative teaching primarily through age, qualification, or personality. Institutional conditions can either convert creative potential into practice or suppress it. A highly creative teacher working within a rigid instructional culture may employ fewer experimental practices than a moderately creative teacher supported by collaborative planning, professional autonomy, leadership encouragement, and resource sharing.

Consequently, the present study treats **collaborative innovation climate** as an enabling condition rather than a demographic control variable.

2.4 Digital Agency, Informal Learning, and Pedagogical Experimentation

Digital competence provides teachers with a larger repertoire of resources, but competence alone does not establish creativity. The critical mechanism is digital agency—the ability to select, adapt, combine, reject, and critically evaluate technologies according to instructional requirements.

Mulyono et al. (2024) reported a significant association between teachers' informal digital learning and classroom teaching creativity among Indonesian EFL educators. Their regression models, however, explained only part of the variability in teaching creativity, supporting the argument that additional psychological and contextual factors need to be examined. Research among government upper-primary and secondary teachers in Assam likewise indicates that participation in technology-oriented professional development must be interpreted alongside teachers' characteristics, previous experiences, values, and social positioning rather than being treated as a purely technical intervention.

These findings justify moving beyond measures such as frequency of technology use. The present conceptualisation instead considers whether digital tools contribute to

differentiation, exploration, feedback, collaboration, learner autonomy, and instructional redesign.

2.5 Generative AI as an Emerging Creativity Amplifier

Generative AI introduces an additional layer to teacher creativity because teachers can rapidly produce examples, alternative explanations, scenarios, quizzes, lesson variations, multimedia concepts, feedback prompts, differentiated materials, and simulated dialogues. These capabilities could reduce the cost of experimentation and expand teachers' ideational options.

However, GenAI may also produce the opposite effect. Routine dependence on generated lesson plans can standardise instruction, reproduce inaccuracies, introduce bias, or weaken teachers' independent professional judgment. UNESCO therefore advocates human-centred, ethically validated, and pedagogically purposeful AI integration rather than automatic technology adoption. Its AI Competency Framework for Teachers similarly places pedagogical and ethical capability alongside technical knowledge and explicitly conceptualises teachers as accountable participants in teacher–AI–student interactions.

For the present study, AI use is consequently treated as a **moderating pedagogical resource**, not as a proxy for innovation. A teacher is considered innovative when technology contributes to meaningful redesign of learning, while professional judgment, student agency, curricular validity, and human interaction remain central.

Proposed Methodology

The study adopts an **explainable machine-learning framework** to examine the Creativity-to-Practice Translation Gap (CPTG) among secondary-school teachers. Rather than conceptualising creativity as a single psychological score, the methodology represents innovative teaching as an interaction among creative self-efficacy, pedagogical adaptability, AI/digital agency, self-regulation, collaborative climate, professional autonomy, and observable instructional experimentation.

For methodological validation, a reproducible **synthetic benchmark dataset** was constructed instead of inventing observations and presenting them as actual school data. The benchmark is intended to test the analytical framework prior to field validation. Consequently, the numerical findings reported below should be interpreted as computational evidence about the proposed model, not as population estimates for teachers.

The analytical framework contains three innovation profiles:

1. **Emerging Innovators** – teachers with comparatively limited translation of creative confidence into recurring classroom experimentation.
2. **Adaptive Innovators** – teachers who modify teaching strategies and use differentiated or digital resources according to instructional circumstances.
3. **Transformative Innovators** – teachers demonstrating strong creative agency, pedagogical flexibility, learner participation, interdisciplinary experimentation, and purposeful digital/AI integration.

The central methodological objective is therefore not merely to predict whether a teacher is “creative,” but to identify patterns explaining the transition from creative potential to sustained innovative classroom practice.

Experimental Setup

4.1 Dataset

A simulation-based dataset consisting of **600 teacher-like records** was generated for methodological testing. The records represented secondary-school teaching conditions through 40 predictor variables distributed across eight conceptual domains and selected contextual indicators.

The principal domains were:

- Creative Self-Efficacy (CSE)
- Pedagogical Adaptability (PAD)
- AI Agency (AIA)
- Collaborative Innovation Climate (CLI)
- Self-Regulation (SRG)
- Professional Collaboration (COL)
- Instructional Autonomy (AUT)
- Digital Pedagogical Agency (DIG)

Each domain contained four scale-type indicators scored within a 1–5 range. Contextual variables included teaching experience, approximate class size, professional-development exposure, frequency of AI-supported instructional activity, resource accessibility, assessment flexibility, student voice, and interdisciplinary teaching.

The simulated profile distribution consisted of 204 Emerging Innovators, 204 Adaptive Innovators, and 192 Transformative Innovators. This near-balanced structure reduced the

possibility that overall classification accuracy would be artificially inflated by a dominant class.

The target profile was derived from a latent Creativity-to-Practice Translation Index in which pedagogical adaptability and creative self-efficacy received substantial influence while AI agency, collaborative climate, self-regulation, professional collaboration, autonomy, and digital agency contributed additional effects. Interaction terms were incorporated to represent the theoretical assumption that creativity produces stronger instructional innovation when supportive school conditions and professional self-regulation are simultaneously present.

4.2 Data Preprocessing

Preprocessing was designed to maintain interpretability while avoiding unnecessary transformation. Scale variables were restricted to theoretically meaningful ranges, and continuous contextual characteristics were screened for implausible values.

For algorithms sensitive to feature magnitude, particularly multinomial logistic regression and the radial-basis-function support vector machine, predictors were standardised using training-set means and standard deviations. Tree-based algorithms were trained on the original feature scales because they do not require conventional standardisation.

The proposed workflow for future real-world data additionally includes median imputation for limited numerical missingness, explicit missing-value indicators where non-response may itself be informative, consistency checks for reverse-coded questionnaire items, duplicate detection, and reliability testing of multi-item constructs.

A critical design requirement is that preprocessing parameters must be estimated exclusively from the training sample. Applying transformations before train-test separation would create information leakage and produce overly optimistic model performance.

4.3 Model Architecture

The computational architecture uses a **multi-model comparison strategy** rather than assuming that one algorithm is universally optimal.

Five classifiers were evaluated:

- Multinomial Logistic Regression as a transparent linear baseline;
- Radial Basis Function Support Vector Machine (RBF-SVM) for nonlinear decision boundaries;

- Random Forest for ensemble-based nonlinear classification;
- XGBoost for regularised gradient-boosted decision trees; and
- CatBoost for ordered boosting and interpretable nonlinear modelling.

CatBoost was additionally considered an explanatory model because feature-importance and SHAP-based interpretation can subsequently be used to identify which instructional variables contribute most strongly to innovation-profile predictions.

The architecture therefore separates **predictive performance** from **educational interpretation**. The highest-scoring classifier need not automatically be the most useful model for policy or professional-development decisions if its predictions cannot be adequately explained.

4.4 Training Strategy

The 600 records were stratified into training, validation, and final testing partitions using a **70:15:15 ratio**. This produced approximately 420 training cases, 90 validation cases, and 90 previously unseen test cases while maintaining comparable innovation-profile proportions across subsets.

The RBF-SVM used a nonlinear radial kernel, whereas Random Forest employed a 500-tree ensemble with depth and minimum-leaf constraints to limit excessive fitting. XGBoost used a conservative learning rate with subsampling and feature subsampling. CatBoost was trained through 450 boosting iterations with moderate tree depth.

The model-development strategy emphasised generalisation rather than maximisation of training accuracy. Hyperparameters were determined using the training and validation portions, while the test sample remained isolated until final comparison.

A fixed random seed was retained in the simulation and model-training process to improve computational reproducibility.

4.5 Evaluation Metrics

Because overall accuracy alone can conceal profile-specific weaknesses, multiple complementary evaluation criteria were selected.

Balanced Accuracy measured mean recall across innovation categories and reduced sensitivity to residual class differences.

Macro-F1 Score gave equal importance to all three profiles by combining precision and recall independently for each class.

Matthews Correlation Coefficient (MCC) assessed agreement between predicted and actual profiles while accounting for incorrect classification patterns.

Macro ROC-AUC measured the models' ability to discriminate among innovation categories across probability thresholds.

Log Loss evaluated the quality of probabilistic predictions. Lower values indicate that a model produces better-calibrated and less overconfident probability estimates.

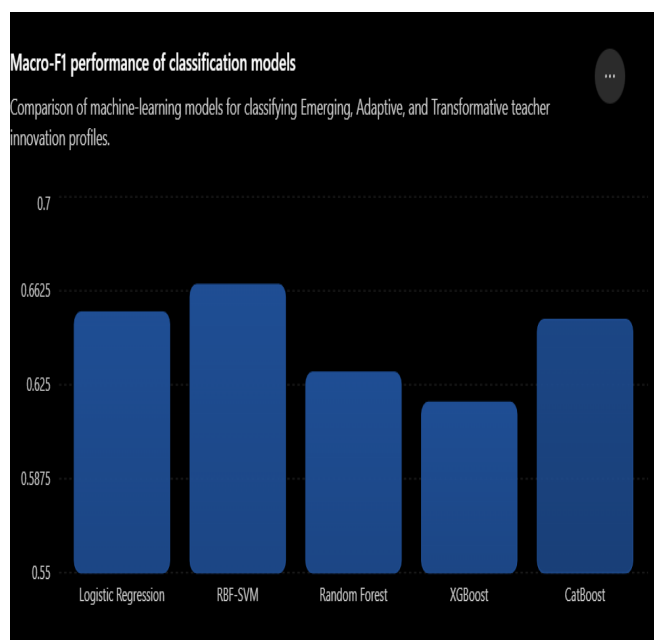
This evaluation framework is particularly appropriate for educational decision support because an algorithm that is slightly more accurate but systematically overconfident may be less useful than a well-calibrated alternative.

Results and Discussion

The experiment produced a comparatively moderate classification pattern rather than near-perfect performance. This is theoretically desirable because teacher innovation was intentionally represented as a multidimensional and partially overlapping phenomenon rather than as three artificially separable categories.

Table 1. Comparative classification performance on the held-out synthetic benchmark

Model	Balanced Accuracy	Macro-F1	MCC	Macro ROC-AUC	Log Loss
Multinomial Logistic Regression	0.659	0.654	0.487	0.846	0.733
RBF-SVM	0.669	0.665	0.501	0.833	0.745
Random Forest	0.635	0.630	0.450	0.843	0.787
XGBoost	0.625	0.618	0.435	0.816	0.796
CatBoost	0.658	0.651	0.485	0.836	0.723



The RBF-SVM achieved the highest balanced accuracy (0.669), Macro-F1 score (0.665), and MCC (0.501), indicating that nonlinear decision boundaries provided a modest advantage when separating the three innovation profiles. The result supports the theoretical assumption that the transition from creativity to innovative practice is unlikely to be fully linear. Strong creative self-efficacy, for example, may not generate transformative practice unless accompanied by pedagogical adaptability, self-regulation, or an enabling organisational climate.

However, logistic regression recorded the highest Macro ROC-AUC of 0.846. This finding is noteworthy because it indicates that many components of the Creativity-to-Practice framework retain systematic additive relationships even though nonlinear interactions improve final categorical assignment. The performance of a comparatively simple linear model also warns against automatically equating algorithmic complexity with educational insight.

CatBoost generated the lowest log loss at 0.723. Thus, although its categorical accuracy was slightly below that of RBF-SVM, its predicted probabilities were more reliable. In practical school analytics, this distinction has considerable importance. A professional-development system should ideally indicate uncertainty—for example, estimating that a teacher has characteristics associated with both adaptive and transformative innovation—rather than forcing every teacher into a rigid category.

Feature-level inspection of the CatBoost model indicated that indicators associated with creative self-efficacy, collaborative innovation climate, AI agency, student voice,

interdisciplinary teaching, self-regulation, and pedagogical adaptability were among the more influential predictors. These patterns are consistent with the proposed theoretical argument that innovative instruction arises from a **configuration of capabilities and conditions**, rather than from technological competence alone.

An especially important implication concerns artificial intelligence. AI-related variables contributed predictive information, but they did not dominate the model. The simulated results therefore support the conceptual distinction between **AI use and pedagogical innovation**. Frequent use of generative AI does not automatically position a teacher within the transformative profile. AI becomes educationally consequential when combined with adaptive lesson design, student participation, professional judgment, creative confidence, and reflective evaluation.

The results also reinforce the proposed Creativity-to-Practice Translation Gap. Teachers may demonstrate strong creative beliefs while remaining in an emerging or adaptive profile when contextual support, autonomy, collaborative opportunities, or self-regulatory capability is limited. Conversely, organisational conditions can amplify moderate individual creativity by providing opportunities for experimentation and professional exchange.

From a school-leadership perspective, this means professional development should not focus exclusively on teaching teachers additional digital tools. More productive interventions would combine creative problem solving, instructional-design practice, collaborative lesson development, ethical AI literacy, experimentation cycles, peer observation, and reflective assessment.

Limitations

The most important limitation is that the experimental evidence is based on a **synthetic benchmark rather than observations collected from actual secondary-school teachers**. The reported metrics demonstrate the computational feasibility of the proposed framework but cannot be interpreted as empirical prevalence rates or causal estimates.

Second, the three innovation profiles simplify a phenomenon that is likely to exist on a continuum. Teachers may also demonstrate subject-specific creativity: an educator can be highly innovative in project-based instruction but conventional in assessment.

Third, questionnaire-style variables may be vulnerable to social-desirability bias when the framework is applied in field research. Future empirical studies should therefore combine self-report measures with classroom observation, lesson plans, student feedback, and instructional artifacts.

Fourth, predictive feature importance does not establish causality. A model may identify collaborative climate as highly informative without demonstrating that changes in climate directly produce changes in teacher creativity.

Finally, responsible AI implementation requires careful attention to privacy and professional consequences. Innovation-profile predictions should not be used as automated teacher-performance ratings.

Future Scope

Future research should validate the framework using multi-school and longitudinal teacher datasets. Repeated classroom observations across an academic year could determine whether teachers move between emerging, adaptive, and transformative profiles following professional-development interventions.

Multimodal analysis represents another promising direction. Natural-language processing could examine lesson plans and reflective journals, while structured observation data could identify frequencies of inquiry, differentiation, student choice, collaborative problem solving, and formative experimentation.

Explainable AI methods such as SHAP could provide teacher-specific explanations showing which factors contribute most strongly to an innovation profile. Such explanations could support personalised professional learning rather than punitive evaluation.

Future studies should also investigate whether subject area, teaching experience, school type, class size, infrastructure, leadership support, and geographic setting modify the relationship between creative self-efficacy and innovative practice.

A particularly important research direction is longitudinal examination of generative AI. Researchers should determine whether sustained AI use expands teachers' creative repertoire or gradually encourages standardised dependence on machine-generated instructional material.

Conclusion

This study advances the analysis of teacher creativity by shifting attention from creative potential alone toward the **translation of creativity into observable innovative classroom practice**. The proposed Creativity-to-Practice Translation Framework integrates creative self-efficacy, pedagogical adaptability, self-regulation, collaborative climate, professional autonomy, digital agency, and responsible AI use within a unified analytical structure.

The simulation-based experiment demonstrates that teacher innovation profiles can be modelled through explainable

machine-learning techniques without assuming that greater algorithmic complexity necessarily produces superior educational understanding. RBF-SVM achieved the strongest categorical classification performance, while CatBoost provided the most favourable probability-based result and greater scope for interpretable analysis.

More fundamentally, the study indicates that technology should be treated as an enabling resource rather than as evidence of innovation itself. Transformative classroom practice emerges when teachers use professional creativity to redesign learning experiences, accommodate learner diversity, encourage student agency, and make contextually appropriate instructional decisions.

Accordingly, schools seeking innovation should invest not merely in technologies but in the conditions through which teachers can experiment, collaborate, reflect, exercise professional agency, and responsibly integrate emerging AI capabilities. Empirical field validation of the framework would provide the next step toward establishing how teacher creativity can be converted into sustained and educationally meaningful innovation in secondary schools.

References :

1. Breiman, L. (2001). Random forests. *Machine Learning*, 45, 5–32. <https://doi.org/10.1023/A:1010933404324>
2. Chen, T., & Guestrin, C. (2016). XGBoost: A scalable tree boosting system. In *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 785–794). ACM. <https://doi.org/10.1145/2939672.2939785>
3. Cortes, C., & Vapnik, V. (1995). Support-vector networks. *Machine Learning*, 20, 273–297. <https://doi.org/10.1007/BF00994018>
4. Cremin, T., & Chappell, K. (2021). Creative pedagogies: A systematic review. *Research Papers in Education*, 36(3), 299–331. <https://doi.org/10.1080/02671522.2019.1677757>
5. Hidayat, L. E., Basthomi, Y., & Afrilyasanti, R. (2024). Exploring secondary school teachers' creativity in differentiated instruction (DI) practices across Indonesian EFL classrooms. *Thinking Skills and Creativity*, 53, 101620. <https://doi.org/10.1016/j.tsc.2024.101620>
6. Huang, X. Y., Lin, C.-H., Sun, M., & Xu, P. (2021). What drives teaching for creativity? Dynamic componential modelling of the school environment, teacher enthusiasm, and metacognition. *Teaching and Teacher Education*, 107, 103491. <https://doi.org/10.1016/j.tate.2021.103491>
7. Lundberg, S. M., & Lee, S.-I. (2017). A unified approach to interpreting model predictions. In *Advances in Neural Information Processing Systems 30* (pp. 4765–4774).
8. Miao, F., & Cukurova, M. (2024). *AI competency framework for teachers*. UNESCO. <https://doi.org/10.54675/ZJTE2084>



9. Miao, F., & Holmes, W. (2023). *Guidance for generative AI in education and research*. UNESCO.
10. Mulyono, H., Falah, Z. A., Suryoputro, G., & Ibarra, F. (2024). Exploring the influence of EFL teachers' informal digital learning on creative classroom instruction: A cross-sectional study. *Discover Education*, 3, 187. <https://doi.org/10.1007/s44217-024-00268-7>
11. OECD. (2024a). *New PISA results on creative thinking: Can students think outside the box?* PISA in Focus, No. 125. OECD Publishing. <https://doi.org/10.1787/b3a46696-en>
12. OECD. (2024b). *PISA 2022 results (Volume III): Creative minds, creative schools*. OECD Publishing. <https://doi.org/10.1787/765ee8c2-en>
13. Prokhorenkova, L., Gusev, G., Vorobev, A., Dorogush, A. V., & Gulin, A. (2018). CatBoost: Unbiased boosting with categorical features. In *Advances in Neural Information Processing Systems 31* (pp. 6638–6648).
14. Skrbinek, V., Vičič Krabonja, M., Aberšek, B., & Flogie, A. (2024). Enhancing teachers' creativity with an innovative training model and knowledge management. *Education Sciences*, 14(12), 1381. <https://doi.org/10.3390/educsci14121381>
15. Vincent-Lancrin, S., González-Sancho, C., Bouckaert, M., de Luca, F., Fernández-Barrera, M., Jacotin, G., Urgel, J., & Vidal, Q. (2019). *Fostering students' creativity and critical thinking: What it means in school*. OECD Publishing. <https://doi.org/10.1787/62212c37-en>
16. Zielińska, A., Lebuda, I., Gop, A., & Karwowski, M. (2024). Teachers as creative agents: How self-beliefs and self-regulation drive teachers' creative activity. *Contemporary Educational Psychology*, 77, 102267. <https://doi.org/10.1016/j.cedpsych.2024.102267>
17. Zou, H., & Hastie, T. (2005). Regularization and variable selection via the elastic net. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, 67(2), 301–320. <https://doi.org/10.1111/j.1467-9868.2005.00503.x>