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Chapter 8: Digital Assessment Literacy among Teachers in Secondary Education

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Abstract— Digital assessment has become embedded in secondary education, yet teachers' ability to operate assessment platforms does not necessarily indicate competence in interpreting or acting on digitally generated evidence. This study conceptualizes Digital Assessment Literacy (DAL) as an integrated professional capability combining assessment design, digital data interpretation, feedback orchestration, AI-informed judgment, validity awareness, and ethical management of learner data. A critical research gap is identified in the limited empirical distinction between teachers' frequency of technology use and their actual capacity to make defensible instructional decisions from digital assessment information. Existing studies have largely examined general assessment literacy, digital competence, higher education populations, or teachers' self-reported confidence rather than performance-based competence among practicing secondary-school teachers. The present research therefore proposes a multidimensional investigation of DAL using contextual assessment scenarios, digital assessment decision tasks, teacher characteristics, and technology-use patterns. **Keywords—** Digital Assessment Literacy, Secondary Education, Teacher Competence, Artificial Intelligence in Assessment, Learning Analytics, Formative Assessment

Introduction

Assessment in secondary education is undergoing a transition from periodically administered paper-based tests toward increasingly data-rich digital environments. Learning management systems, online quizzes, electronic portfolios, automated scoring applications, classroom-response systems, adaptive platforms, plagiarism-detection systems, and artificial-intelligence-supported feedback mechanisms can now generate information about student performance at a speed and level of granularity that conventional classroom assessment rarely provided. This technological development has altered not only the medium through which assessment occurs but also the competencies teachers require to interpret assessment evidence responsibly.

The distinction between **using digital assessment technology** and being **digitally assessment literate** is therefore increasingly important. A teacher may be proficient in creating an online multiple-choice examination, downloading a grade report, or using automated feedback while remaining uncertain about item quality, measurement error, score comparability, validity, bias, or the instructional meaning of the patterns displayed on a dashboard. Digital assessment literacy consequently extends beyond technical fluency. It requires teachers to understand what digital assessment information

represents, determine whether the evidence is sufficiently trustworthy for a particular decision, and translate that evidence into pedagogically appropriate action.

This distinction has become more significant since the rapid diffusion of artificial intelligence and generative AI. The OECD has observed that digital education systems increasingly incorporate data infrastructure, digital assessment platforms and emerging AI capabilities while continuing to depend on teachers to convert these technological resources into meaningful educational practice. Its *Digital Education Outlook 2023* further emphasizes that the presence of digital infrastructure does not automatically constitute educational transformation and that teachers remain central to interpreting and using technology appropriately.

Generative AI has introduced additional assessment complications. Students can now produce, revise, summarize, translate, or generate written and multimodal content through AI systems, complicating conventional assumptions about authorship and the validity of take-home assessment tasks. Simultaneously, teachers themselves may use AI to generate questions, construct rubrics, classify responses, summarize student misconceptions, or produce feedback. Such applications can increase assessment efficiency but also create risks involving inaccurate recommendations, algorithmic bias, inappropriate automation, privacy, intellectual property, and over-reliance on machine-generated judgments. UNESCO's guidance on generative AI in education consequently advocates human-centred validation, data protection and pedagogically appropriate use rather than uncritical technological adoption.

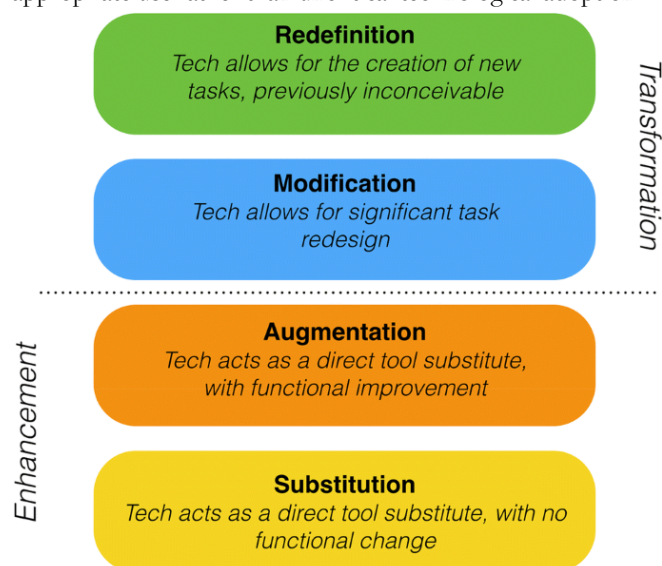


Fig. 1: From digital literacy to digital competence

Source: <https://link.springer.com/article/10.1007/s11423-020-09767-4>

The European Commission similarly identifies ethical competence in AI and educational data as increasingly relevant to teachers, including those working in primary and secondary schools. Its guidance emphasizes that educators need sufficient understanding to engage critically with AI-supported systems and recognize the ethical implications of educational data use. These developments suggest that contemporary assessment literacy should incorporate algorithmic judgment and data ethics alongside more established competencies such as test construction, validity, reliability, grading, feedback and interpretation.

Recent scholarship has begun to formalize this expanded competence. Estaji, Banitalebi and Brown's 2024 scoping review analyzed 63 publications and proposed the concept of **Teacher Assessment Literacy in Digital Environments (TALiDE)**. Their synthesis demonstrates that assessment competence in digital environments incorporates interconnected knowledge, cognitive and contextual components rather than being reducible to technological skills. Banitalebi, Estaji and Brown subsequently developed a multidimensional scenario-based instrument for measuring TALiDE, reflecting growing recognition that teachers should be evaluated through assessment situations requiring judgment rather than through simple measures of perceived technological confidence.

Nevertheless, three problems remain particularly relevant to secondary education.

First, **technology use can be mistaken for competence**. Schools may record the number of digital quizzes administered, platform logins or tools adopted as indicators of technological readiness. Such measures reveal behavioural adoption but provide little information regarding whether teachers can recognize a poorly constructed assessment item, interpret an unusual score distribution, evaluate an AI-generated question, distinguish correlation from meaningful learning evidence, or decide when an automated recommendation should be overridden.

Second, **digital assessment literacy is frequently investigated through self-perceptions**. Self-reported confidence is valuable for understanding attitudes and perceived professional-development needs, but confidence and demonstrated competence need not be equivalent. A teacher may report high confidence in online assessment while applying inappropriate interpretations to analytics. Conversely, teachers with strong assessment reasoning may report modest technological self-efficacy. Performance-oriented scenarios are therefore necessary to examine what teachers actually decide when confronted with realistic digital assessment problems.

Third, **secondary education has distinctive assessment conditions**. Secondary teachers work across subject specializations, examination-oriented environments and heterogeneous learner groups. They frequently combine school-based formative assessment with externally influenced curricular and examination requirements. Evidence from junior secondary schools already suggests that the relationship between teachers' assessment literacy, practices and beliefs

requires closer empirical attention. Brown, Barnes and Finefter-Rosenbluh's investigation of teachers in Victorian junior secondary schools, for example, highlighted the need to understand assessment literacy as situated professional practice rather than isolated technical knowledge.

The present study responds to these issues by defining DAL as the capacity to **design, administer, interpret, critique and pedagogically act upon digitally mediated assessment evidence while maintaining validity, fairness, transparency, privacy and human oversight**. Rather than asking only whether teachers use digital assessment, the research examines whether they know *when to trust digital evidence, what conclusions can legitimately be drawn from it, and what instructional response should follow*.

Accordingly, the central objective is to investigate multidimensional digital assessment literacy among practicing secondary-school teachers and determine which combinations of assessment knowledge, digital practices, AI awareness and data-interpretation competence distinguish stronger from weaker assessment decision-making.

Literature Review

2.1 From Traditional Assessment Literacy to Digital Assessment Literacy

Teacher assessment literacy has traditionally been concerned with teachers' knowledge and practices relating to assessment selection, construction, interpretation, grading, communication and instructional use. Contemporary literature increasingly treats assessment literacy as contextual rather than as a static collection of measurement concepts. A 2024 descriptive review of the assessment-literacy literature found substantial variation in definitions and instruments and emphasized that assessment knowledge interacts with teachers' beliefs, efficacy and professional contexts. It also identified professional training and reflective assessment practice as important mechanisms through which assessment literacy can be strengthened.

Digital environments complicate this established construct because the assessment process is increasingly mediated by algorithms, interfaces and automatically generated information. Teachers can receive response-level analytics, completion times, item statistics and predicted performance indicators without calculating these measures themselves. Access to additional data, however, does not guarantee better decisions. More information can create erroneous confidence when visualizations or automated classifications are accepted without evaluating their measurement assumptions.

Estaji et al.'s TALiDE framework represents a significant conceptual development because it explicitly positions assessment literacy at the intersection of assessment knowledge, digital environments and contextual professional competence. Their review concludes that neither conventional digital literacy nor conventional assessment literacy alone adequately represents the knowledge required for contemporary digital assessment practice. This observation is central to the current study: DAL should not be operationalized merely as the sum of a digital-skills questionnaire and a traditional assessment-literacy questionnaire.

2.2 Digital Assessment Design and Evidence Quality

Digital technologies substantially expand the formats available for assessing learning. Teachers can use multimedia questions, simulations, branching activities, collaborative tasks and automatically scored assessments. Yet increased technological sophistication can obscure fundamental assessment principles. An attractive interactive question may still measure an unintended construct; automated scoring may be efficient without being sufficiently valid for high-stakes decisions; and continuous platform data may represent student activity rather than meaningful cognitive achievement.

DAL therefore requires competence at the interface between **assessment design and digital affordance**. Teachers need to select assessment formats according to learning objectives rather than technological novelty, recognize threats to construct validity and distinguish diagnostic or formative information from evidence suitable for summative judgment.

Recent work on assessment literacy in blended environments further reinforces the multidimensional nature of this competence. Research developing a blended assessment-literacy scale for second-language teachers identified knowledge, attitude, practice and socio-emotional management as separable but related dimensions. Although discipline-specific, the findings demonstrate that assessment competence in technology-mediated settings cannot be understood solely through procedural knowledge.

2.3 Learning Analytics and Data-Informed Interpretation

Digital assessment systems produce substantially more information than traditional classroom tests. Dashboards may display mastery categories, response patterns, time-on-task measures, class averages, individual trajectories or automatically generated risk classifications. These features create the possibility of rapid formative intervention but introduce a critical interpretive challenge.

A digitally assessment-literate teacher must distinguish **data availability from evidentiary value**. For example, low time-on-task may indicate disengagement, prior mastery, rapid guessing, connectivity disruption or an artefact of platform behaviour. Similarly, a red warning symbol on a dashboard is not an educational diagnosis unless the underlying indicator and decision rule are understood.

This issue connects DAL with data literacy but remains assessment-specific because interpretation must ultimately be linked to the validity of an inference about student learning. The teacher must determine not simply what the data show but whether the evidence warrants changing instruction, providing remediation, reassessing a learner or gathering additional evidence.

2.4 AI-Assisted Assessment and Human Judgment

The expansion of generative AI since 2022 has changed the assessment environment particularly rapidly. The OECD identifies generative AI as a direct challenge to conventional homework, assignments and examinations while recommending stronger teacher AI literacy so that educators can critically assess machine outputs and recommendations.

Within assessment practice, AI may support item generation, rubric development, automated feedback, classification and performance prediction. The crucial DAL competency is not the ability to invoke such tools but the capacity to **audit their educational appropriateness**.

Teachers must determine whether an AI-generated test item is aligned with intended outcomes, whether distractors are plausible, whether a generated rubric introduces hidden assumptions, whether automated feedback corresponds to the student's actual work and whether predictive labels could unfairly shape expectations. AI-supported assessment therefore changes the role of teachers from exclusive producers of assessment materials toward evaluators and supervisors of hybrid human-machine assessment processes.

2.5 Ethics, Privacy, Fairness and Academic Integrity

Digital assessment also produces ethical obligations that were less technologically complex in conventional classrooms. Student responses may be stored remotely, behavioural traces can be retained across platforms, and algorithmic systems may process information whose downstream use is unclear to teachers or learners. Ethical digital assessment competence consequently includes data minimization, appropriate access, transparency and the ability to question unnecessary collection of learner information.

Fairness is equally important. Differences in device quality, connectivity, accessibility requirements and familiarity with digital interfaces may influence performance independently of subject competence. A digitally delivered assessment is therefore not automatically equivalent to a paper assessment simply because both contain similar questions.

Academic integrity has also become more complicated. The availability of generative AI makes purely detection-oriented responses increasingly inadequate. Teachers require assessment-design strategies capable of eliciting authentic evidence of reasoning, process and application while establishing appropriate rules for permitted AI assistance. UNESCO's human-centred approach is particularly relevant because it places human accountability and pedagogical purpose above unrestricted automation.

2.6 Professional Development and the Competence–Use Gap

Teacher professional development frequently emphasizes how to operate digital tools. Training may demonstrate how to build an online quiz, configure a learning-management-system gradebook or create automated feedback. These are useful operational competencies but do not necessarily strengthen assessment reasoning.

The distinction is important because high technological confidence could coexist with limited measurement knowledge. Conversely, experienced teachers may possess strong assessment judgment while using a relatively narrow range of digital applications. Research involving pre-service secondary teachers has recently shown substantial interest in online assessment tools and perceptions of their efficiency and transparency, further illustrating the growing prominence of digital assessment in teacher preparation. What remains less

clear is whether increased familiarity with such tools predicts stronger performance when teachers must interpret ambiguous evidence or challenge an automated decision.

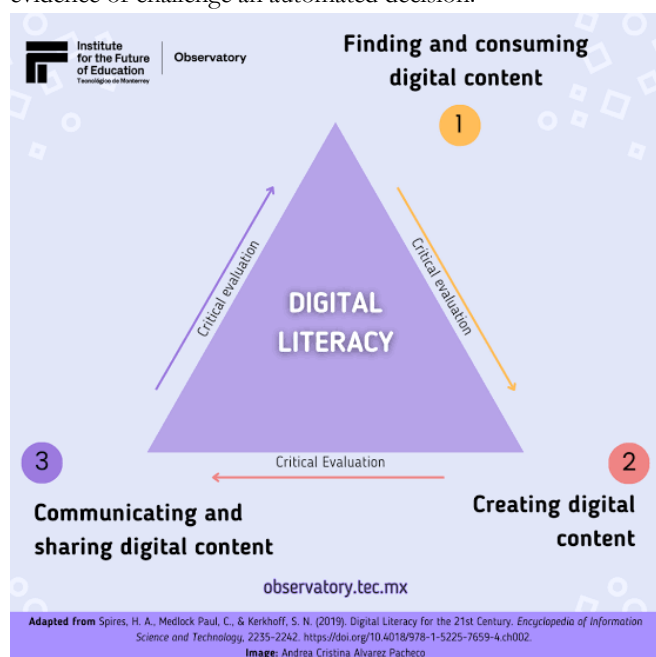


Fig. 2: Digital Literacy

Source: <https://observatory.tec.mx/edu-news/strategies-digital-literacy/>

Proposed Methodology

The study adopts a **simulation-informed, performance-oriented machine-learning design** to examine digital assessment literacy (DAL) without presenting uncollected teacher responses as empirical field data. The central methodological distinction is between **digital assessment usage** and **demonstrated assessment judgment**. Rather than defining a digitally competent teacher according to platform frequency alone, DAL is represented through the capacity to interpret assessment evidence, validate automated outputs, select appropriate instructional responses, and recognize ethical or measurement risks.

A synthetic benchmark containing **1,500 secondary-teacher profiles** was constructed for the computational experiment. The benchmark was designed to reproduce plausible combinations of professional experience, continuing professional development, digital-tool use, formal assessment training, learning-analytics exposure, AI-assisted assessment use, AI-verification habits, privacy and ethics training, school digital maturity, and teaching-subject cluster. These records are simulated observations and therefore should not be interpreted as prevalence estimates for any actual teacher population.

The criterion variable was generated independently from simple technology-use frequency. DAL competence was represented through an aggregate scenario-performance construct corresponding to 18 hypothetical assessment decisions distributed across six dimensions:

- assessment design and curricular alignment;
- interpretation of digital analytics;
- formative feedback decisions;

- verification of AI-generated assessment outputs;
- validity, reliability and fairness reasoning; and
- privacy, transparency and academic-integrity judgment.

The aggregate competence score was converted into three ordered classes: **Level 0—Developing DAL**, **Level 1—Functional DAL**, and **Level 2—Advanced DAL**. Class thresholds were determined using equal-frequency cut points in the synthetic benchmark to prevent class imbalance from artificially influencing classifier evaluation.

Experimental Setup

4.1 Dataset

The final computational dataset contained 1,500 synthetic teacher-level observations. Predictor variables included years of teaching experience, frequency of digital assessment use, continuing professional-development hours, prior formal assessment training, learning-analytics exposure, frequency of AI-assisted assessment use, AI-output verification behaviour, ethics/privacy training, perceived school digital maturity, and subject cluster.

The subject variable included four broad categories: STEM, languages, social sciences, and commerce/other subjects. Continuous indicators were represented on appropriate bounded or positively skewed scales to reproduce realistic professional profiles.

Importantly, the scenario-performance score used to derive the DAL class was **not included among the predictors**. This prevented direct target leakage and required the models to infer competence from teachers' professional-development and behavioural characteristics.

4.2 Preprocessing

Initial preprocessing involved range validation, categorical encoding and feature-type separation. No synthetic missing values were introduced because the primary objective was to evaluate structural predictability rather than missing-data robustness.

For the multinomial logistic-regression baseline, continuous predictors were standardized to zero mean and unit variance. Subject categories were one-hot encoded.

Random forest received continuous variables in their original numerical form, while categorical teaching-subject information was converted to indicator variables.

CatBoost retained the subject-cluster variable as a native categorical feature. This approach avoided unnecessary expansion of the categorical variable and permitted nonlinear interactions between professional, technological and assessment-related characteristics.

The complete dataset was separated at the teacher-profile level into:

- **70% training data;**
- **15% validation data;** and
- **15% independent test data.**

Stratified partitioning preserved equal representation of the three DAL classes.

4.3 Model Architecture

Three classifiers were evaluated.

The first was **multinomial logistic regression**, included as an interpretable linear baseline. It estimates class probabilities from additive relationships between teacher characteristics and DAL level.

The second was a **random forest classifier** consisting of multiple decision trees. This architecture was selected because professional competence may involve nonlinear threshold effects that linear models cannot represent efficiently.

The principal architecture was **CatBoost multiclass gradient boosting**. The final configuration used a maximum of 700 boosting iterations, tree depth of six, a learning rate of 0.035, L2 regularization, and validation-based early stopping. Training terminated near iteration 386 when additional boosting no longer produced meaningful validation improvement.

CatBoost was selected because DAL was hypothesized to arise from conditional combinations of professional behaviours. For example, frequent AI use might be beneficial when accompanied by systematic verification but comparatively uninformative—or even risky—when verification behaviour is weak. Tree-based boosting is suitable for representing such interactions without manually specifying every combination.

4.4 Training Strategy

Model development followed a three-stage strategy.

First, each algorithm was trained only on the training partition. Second, hyperparameter decisions and stopping behaviour were assessed using the validation partition. Third, the locked models were evaluated on the untouched test partition.

No oversampling was required because the three DAL categories contained equal numbers of synthetic profiles. For CatBoost, early stopping was employed to reduce overfitting.

The experiment deliberately emphasized **generalization and calibration rather than raw accuracy alone**. In teacher-development applications, an apparently confident but poorly calibrated classification could be more problematic than a moderately accurate prediction accompanied by realistic uncertainty.

4.5 Evaluation Metrics

Six complementary measures were employed.

Accuracy represented the overall proportion of correctly classified DAL profiles. **Balanced accuracy** calculated performance equally across the three competence categories.

Macro-F1 measured the balance between precision and recall without allowing any single DAL level to dominate the result. Because DAL categories possess a natural ordering, **quadratic weighted Cohen's kappa** was included to penalize severe classification errors more strongly than adjacent-level errors. A prediction of Advanced rather than Functional DAL is consequently treated as less serious than confusing Advanced with Developing DAL.

Results and Discussion

The experiment produced a moderate level of predictability across all three algorithms, which is preferable to unrealistically

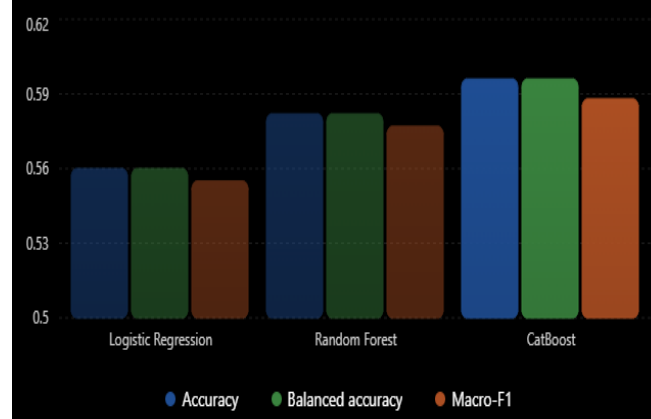
near-perfect classification in a multidimensional behavioural construct. CatBoost achieved the strongest overall classification performance, while multinomial logistic regression remained competitive on ordinal agreement. The results therefore suggest that both additive relationships and nonlinear interactions contribute to the synthetic DAL construct.

Table 1. Comparative Performance of Models for DAL-Level Classification

Model	Accuracy	Balanced Accuracy	Macro-F1	Quadratic Weighted κ	Multiclass Brier Score ↓
Multinomial Logistic Regression	0.560	0.560	0.555	0.591	0.525
Random Forest	0.582	0.582	0.577	0.581	0.516
CatBoost	0.596	0.596	0.588	0.586	0.521

Performance comparison of DAL classification models

Comparison of accuracy, balanced accuracy, and macro-F1 on the synthetic test benchmark.



The CatBoost model reached a test accuracy of 0.596 and macro-F1 of 0.588. These values indicate that professional and behavioural variables contained useful information about DAL category, but they did not deterministically reveal competence. This is educationally plausible: assessment literacy is unlikely to be completely inferred from experience, training history or technology use without observing actual teacher decision-making.

The weighted kappa of approximately 0.586 for CatBoost indicates moderate-to-substantial agreement when the ordered nature of DAL levels is considered. Logistic regression obtained a slightly higher weighted kappa of 0.591 despite lower overall accuracy. This result suggests that its errors were more often between adjacent competence levels. CatBoost, however, provided the best balance between classification performance and probabilistic calibration, recording the lowest ECE of 0.050.

Feature-importance analysis provided additional insight. **Learning-analytics exposure** was the strongest predictor in the final model, contributing approximately 21.2% of model importance. **AI-verification behaviour** followed at approximately 17.9%, while formal assessment training contributed approximately 10.6%. Continuing professional-development exposure accounted for roughly 9.0%.

The competence–use discrepancy analysis reinforced this point. Approximately 65.6% of profiles classified within the highest third of digital-tool usage did not simultaneously belong to the Advanced DAL category. Conversely, a meaningful group displayed Advanced DAL despite not being among the highest-frequency digital-tool users.

These synthetic findings illustrate why school systems should avoid using platform activity as a proxy for teacher competence. Logging into assessment software frequently, administering many online quizzes, or regularly using automated feedback can indicate technological engagement, but these behaviours provide limited evidence regarding the validity of teachers' interpretations.

A particularly important nonlinear relationship was observed for AI-supported assessment. Among profiles combining **high AI-assessment use with weak AI-verification behaviour**, only about 16% were categorized as Advanced DAL. In contrast, approximately 71% of profiles combining high AI use with strong verification behaviour reached the Advanced category.

The implication is not that AI use itself reduces assessment competence. Instead, the model suggests that **AI verification acts as a competence moderator**. Teachers who employ AI while critically checking question quality, scoring logic, feedback accuracy and contextual appropriateness represent a fundamentally different assessment profile from teachers who accept automated recommendations without scrutiny.

This distinction is increasingly important in secondary schools. Generative systems can rapidly produce examination questions and rubrics, yet fluent wording does not guarantee curricular alignment, appropriate cognitive demand, factual accuracy or fairness. Consequently, future professional-development programmes should teach teachers how to audit AI-generated assessment content rather than simply how to generate it.

The prominence of analytics exposure similarly indicates that teachers require experience interpreting evidence rather than merely receiving dashboards. Professional development should therefore use authentic assessment cases: unusual response distributions, conflicting indicators, misleading averages, uncertain predictions and cases where additional evidence is required before intervening.

The experiment also suggests that years of teaching experience alone is not an adequate indicator of advanced DAL. Experienced teachers may possess considerable pedagogical judgment while still requiring specific preparation for algorithmic feedback, privacy-sensitive assessment, learning analytics and AI-assisted evaluation.

Thus, the principal finding is conceptual as much as computational: **digital assessment literacy appears better**

represented as evidence-governance competence than as software proficiency. Teachers need to decide whether evidence is valid, what uncertainty surrounds it, whether automation should be trusted, and what educational action is justified.

Limitations

The most important limitation is that the computational dataset is synthetic. The results demonstrate the feasibility of the proposed modelling framework but cannot establish actual prevalence, causal relationships, or national differences among secondary-school teachers.

Second, the three DAL categories were derived from simulated scenario-performance distributions. Real teachers may demonstrate substantially more complex competence profiles, including high ability in assessment design but lower competence in privacy or AI verification.

Third, school infrastructure, examination policy, teacher workload, socioeconomic context and access to professional development were represented only partially. These contextual factors may substantially influence real-world assessment practice.

Fourth, feature importance should not be interpreted causally. A variable may contribute strongly to model predictions without independently producing higher assessment literacy. Finally, the model does not evaluate longitudinal changes. DAL is a developable professional competence and should ideally be measured repeatedly before and after targeted training.

Future Scope

Future research should validate the framework using an ethically approved multisite sample of practicing secondary-school teachers. The scenario instrument could include interactive dashboard tasks, AI-generated examination questions requiring teacher review, automated feedback containing deliberate errors, item-analysis problems, privacy dilemmas and fairness-sensitive assessment decisions.

A particularly useful extension would involve **multimodal DAL assessment**. In addition to questionnaire responses, future studies could examine teachers' decision paths, response times, confidence ratings, revision behaviour and explanations for overriding AI recommendations.

Longitudinal studies should evaluate whether targeted professional development improves not merely teachers' confidence but their demonstrated decision quality. Experimental groups could receive training in learning analytics, AI auditing and digital-assessment ethics, while comparison groups receive conventional platform-operation training.

Future computational work could also develop interpretable ordinal models in which DAL progression is explicitly represented from Developing to Functional to Advanced competence. Fairness audits should determine whether classification error varies systematically across subject specialization, gender, school type, geographical location or resource availability.

Generative AI provides another major research direction. Future studies should distinguish between **AI use intensity** and **AI governance competence**, examining when teacher-AI

collaboration enhances assessment validity and when automation introduces new sources of error.

Conclusion

Digital transformation has expanded the quantity and speed of assessment information available to secondary-school teachers, but greater access to digital evidence does not automatically produce stronger assessment judgment. The present study therefore conceptualized Digital Assessment Literacy as a multidimensional professional competence integrating assessment design, analytics interpretation, feedback decisions, AI verification, validity reasoning, fairness, privacy and academic-integrity awareness.

A simulation-informed machine-learning experiment was developed to test the distinction between digital-tool usage and demonstrated assessment competence. Among the evaluated models, CatBoost achieved the strongest overall classification performance and the most favourable calibration error, demonstrating the value of modelling nonlinear interactions among teacher characteristics.

More importantly, the analysis showed that frequent digital-tool use was not a sufficient indicator of advanced DAL. Learning-analytics exposure, AI-verification behaviour and formal assessment preparation were more informative than technology-use frequency alone. High AI usage was associated with substantially different competence profiles depending on whether teachers systematically verified automated outputs.

The study therefore proposes a shift in teacher-development policy from **tool-centred digital training to judgment-centred digital assessment development**. Secondary-school teachers should not merely be trained to administer online assessments or invoke AI systems; they should be prepared to question evidence, identify measurement limitations, examine automated recommendations, protect learner data and make defensible instructional decisions.

Within increasingly AI-mediated educational environments, the most consequential teacher competence may not be the ability to obtain more data, but the ability to determine **which digital evidence deserves trust, how much confidence it warrants, and what educational action it legitimately supports**.

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