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Leveraging learning analytics to support teachers' professional development: insights from a digital application

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This study investigates the effectiveness of a digital application with a Learning Analytics module in supporting teachers' professional development. The user experience of unqualified teachers, qualified teachers and professional assessors is assessed to determine how the digital application contributes to understanding and progression towards higher levels of qualification. Learning Analytics is presented as a mechanism for identifying developmental needs, improving performance and fostering professional growth. The digital application allows for ongoing monitoring of teaching competences, self-assessment and feedback. The results show that the digital application effectively promotes self-development and improves pedagogical skills by enabling teachers to monitor their professional development progress and teaching practices. As a result, users report increased confidence and self-esteem, which highlights the role of the application in supporting continuous professional growth.

KEYWORDS

professional development, learning analytics, self-assessment, digital application, lifelong learning

1 Introduction

The teacher has a key role in every educational system. Retaining teachers in the profession while simultaneously supporting their professional development (PD) represents one of the main challenges in contemporary education (Fairman et al., 2020). Teacher PD and qualification remain pressing concerns in education management worldwide [Cardichon et al., 2020; Ladd and Sorensen, 2016; Sutchter et al., 2016; UNESCO IICBA (International Institute for Capacity-Building in Africa), 2017]. Societal changes, teacher shortages, and rapid technological advancements further intensify these challenges and demand new approaches and teaching models (Manalu et al., 2023). At the same time, conceptions of learning have evolved, alongside teachers' willingness to consider learners' individual needs, adapt content, and align learning goals with students' prior knowledge, abilities, and progress (Chounta et al., 2022).

Research consistently shows that teacher qualifications and experience are critical for learners' opportunities, well-being, and academic achievement (Cardichon et al., 2020; Li et al., 2022). While most studies on Learning Analytics (LA) emphasize its use in monitoring teacher behavior in technology-enhanced environments (Gabbi, 2022), its potential to directly support teacher PD remains underexplored.

Evaluating teacher competence is a multifaceted process (Zeggelaar et al., 2020), often framed either as a political interest (Popkewitz, 2000; Sachs, 2003) or as a pathway to improve teaching quality (Kraft and Gilmour, 2016). This duality presents challenges, particularly in Estonia, where teachers lack structured opportunities to continuously monitor their PD,

engage in self-assessment, and systematically document their progress (Leibur et al., 2020). Furthermore, there is limited access to automated data collection and analysis tools that would allow teachers to identify their professional strengths and weaknesses through visualized feedback. In this regard, LA offers significant potential by enabling the identification of teachers' unique features, goals, and motivations, while providing summarized feedback to support competence evaluation (Chatti et al., 2012). A web-based technological solution could therefore enhance lifelong learning by offering teachers comprehensive tools for assessment, feedback, and PD monitoring.

Previous studies have already identified shortcomings in the qualification process, as well as the needs and expectations of stakeholders regarding a digital application. Building on these findings, a theoretical concept for such an application was proposed (Leibur et al., 2021, 2023). This solution would allow teachers to integrate data from multiple digital systems and applications, both to demonstrate competence during qualification procedures and to receive immediate feedback on their PD in line with professional standards (PS). In doing so, teachers could more effectively identify their developmental needs, fostering continuous self-improvement (Simons and Ruijters, 2014). The application would also support teachers in assessing their professionalism according to competency-based job descriptions outlined in PS documents. Considering that self-reflection has traditionally been a time-consuming and labour-intensive process, and that no secure platform currently exists for storing and analyzing PD data (Leibur et al., 2021), the development of an LA-powered self-evaluation module is highly relevant. Such a module could enable teachers to evaluate their professionalism against the PS, which outlines the skills, knowledge, attitudes, and activities required in the profession (Kutsekoda, 2019).

This research therefore focuses on how teachers' continuous self-development can be supported through a digital application that incorporates an LA module. LA is framed here as a tool to support teachers as Learning Professionals (Simons and Ruijters, 2014), enabling them to engage in self-assessment, identify personal learning needs, and enhance the effectiveness of their PD. The opportunities offered by technology to facilitate self-development, self-evaluation, and feedback on competencies are analyzed through the lens of the Learning Professionals model (Pedaste et al., 2019; Simons and Ruijters, 2014) and the LA framework (Greller and Drachler, 2012).

For this purpose, a non-commercial digital Teacher Appraisal and Professional Portfolio (TAPP) was developed and evaluated through a qualitative study of user experiences. The TAPP allows teachers to draw on application feedback and database resources for both professional qualification applications [Estonian (EstQR), 2024; European Qualifications Framework (EQF), 2024] and self-evaluation, supporting the assessment of professional levels and PD needs. The study objectives are: (1) To explore the potential of LA in supporting teachers' professional development (PD), (2) To move beyond the use of LA to monitor teacher behavior and instead apply it as a tool for self-assessment, feedback and reflection, (3) To assess the functionality and usefulness of the TAPP, (4) To assess how effectively TAPP supports teachers in collecting, visualising and analysing their professional data, (5) To explore teachers' and professional assessors' perceptions of TAPP and to determine whether the application meets their needs in terms of self-assessment, PD and the qualification process, (6) To

identify how TAPP contributes to the recognition of teachers' development needs and the promotion of lifelong learning, (7) To explore how digital solutions can make self-reflection more systematic, effective and aligned with professional standards.

The aim of this article is therefore to explore teachers' and professional assessors' evaluations of the TAPP's functionality in identifying PD and developmental needs, and to assess whether the application fulfilled its intended purpose. Based on this, the research question was formulated: How do teachers (qualified and unqualified) and professional assessors evaluate the usefulness and effectiveness of the TAPP for professional development and the identification of developmental needs in the qualification process?

2 Theoretical framework

This study integrates two complementary perspectives: the Framework for Learning Analytics (Greller and Drachler, 2012) and the Model of the Learning Professional (Simons and Ruijters, 2014; Pedaste et al., 2019). Together, they inform both the design of the digital application and the interpretation of its use.

Greller and Drachler (2012) delineate six critical dimensions that any learning-analytics-enabled environment should justify: (1) stakeholders (e.g., learners, teachers, institutions); (2) goals; (3) data; (4) instruments (methods, algorithms, and visualizations, including the pedagogical assumptions they embed); (5) external constraints (ethics, privacy, law, politics); and (6) internal constraints (notably users' competencies and interpretive capacities). While the framework treats learning environments as theoretically pedagogically neutral, it cautions that technologies are never entirely neutral in practice; realized benefits depend on how competencies, ethics, and goals are specified and enacted.

Simons and Ruijters (2014) reconceptualize professionalism as a deliberately assumed stance inseparable from continuous learning. They identify core characteristics – commitment, integrity, body of knowledge, theory of action, and professional framework – and link these to four learning modes: individual, collective, research-based, and practice-based. Pedaste et al. (2019) further elaborate this model of the “self-defined learning professional,” emphasizing the dynamic interplay between professional attributes and preferred learning modes.

Because the concept of the Learning Professional underpins the digital application developed here, the analysis proceeds in three steps: first, it outlines the Learning Analytics framework; second, it presents the Model of the Learning Professional; and third, it examines their points of intersection. In particular, the study maps the six Learning Analytics dimensions onto the characteristics and learning modes of the Learning Professional to derive design and implementation implications for the application.

2.1 Learning analytics

Learning Analytics has become a central area of technology-enhanced learning because of its potential to improve teaching and learning while supporting institutional decision-making (Ferguson, 2012). It provides teachers with feedback, both visual and verbal, on their professional competence and helps assess the alignment of

competencies and practices to strengthen teaching effectiveness (Boud and Molloy, 2012).

LA contributes to teacher professionalism by identifying development needs, offering data on teaching practices and student outcomes, and enabling goal setting for growth. This process fosters reflective practice, a key element of lifelong professional development (Qazi and Pachler, 2024). Beyond diagnostics, LA can personalize professional development opportunities by addressing individual needs, while also highlighting both strengths and areas requiring improvement. Such feedback helps teachers refine their practices and access targeted resources and support (Banihashem et al., 2022). At the institutional level, access to performance data encourages a culture of continuous learning within schools and districts, motivating teachers to engage in ongoing professional development (de La Hoz-Ruiz et al., 2024).

To support these processes, Greller and Drachsler (2012) proposed a framework for LA that identifies six critical dimensions: stakeholders, goals, data, resources, external constraints, and internal limitations (Figure 1). According to Joksimović et al. (2019), these dimensions shape the functionality of LA. They encompass the roles of learners, teachers, and institutions; the objectives of analysis; the types of data collected; the methods, algorithms, and pedagogical constructs applied; as well as external considerations such as ethics, privacy, law, and policy, and internal factors such as competence and interpretive literacy. Although designed as pedagogically neutral, the framework underscores that technologies are never entirely neutral in practice – their benefits depend on how competences, ethics, and objectives are managed. Central to this model are visual feedback and pedagogical interventions (a pedagogical LA intervention refers to orchestrating how analytic tools, data, and reports are integrated into teaching and learning activities. It is not just technology – it involves designing when, who, why, and how LAs are used in context), as they directly influence teaching behavior (Greller and Drachsler, 2012). Thus, Professionals (teachers) act as mediators, interpreting analytics to decide when and how to intervene pedagogically. Designing interventions becomes a reflective, skillful practice

requiring both technical awareness and pedagogical insight (Greller and Drachsler, 2012; Simons and Ruijters, 2014).

This framework also illustrates how LA can evaluate didactic approaches and generate evidence to support pedagogical theories of learning. Linking LA to theory reinforces the validity of measuring professional competencies and provides a foundation for interpreting results (Joksimović et al., 2019). By integrating insights from both LA and the concept of Learning Professionals, teachers are positioned as active participants in lifelong learning. This integration enhances professionalism through self-reflection, the identification of development opportunities, and the provision of actionable insights via visual and verbal feedback.

2.2 Teacher as a learning professional

Simons and Ruijters (2014) define a Learning Professional as an individual who is engaged in continuous learning to improve their professional practice and learning from others. The concept is based on the teacher as a specialist—a “knowledge worker” who uses their knowledge to create value for themselves, their organizations, and society. A learning professional is one who self-consciously chooses to improve student learning by formulating explicit objectives, selecting and critiquing data and instruments, acting ethically within constraints, and leading collective inquiry to build and test a context-specific theory-of-action (adapted from Greller and Drachsler, 2012; Simons and Ruijters, 2014; Pedaste et al., 2019). The learning professional is seen as a constantly evolving, reflective, collaborative practitioner. A learning professional is oriented towards continuous improvement of their knowledge, skills and results and the creation of new and innovative solutions to educational challenges. Hence, this study relies on the concept of professionalism, which focuses on the expectations of a contemporary competitive society where teachers continue their PD (Pedaste et al., 2019; Simons and Ruijters, 2014) throughout their careers. This concept distinguishes four aspects – aims, qualities, requirements, and benefits (Figure 2). Accordingly, the aims of professional teachers are expressed in their aspirations for continuous professional development (lifelong learning) to keep up with changes, improve their qualifications,

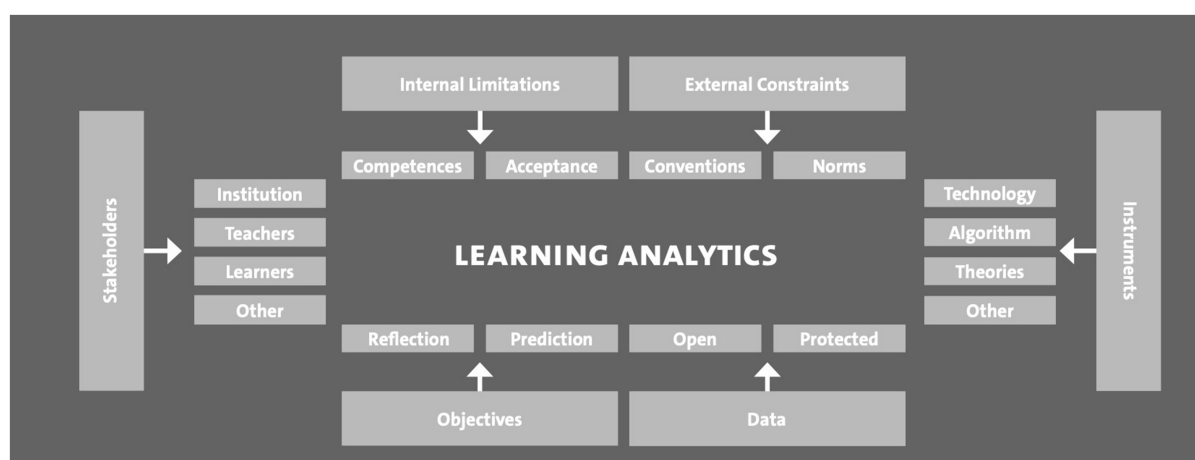


FIGURE 1
Framework of learning analytics, adapted from Greller and Drachsler (2012).

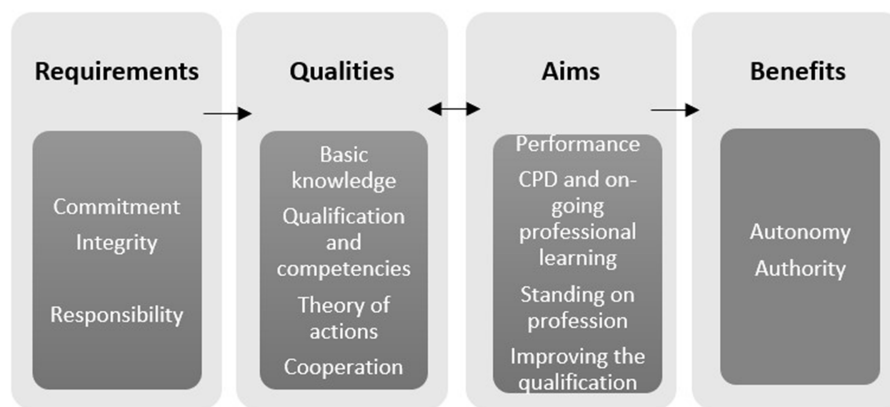


FIGURE 2

The concept of professionalism based on [Simons and Ruijters \(2014\)](#) and [Pedaste et al. \(2019\)](#). CPD, continuing professional development.

and stay in their job. This framework is also used in the Estonian teacher education curricula ([Pedaste et al., 2019](#)).

By critically reflecting on their assumptions and beliefs, learning professionals can challenge and transform their perspectives and approaches, leading to deeper and more sustainable changes in their work practices.

2.3 Integrating LA with the concept of learning professional

Learning Analytics can serve the Learning Professional not only as an evaluative tool but also as a collaborative research framework that supports goal-setting, critical data interpretation, ethical decision-making, and continuous professional growth ([Greller and Drachsler, 2012](#)). The relationship between LA and the Learning Professional can be conceptualized as a feedback cycle. First, teaching practices generate data through pedagogical interactions and performance. Next, LA systems capture, process, and visualize this data. The subsequent stage involves the analysis of teacher competencies, identifying both the presence and absence of professional skills and highlighting areas requiring further development. This is followed by professional development activities, including reflection, collaboration, and the setting of developmental goals. Finally, insights are integrated into practice, which in turn produces new data, thereby sustaining the cycle. Within this model, the teacher simultaneously occupies the roles of subject (whose competencies are assessed) and beneficiary (who receives actionable feedback). This dual role reinforces the teacher's identity as a Learning Professional actively engaged in self-improvement.

Building on the frameworks of [Greller and Drachsler \(2012\)](#) and [Simons and Ruijters \(2014\)](#), the following analysis aligns the six dimensions of the LA model with the characteristics of the Learning Professional, highlighting their combined implications for teacher PD ([Table 1](#)).

2.3.1 Stakeholders and professional identity

Teachers must navigate the dual position of being both data subjects (measured by analytics) and data users (acting upon analytics). This duality extends professional identity beyond

pedagogical expertise toward socio-technical negotiation, requiring teachers to mediate between analytics, students, colleagues, and institutional systems.

2.3.2 Objectives and professional integrity

LA demands that professionals articulate explicit goals and success criteria (e.g., risk prediction, formative feedback, equity). Integrity in this context entails addressing the uncertainty inherent in probabilistic and incomplete data, and aligning analytic aims with broader educational commitments to learners and society.

2.3.3 Data and the body of knowledge

Professional expertise increasingly includes data literacy, encompassing knowledge of validity, bias, and interpretive limits of digital traces. Teachers must not only maintain disciplinary knowledge but also understand the epistemic boundaries of measurement data.

2.3.4 Instruments and theories of action

Dashboards, predictive models, and social network analyses embody implicit pedagogical assumptions. Learning Professionals must formulate and test explicit theories of action linking analytics to instructional choices and evaluating their effectiveness in particular contexts.

2.3.5 External constraints and ethical stewardship

Ethics in LA extends beyond compliance to an active professional practice. Teachers are required to co-construct norms with learners around transparency, informed consent, and proportional use of data, exercising judgment about when analytics should and should not inform practice.

2.3.6 Internal limitations and collective learning

Professional growth is increasingly grounded in collaborative interpretation of analytics. By engaging in collective sense-making, teachers can moderate biases, challenge assumptions, and ensure equity in data-informed decision-making. Professionalism is therefore reframed as a shared, evidence-informed practice rather than an individual endeavor.

TABLE 1 Connections between LA dimensions and the development of a learning professional.

LA dimension (Greller and Drachler, 2012)	Characteristics of learning professional (Simons and Ruijters, 2014)	Professional development focus
Stakeholders	Professional frame & identity	Recognize dual role as data subject and data user; negotiate shared goals for competence development.
Objectives	Commitment & integrity	Define explicit and defensible analytic goals; align with professional priorities.
Data	Body of knowledge	Develop data literacy: validity, bias, interpretation limits.
Instruments	Theory-of-action	Connect analytic outputs to pedagogical decisions; evaluate contextual effectiveness.
External constraints	Ethical stewardship	Embed privacy, consent, and transparency into everyday practice.
Internal limitations	Collective learning	Foster team-based interpretation, surface tacit assumptions, and challenge biases.

Taken together, these dimensions position the Learning Professional as a data-informed, ethically responsible, and collectively reflective practitioner whose professional authority derives from transparent and evidence-based integration of analytics into practice.

Integrating the concept of the Learning Professional with LA holds significant potential for enhancing teacher professionalism. A data-informed approach enables refinement of teaching methodologies, identification of professional developmental needs, and ongoing skill enhancement (Greller and Drachler, 2012; Simons and Ruijters, 2014; Tammets and Laanpere, 2015). However, from an ethical standpoint, two limitations remain prominent. First, research to date provides limited evidence on the long-term effects of digital applications on teacher PD. Second, challenges persist regarding the security and ownership of educational data. One possible safeguard is granting teachers greater control over the use of their personal data.

Despite these limitations, combining the two conceptual frameworks enables teachers to monitor their PD continuously, receive targeted feedback, and engage in more objective evaluations of their competencies, thereby reducing the influence of social biases (Bjork et al., 2013). Moreover, LA creates shared artefacts (e.g., dashboards, cohort maps) that facilitate structured professional dialogue, allowing teams to articulate tacit theories, surface potential biases, and align collective actions (Simons and Ruijters, 2014).

Nevertheless, a balanced approach remains critical: while LA offers powerful tools for evidence-based reflection, it must be integrated with the human dimensions of teaching to ensure that professional development is both holistic and ethical.

The present study contributes to this discourse by supporting teacher PD through a self-assessment process aligned with professional standards. The digital application (TAPP), developed as part of this research, enables teachers to conduct structured self-analysis, receive feedback and recommendations, and collect evidence-based documentation (e.g., certificates, photographs) to substantiate their competencies.

2.4 Critical and ethical aspects of using LA in research

The use of Learning Analytics in research on teacher professional development has highlighted several critical considerations. First, data privacy and ethical practice: LA collects and analyses extensive data from teachers, raising questions about privacy and ethical data use. Data collection and analysis should

follow applicable data-protection regulations and protect teachers' rights throughout the process (Hoel and Chen, 2018; European Parliament and Council of the European Union, 2016). Practical safeguards include data minimisation, secure storage, clear retention/deletion schedules, and transparent consent or legitimate-interest justifications, with special care around secondary uses (Pardo and Siemens, 2014; Slade and Prinsloo, 2013; Sclater, 2017).

Second, data interpretation is challenging; incorrect conclusions can lead to ineffective or even harmful PD decisions. Analyses should be conducted by qualified experts, with uncertainty clearly communicated and stakeholder sense-making supported (Silm et al., 2024). Avoid punitive or surveillance-like uses; when stakes are high, prefer interpretable approaches or pair complex models with rigorous explanation and error analyses (Pardo and Siemens, 2014; Rudin, 2019).

Third, over-reliance on technology can make PD disproportionately dependent on tools. It is important to balance technological analytics with interpersonal and contextual knowledge. LA may not fully account for specific learning environments, cultural differences, or individual needs, which can shape both interpretation and decisions. Mixed-methods designs that complement LA with qualitative evidence (e.g., observations, interviews) provide deeper contextual insight (Ferguson, 2012; Clow, 2013). It is also important to consider theoretical limitations. For example, many LA indicators (e.g., clicks, time spent on a task) only partially reflect teacher learning or the quality of in-service training and provide evidence of reliability or validity (Clow, 2013; Shadish et al., 2002). Observational LA studies may also be a limitation; their patterns are correlational and sensitive to confounding or selection. In this regard, more attention needs to be paid to robust design and sensitivity analyses of attention applications (Pearl, 2009; Shadish et al., 2002). Another concern is the transferability of models trained on a platform/wave/culture to other environments; performance may suffer (Ferguson, 2012; Gama et al., 2014). Interpretability vs. accuracy is very important, which can limit the teacher's ability to act; interpretable models should be preferred or reliable explanations should be provided (Rudin, 2019). Reliability and transparency (Little and Rubin, 2002) and performance are therefore necessary. Dashboards or metrics can significantly change teacher behavior ("teaching by metrics"), so it is very important to detect and mitigate their effects (Slade and Prinsloo, 2013). Aggregation errors should be avoided, it is important to link the unit of analysis (individual/school) to the level of inference (Shadish et al., 2002). Considering these ethical and theoretical aspects helps ensure that using LA in teacher PD research remains responsible, balanced, and effective.

2.5 LA in professional self-analysis and applying for a qualification

The use of Learning Analytics in teacher qualification processes is motivated by its integration with digital technologies and the benefits it offers (Leibur et al., 2023). LA supports professional self-analysis and reflection by collecting evidence-based material and providing personalized, timely assessment and feedback (Joksimović et al., 2019). Teachers describe LA as a mechanism that delivers data-driven feedback on teaching practices, such as assessment and instructional methods; which strengthens professional awareness and reflective practice (Vezzoli et al., 2020).

Unlike traditional educational data mining, the primary aim of LA is to enhance teachers' diagnostic pedagogical decision-making. Greller and Drachsler (2012) emphasize its potential to evaluate didactic approaches and generate evidence to substantiate pedagogical theories of learning. Their six-dimensional framework (stakeholders, goals, data, resources, external constraints, and internal limitations) supports changes in pedagogical behavior and contributes to improving professional qualifications (Figure 3).

For meaningful outcomes, LA models must integrate relevant goals (e.g., improving learning and exploring learning processes), appropriate components aligned with purpose, and theoretically grounded methods (Sengupta et al., 2020; Quadir et al., 2021). Learning Analytics is effective when: first, teachers use it to design timely and contextual pedagogical interventions. The role of LA is to identify different patterns (risk, progress, weak concepts) to support the development of teacher PD. While according to the theory of the learning professional, the teacher analyzes their actions by combining tools, timing and pedagogy – not only the implementation of technology. Second, it provides visual feedback and interpretation for further development of PD. This means that the LA model supports the use of dashboards/visuals that show the user their professional competence, while making behavior and gaps visible, supporting self-regulation and adaptive teaching. At the same time, teachers use visuals to diagnose unexpressed competencies and development needs, support reflection and personalize professional development journeys. In summary, visualization is a bridge from raw

data to learner (in this case, teacher) reflection. And third, the connection between these two theories is important in supporting reflective practitioners who are continually improving their practice. LA provides continuous evidence of engagement, performance and perceptions. A reflective practitioner is critical of their teaching practices, drawing on educational data to continually improve teaching (Schön, 1983; Timperley et al., 2007; Mandinach and Gummer, 2016). The Learning Professional combines the creation of meaning from data with pedagogical judgment; develops feedback competence. Feedback in turn increases engagement, especially for learners with lower self-regulation.

Research has explored LA in various contexts, including learner support (Minović et al., 2015), administration (Macfadyen and Dawson, 2012), predictive modelling (Brooks and Thompson, 2017), collaborative learning, and personalized recommendations (Dai et al., 2022). In the context of professional development, LA holds significant potential for supporting lifelong learning (de Laat and Schreurs, 2013). It enables teachers to monitor progress toward learning outcomes and competencies, identify areas for improvement, supplement missing skills, and collect evidence for qualification assessments (Johnson et al., 2011). These processes serve as a foundation for competence-based development and continual improvement.

Overall, LA supports the evaluation of didactic approaches, providing evidence for pedagogical theories and strengthening teachers' ability to meet professional standards. In this way, LA contributes not only to professionalism in learning but also to the broader development of teacher competencies. Connecting LA with PD thus provides computational and methodological support, evidence-based reflection, and feedback for sustained competence growth.

2.6 Applying for teacher qualification, the Estonian context

The following is a brief overview of the qualification framework, which is important in the qualification application process in the Estonian context. The European Qualifications Framework (EQF) is an 8-level framework based on learning

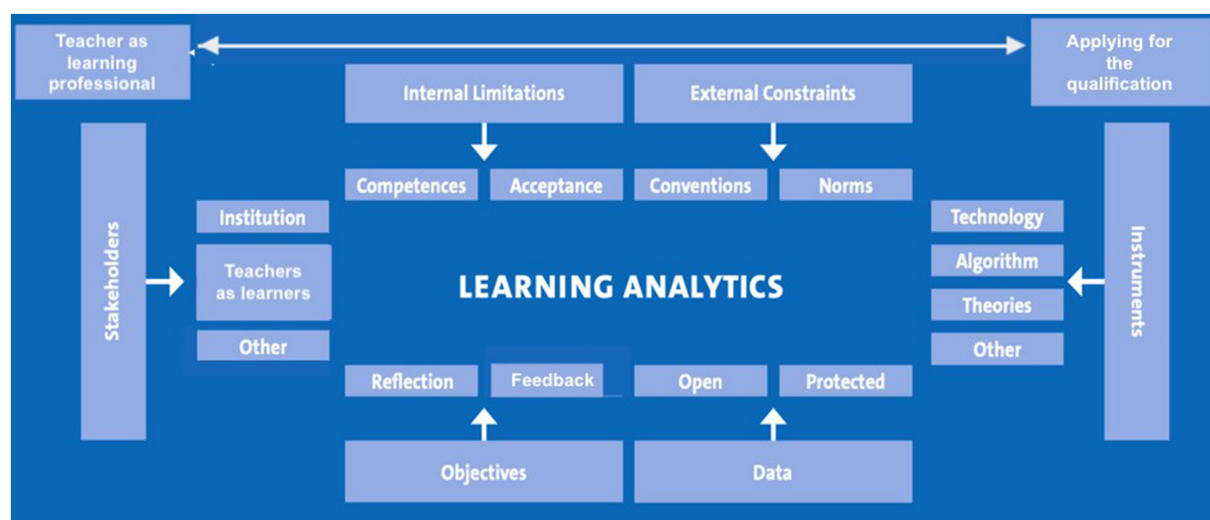


FIGURE 3

Framework of LA (adapted from Greller and Drachsler, 2012) embedded in teacher PD and applying for qualification.

TABLE 2 LA framework dimensions adapted from Greller and Drachsler (2012) for the TAPP.

Dimension	TAPP application values
Stakeholders	Data subjects: a group of lifelong learners – teachers Data clients: teachers, schools, professional assessors
Objective	Reflection: analyse teacher self-analysis, identify teachers' needs for development Prediction: qualification level
Data	Protected dataset: teacher self-reflection, data from protected databases. Interfaces with external Estonian education systems EHIS, JUHAN, eKool/Studium. Interfacing with external systems allows a teacher to obtain evidence of their qualifications and career history from national databases. Interfacing also creates an opportunity to transfer data to, for example, a professional committee. The goal of developing data exchange options is to ensure smooth functioning of the system in cooperation with other e-government services. Open data: data from open web environments
Instrument	Pedagogical theory: teacher as learning professional (Pedaste et al., 2019; Simons and Ruijters, 2014) explained in Figure 2. Technology: xAPI, statistics. The application is based on open-source technologies (PHP, MySQL) Presentation: visualization, feedback
External limitations	Privacy: protected data. Logging into the environment is done with an id-card, mobile-Id and smart-Id using the universal state-provided TARA service, as well as the HarID service (national educational ID). Norms: based on national professional standards
Internal limitations	Competencies—required competencies for data interpretation Clarity of visualization and interpretation of results. Further use of received information (understanding and interpretation)

outcomes for all types of qualifications, which acts as a translation tool between different national qualifications frameworks. This framework helps to improve the transparency, comparability, and portability of people's qualifications and allows for comparisons of qualifications from different countries and institutions. The EQF covers all types and levels of qualifications, and the use of learning outcomes clarifies what a person knows, understands, and can do. The levels increase according to the level of proficiency, with level 1 being the lowest and level 8 the highest. Most importantly, The European Qualifications Framework (EQF), 2025 is closely linked to the national qualifications frameworks, so it can provide a comprehensive map of all types and levels of qualifications in Europe, which are increasingly available through qualifications databases [European Qualifications Framework (EQF), 2024]. The EQF is the basis for the Estonian Qualifications Framework.

Next, an overview of the current teacher qualification application process in Estonia is given (Figure 4). Firstly, the teachers create an e-portfolio to analyze their pedagogical activities based on PS and add evidence (e.g., files) that proves their competence.

The completed e-portfolio is then presented to the Vocational Assessment Committee, which consists of assessors; they are practicing professional teachers who have previously got the qualification of level 8. Professional assessors serve at the initial level in the assessment process: they review the applicant's e-portfolio, pose additional questions, if necessary (if competence is not demonstrated or is demonstrated to a limited extent), and check all materials proving competencies (photos, files, etc.). If all requirements are met, a vocational examination is conducted in the form of an interview. During this process, the assessors provide feedback to the applicant and submit a well-reasoned recommendation to the Vocational Committee regarding the granting or denying of the qualification.

3 A digital application for enhancing teacher professional development

3.1 Purpose and background

Prior work shows that the TAPP application helps teachers continuously monitor and analyze their teaching and professional development. It accelerates qualification progress and supports the Vocational Assessment Committee by enabling ongoing tracking of competencies and targeted development (Leibur et al., 2021, 2023).

3.2 Framework and design

The application is grounded in the Learning Analytics framework by Greller and Drachsler (2012), incorporating six dimensions – stakeholders, objectives, data, tools, external limitations, and internal limitations (Figure 1). These dimensions are adapted for TAPP and complemented with TAPP-specific values (Table 2). LA has strong potential to support PD and lifelong learning (Siemens, 2013). Accordingly, TAPP uses LA-driven data collection and visualization to enable personalized, adaptive learning.

3.3 Core criteria

TAPP was developed around four criteria aligned with national teacher professional standards

1. Monitoring self-assessment of professional competence via self-reflection (LA tracks progress toward desired competencies),
2. Identifying areas for improvement,

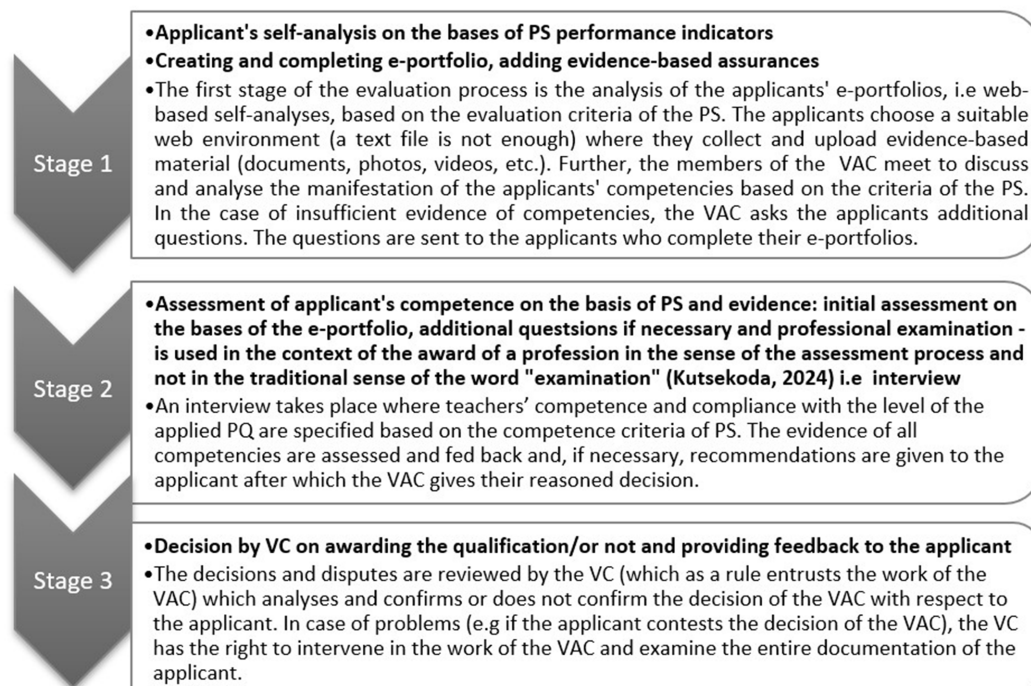


FIGURE 4
Process of professional application (Leibur et al., 2021).

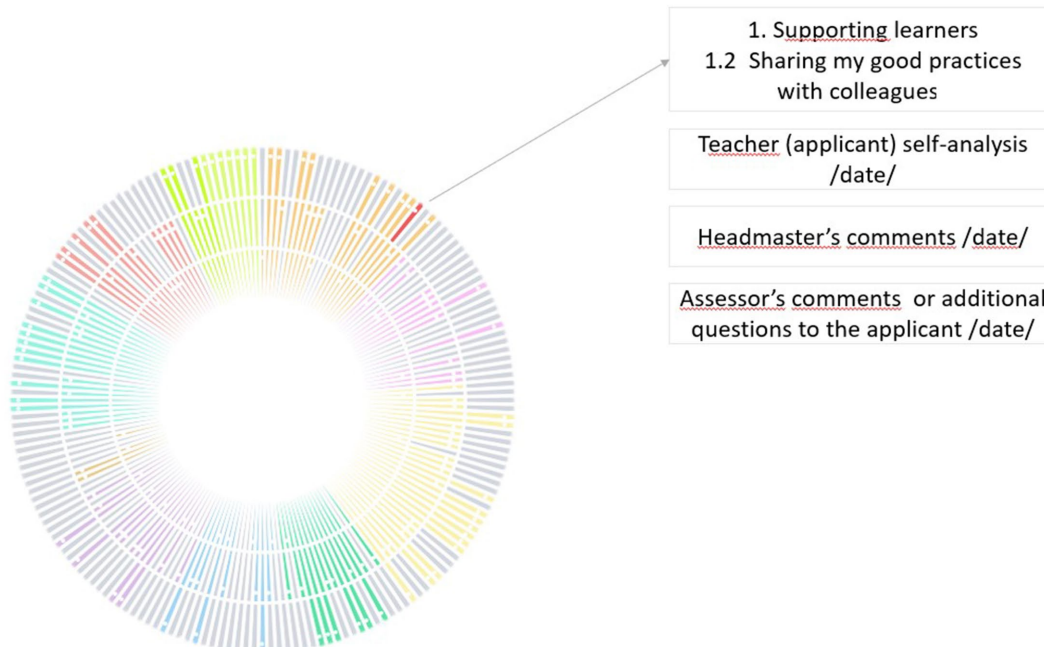


FIGURE 5
Visual feedback (rose diagram) and feedback from colleagues/headmaster/assessors.

3. Assessing compliance with qualification requirements, and
4. Compiling evidence for qualification applications.

A visual dashboard (rose diagram) summarizes achievement against these criteria by displaying levels of well-developed and

underdeveloped competencies and allows adding recommendations for further development (tools/instrument; Figure 5). The visualization also surfaces aspects of teachers' cognitive development (e.g., knowledge/skills in evaluating PD results).

The TAPP prototype content and structure were created by the authors and tested for professional evaluation purposes (objective).

3.4 Access, security, and stakeholders

Access is restricted to teachers working in Estonian state, municipal, or private schools. Authentication uses ID-card, Mobile-ID, Smart-ID, the state TARA service, or HarID. This protects data confidentiality and adheres to data security and privacy principles. Teachers may invite colleagues/school leaders and professional assessors to contribute evaluations (Stakeholders).

3.5 Workflow: self-analysis and evidence

3.5.1 Self-analysis

Applicants conduct self-analysis guided by performance indicators from six professional standards:

- planning of learning and teaching,
- shaping the learning environment,
- supporting learning and development,
- reflection and PD,
- counselling and mentoring,
- development, creative and research activities (Figure 6).

Indicators differ by professional level: teacher level 7, senior teacher level 7, and master teacher level 8 [Estonian (EstQR), 2024].

3.5.2 Evidence

Users attach evidence for each described competence by uploading files or linking to profession-related online environments. In addition to user-provided evidence, the external interface can gather data from protected professional databases and public environments (Data).

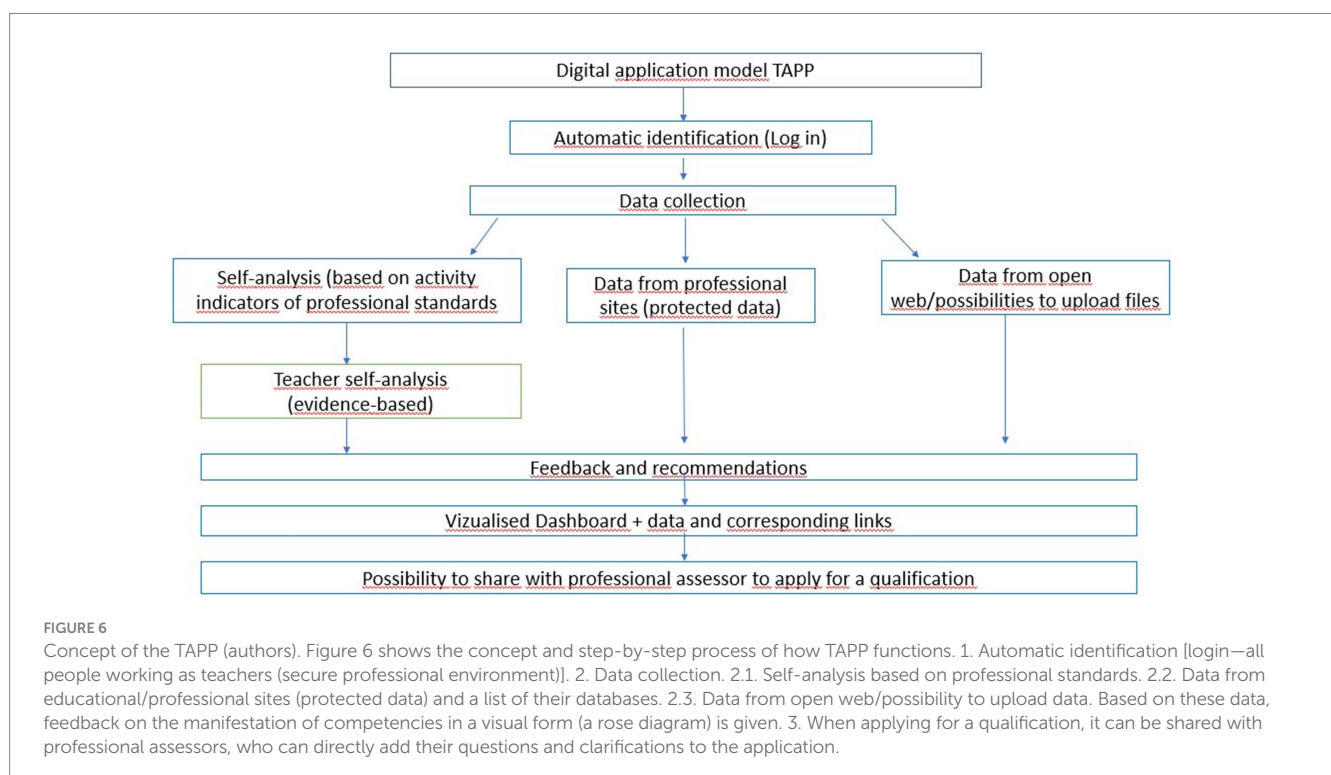
3.6 Dashboard and visual feedback

Self-analysis results are shown in a rose diagram where ray length corresponds to qualification level (longer = higher competence). For example, the sub-competency “*sharing my good practices with colleagues*” under “*supporting learners*” is illustrated in Figure 5.

- Different colored segments represent the six competency areas and can be highlighted as individual beams (activity indicators).
- The right-hand panel displays the selected competence, activity indicators, the teacher’s self-analysis text, and comments from the headmaster/professional assessor (Figure 5).

3.7 Interpreting analytics: opportunities and challenges

TAPP presents self-analysis results in an accessible visual format (Ebner et al., 2015). Although LA dashboards have been criticized for limited support of metacognitive skill development (Matcha et al., 2019), here the emphasis is on planning, monitoring, and evaluating professional activities. Still, teachers may face challenges in interpreting visuals and linking them to concrete pedagogical actions (Gray et al., 2021; Dazo et al., 2017). Visual feedback can



strengthen self-efficacy and influence teaching practice (Chen et al., 2009).

3.8 Contribution and benefits

TAPP supports teachers' self-analysis and self-monitoring, provides feedback on PD, and compiles evidence of professional activities (Objective). Automated data collection reduces administrative load while helping teachers select appropriate documentation to demonstrate performance indicators. When applying for a qualification, colleagues/school leaders and professional assessors can participate in the evaluation process (Stakeholders).

3.9 Connecting the frameworks: learning analytics and the learning professional

TAPP operationalizes the Learning Professional model (Simons and Ruijters, 2014) within the Learning Analytics framework (Greller and Drachsler, 2012) so that teachers' self-directed professional growth is continuously evidenced, visualized, and governed.

- Stakeholders $\rightleftharpoons$ Professional community. LA's stakeholder dimension (teachers, colleagues, leaders, assessors) provides the collective context in which learning professionals develop autonomy and authority through shared reflection and co-creation.
- Objectives $\rightleftharpoons$ Commitment & purpose. LA requires explicit objectives; in TAPP these are anchored in the learning professional's commitment to clients/society and to their own ongoing learning, instantiated as qualification and PD goals set by national standards.
- Data $\rightleftharpoons$ Body of knowledge, theory-of-action, field of expertise. Evidence (artifacts, feedback, activity traces) collected via LA makes the learning professional's knowledge, practice theories, and growing expertise visible and discussable.
- Instruments (dashboards) $\rightleftharpoons$ Inquiry, practice, creation + bridges. LA instruments (e.g., TAPP's rose-diagram dashboard) support the learning modes Simons & Ruijters highlight inquiring, practicing, creating, while the dashboard's reflection/connection features function as the "bridges" that integrate these modes into professional growth.
- Internal & external limitations $\rightleftharpoons$ Standards, ethics, policy. LA explicitly considers constraints; in TAPP, internal limitations are the teacher professional standards that define competence expectations, while external limitations include privacy, security, and sectoral policy.

3.9.1 Synthesis

In short, Greller and Drachsler's LA dimensions supply the *socio-technical scaffolding* (who, why, what data, which tools, under what constraints) that turns Simons and Ruijters' learning-professional characteristics (commitment, integrity, knowledge, theory-of-action, expertise, community, autonomy, authority) into measurable, feedback-rich professional learning cycles aligned with Estonia's standards (Pedaste et al., 2019).

4 Methodology

The aim of the study is to explore teachers' and professional assessors' evaluations of the TAPP's functionality in identifying PD and developmental needs, and to assess whether the application fulfilled its intended purpose. Inclusive UX Research is explicitly designed to examine how real users with diverse needs interact with a product and whether it helps them achieve their goals (Vermeeren et al., 2015).

The sample covers the full stakeholder spectrum by involving unqualified teachers, qualified teachers, and professional assessors, the method captures varied workflows, expertise levels, and pain points, which is essential for a system that underpins both self-assessment and formal evaluation (Vermeeren et al., 2015). In order to ensure ecological validity through end-to-end use, the participants created accounts and completed the entire self-analysis and competence-verification process, received feedback, and reflected on PD needs. Studying authentic, end-to-end journeys reveals breakdowns and opportunities that lab-only or survey-only approaches would miss (Vermeeren et al., 2015). Combining hands-on product use with semi-structured interviews yields both behavioral and attitudinal insights – what users did and why. This is ideal for discovering issues to fix and prioritizing next steps in a formative cycle (Rohrer, 2014). The rose-diagram dashboard and evidence-collection flows are central to TAPP. UX research tests whether these analytics and visuals are understandable, trustworthy, and decision-supportive in practice, not just technically correct (Vermeeren et al., 2015). In order to leverage the domain expertise, the teachers who have completed the qualification process and professional assessor were invited to participate. This ensures that the design aligns with standards, evidence requirements, and assessment practices – key for a compliance-sensitive tool (Vermeeren et al., 2015). Semi-structured interviews let researchers probe unexpected findings, compare perspectives across user groups, and surface “unknown unknowns,” making them a strong choice for formative evaluation and rapid refinement (Rohrer, 2014) throughout the whole process of prototyping.

Therefore, inclusive UX research was chosen as the most appropriate methodological choice because it directly tests, with all key user groups, whether the TAPP's LA-driven design is usable, accessible, and effective for supporting teachers' PD and qualification processes—while producing concrete, interview-backed insights to guide iterative improvement (Vermeeren et al., 2015; Rohrer, 2014).

4.1 Participants

The study used purposive sampling, which consists of participants who can purposefully provide an understanding of the research problem and the central phenomenon of the study (Creswell and Poth, 2018). To conduct the study, unqualified teachers, teachers with professional qualifications (teachers who have completed the professional application process), and professional assessors (who are qualified as master teachers and have completed relevant training for assessors) were contacted.

To participate in the study, the teachers gave voluntary written consent, which they could withdraw at any time by notifying the researcher. Invitations were sent to teachers through random selection,

contingent upon their consent to participate in evaluating their professional development. Additionally, invitations were extended to teachers who had previously expressed interest in participating, as recorded by the Teachers' Union. The teachers participating in the study were sent an invitation and a consent form electronically; they confirmed their consent to participate in the study with a digital signature. In the study, only the teacher's name was used as personal data to confirm their voluntary consent to participate in the study and to receive feedback. Before obtaining informed consent, the participating teachers were provided with all necessary information regarding the purpose and details of the study. Anonymity was ensured, and the data were analyzed to prevent any results from being traced back to individual respondents.

Before each interview, the purpose of the study was explained to the subjects and ethical requirements were introduced, including the confidentiality of participation in the study, permission was asked for recording. The Human Research Ethics Committee of the University of Tartu has approved the study.

The sample consisted of 20 people ([Appendix 1](#)): unqualified teachers ($n = 4$), qualified teachers, who all had previously completed the qualification application process ($n = 7$), and professional assessors ($n = 9$) i.e. master teachers who participate in the qualification compliance assessment process.

4.2 Data collection

Data were collected with individual interviews between May and July 2023. Based on the research question, the interview plan was prepared, and the questions were formulated. The interview questions were adapted to different target groups according to the teachers who passed the application process and the professional assessors: 12 questions for unqualified teachers, 12 questions for qualified teachers, and 12 for professional assessors. The questions explored whether the TAPP allows to find out the teacher's PD needs (interview questions 1–6), and how the TAPP supports teacher PD and the application process (interview questions 7–12). First, a pilot interview was conducted, but no significant changes were made to the interview plan ([Appendix 2](#)). Therefore, the data from the pilot interview was added to the main data of the study. At the beginning of the interview, the interviewer introduced herself (interview conducted by the first author, qualified master teacher, level 8) and the purpose of the research being conducted. Each interview was explained to the subjects the purpose of the study, and ethical requirements were introduced, including the confidentiality of participation in the study. Interviews were conducted via Zoom, recorded, and transcribed manually. The interviews were transcribed on a total of 90 pages. Pseudonyms were used in the transcripts.

4.3 Data storage and protection

To ensure confidentiality and anonymity, the researcher coded all participant data. The results of the self-analysis and evidence related to the performance indicators of the professional standard (self-assessment) were accessible only to the study participants, with no third-party access. Personal data collected by the application from protected environments was available exclusively to authorized individuals directly involved with

the data. Researchers gained an overview of the data collection functionality (e.g., personal data from EHIS) through interviews.

All data collected during the study were used solely to achieve the research objectives and were not disclosed to third parties. Upon request, study participants could access their data directly. Once all planned functionalities were implemented, participants received immediate feedback on their data within the secure TAPP environment, accessed via password, ID card, or Mobile-ID.

The data collected were used strictly for scientific purposes and were published in a way that ensured participants' identities remained confidential. The data were stored on a password-protected server managed by the software developers until February 2024, after which the code key was permanently destroyed on February 28, 2024.

4.4 Data analysis

The interviews were analyzed following an inductive thematic analysis procedure. This means the directed content analysis, where the data is analyzed to prove and verify the theory being used ([Hsieh and Shannon, 2005](#)). Fragments of the recordings that could reveal the identity of the interviewees were not transcribed. Data analysis was performed with NVivo, a qualitative data analysis web application. The average length of the interview was 50 min. The shortest interview lasted 45 min, the longest 1 h and 35 min.

During data analysis, the generated codes were grouped into categories based on similarities, the process was carried out in the NVivo environment. In the final stage, the category names were specified and illustrative text examples were taken from the interview transcripts to ensure clarity and context. Two main categories emerged from the coding: supporting professional development and identifying development needs ([Appendix 3](#)).

The results of the data analysis are presented in accordance with the research questions and structured around the twelve categories identified during the inductive analysis process ([Figure 7](#)).

5 Results

5.1 Supporting professional development

When teachers and professional assessors went through the application process in the TAPP application, they evaluated the functionality of the digital tool in supporting their professional development (PD) and in applying for a qualification to identify PD needs. As a result, were two main categories – supporting professional development and development needs, and eight categories for the first research question were emerged – protected environment, supported teacher self-analysis process (compliance with PS performance indicators, effective frameworks of the self-analysis structure, effective guidelines for self-assessment, supported qualification application process with progress bar), supported data collection and supported feedback.

5.1.1 Supportive environment

Both target groups considered it important to have a secure environment that is linked to the teacher's institution and requires logging in with personal authentication. Then, the teacher no longer

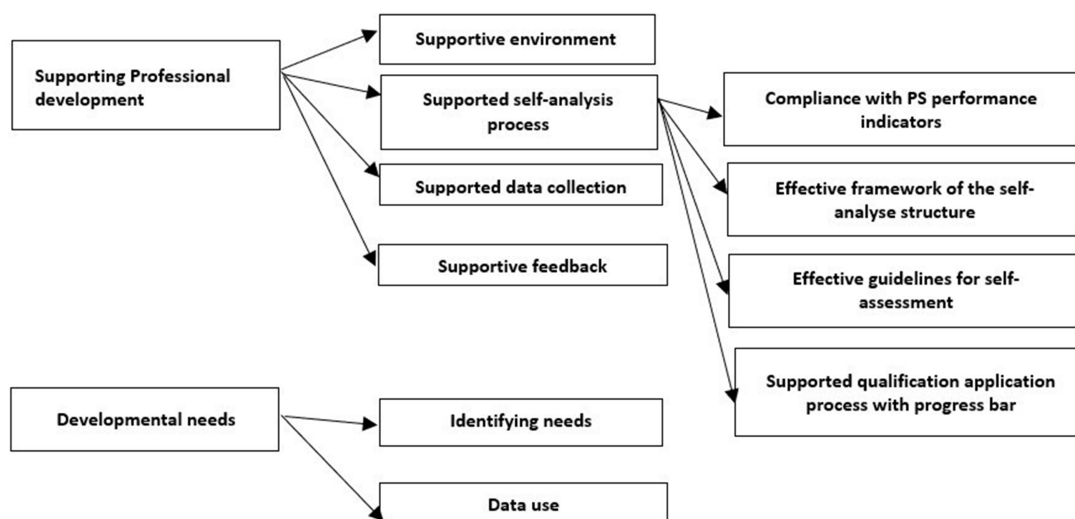


FIGURE 7
Code tree.

must worry about their portfolio or self-analysis being made public and visible to everyone.

The interviewees highly valued the possibility of storing all the self-analysis made during the years of work together with feedback. The assessors considered it important to have the possibility of adding the recommendations and feedback of colleagues, school leaders, and the assessor directly to the TAPP environment.

The opportunity to share self-analysis with an assessor is great. This functionality simplifies the work of both the applicant and the assessor. At the same time, the assessor can give their own recommendations. A6

In conclusion, both the teachers and the assessors highly rated the safety of the TAPP in teachers' self-assessment, the safety of giving assessments/feedback from other parties, and the secure storage of data.

5.1.2 Supported self-analysis process

The teachers valued the possibility of self-analysis in the protected environment of TAPP, where it is possible to keep the reflections made during the years of work and monitor the path of their PD. It was jointly pointed out that the possibility offered by the TAPP to preserve the teacher's self-analyses created over the years (i.e., the teacher's professional development path) is very important in supporting the teacher's PD.

I find that the TAPP definitely supports the qualification application process. It also simplifies the understanding of what level the teacher is and what they do. A8

In a broader, organizational view, teachers and professional assessors considered the self-analysis in mapping the school's internal development and development needs important.

The self-analysis carried out in the TAPP would be a very good tool for mapping teachers' development needs during in-school

appraisals. After all, teachers' competencies can be assessed by competence blocks. Each year, the focus is on specific competencies, identifying stronger competencies that need developing. A8

Thus, both target groups considered the functionality of the TAPP to be very useful, through which the teacher, colleague, head of school, and assessor can give progressive feedback, draw attention to the teacher's strengths, and at the same time pay attention to the competencies that need further development.

5.1.2.1 Compliance with PS performance indicators

The assessors of the professional qualification pointed out that reflection may still be difficult for the teachers, but through the reflection process, they come to an understanding of their strengths and weaknesses (which competencies have been demonstrated and which have not). The teachers jointly found that through the process of self-analysis, they receive information about their specific competence-based development needs. At the same time, the statements based on the activity indicators of the professional standard help the teacher in the process of self-analysis, and, to become aware of their professional competence. The application offers the opportunity to professionally evaluate themselves and apply, for example, for a higher qualification level.

As the TAPP can store the teacher's self-analyses, the teachers value the possibility of setting their future development goals based on the identified development needs.

I have done self-analyses over the years. I can look at my professional development path and analyze my previous self-analyses and set new goals for further development according to the identified development needs. T4

Also, both target groups found that the PS activity indicators in the TAPP make the self-analysis process understandable and simplify it, regardless of whether the self-analysis is performed to apply for a qualification or to gain an overview of the teacher's own PD.

Teachers often have trouble reading the professional standard and making sense of it. The TAPP offers the applicant simply and comprehensibly explained competencies, to understand what is expected of the teacher. A7

It was generally found that the provided activity indicators of the professional standards have a positive and supportive effect on the entire self-analysis process. Both target groups considered the increase in the teacher's self-esteem after completing the self-analysis very important.

5.1.2.2 Effective framework of the self-analysis structure

Another functionality considered important by both target groups was the structure of self-assessment. They assessed self-analysis, together with the fulfilment of the necessary criteria, and proving competence, as quite a difficult process. Therefore, the presence of a given structure was considered important and supportive.

According to the respondents, self-analysis as a process is essential for a teacher as a reflector as in this process, they can look deeply into themselves and, at the same time, be observers of their own activities. Teachers pointed out that following specific guidelines (so that all competencies are covered) supports the teacher throughout the process.

It helps to follow whether I have filled in all the important boxes. If in the e-portfolio I can overlook some activity indicators (I leave it open), here I am forced to fill in all the fields. T1

Thus, the structure both supports the teacher in the process of self-analysis to maintain focus and simplifies the assessor's work.

5.1.2.3 Effectiveness of guidelines for self-assessment and qualification application

The guidelines that allow teachers to read the relevant methodological material and give tips on what needs to be done to justify the given activity indicator were highly appreciated by the teachers and assessors. It was found that due to the complexity of the process, any guiding instructions for the teacher will certainly be useful.

It is one of the most necessary tools for analysis. Our teachers are of very different levels: there are teachers who are used to constantly reflecting on themselves, and those who do not understand what they must do at all. The more guidelines, the better. A3

This functionality was considered important by both target groups. As a suggestion for further development, it was also recommended to add more user manuals (reflection models, theory, methodology, etc.) that would make the process more productive and simplify the self-analysis even more.

5.1.3 Supported qualification application process with progress bar

As another supporting functionality, the progress bar facilitates the teacher's self-analysis process. Since the self-analysis is long-term

and voluminous, the progress bar keeps tracking and signals the competencies proven or not yet proven with green and red signs.

Both target groups agreed that the progress bar supports the teacher in the self-analysis process and provides an opportunity to monitor the progress throughout the self-analysis.

5.1.4 Supported data collection

In the TAPP, both the functionality of the automatic data collection and the possibility to upload the necessary files were highly appreciated by the target groups. They highly valued the opportunity to make their own choices based on the collected data, what to include as evidence-based and what not.

The application collects my evidence-based material (for real verification of the performance indicators) from both profession-related environments and the open web. All that remains for me is to choose what I want to add and what not. T10

Assessors pointed out some shortcomings in file uploading skills. When adding evidence-based materials (which were brought out by the assessors of the profession), insufficient computer skills were revealed (but the need to develop digital competencies, which is a comprehensive competence in the professional standards).

...teachers don't know how to upload files. A1

Therefore, the functionality of TAPP (data collection) highlights the deficiencies in the proof of competence (required documents, photos, etc.), which can be mapped and then the deficiencies eliminated.

5.1.5 Supportive feedback

The TAPP dashboard providing a visual overview of the teacher's competencies, found mutual approval by both the teachers and the assessors. In the current application process, it is difficult for the teacher to get an overview of their competencies. They can analyze themselves but may not accurately perceive their professional strengths and shortcomings.

Such functionality is very helpful for a person doing self-analysis. I get encouraged, and the visual of my competencies gives me accurate feedback and possibly raises my self-esteem. T11

Also, the target groups valued the TAPP's functionalities to provide automatic visual feedback and for the school principal and professional assessors to add verbal feedback directly to the TAPP.

5.2 Identifying needs

In response to the second research question concerning the identification of teachers' professional development needs, two categories emerged – needs identification and data use.

5.2.1 Needs identification

TAPP's ability to highlight a teacher's strengths and development needs.

The respondent considered visual feedback (rose diagram) valuable and comprehensive, according to which it is good for teachers to evaluate themselves, while visual feedback also made it possible to precisely define the competencies that need further development.

...it is important to follow the rose diagram and verbal explanation of your choice. As a self-assessment tool, the app is very, very good. A1

Visualization is done using a rose diagram, the longer the beam of the action indicator, the higher the competence of the teacher, the shorter the beam, the lower the competence rating. From the aspect of further development, it was found that the visual helps to understand the current competence/qualification level better and allows setting specific goals for further development.

Now, the teachers receive visual feedback for each activity indicator separately. However, they suggested adding the possibility to get an overview of the entire competence block. From the aspect of further development, it was found that the visual could help set specific goals for the future.

For a teacher as a qualification applicant, the feedback from the professional assessor is also important.

The applicant receives adequate information about what they lack professionally. They get an overview of what they should do, in which direction to develop. They also see what their strengths are. T2

The respondents also considered visual feedback valuable and comprehensive, according to which it is good for teachers to evaluate themselves, while visual feedback also made it possible to precisely define the competencies that need further development.

Both target groups also highly appreciated the opportunities for feedback via the TAPP by a colleague, the head of school, and the professional assessor (in case a qualification is applied for), thus drawing attention to the need for further teacher development.

5.2.2 Data use

Uses self-assessment data collected to assess professional development.

Both in self-analysis and when applying for a qualification, the teachers have to upload to the TAPP all existing professional data to demonstrate their competence. The inclusion of files and links to prove the compliance of activity indicators and automatic data collection from professional databases and open online environments was estimated by the participants as a good opportunity to find out the competencies that need to be developed.

6 Discussion

The aim of this study was to explore the target groups' (unqualified teachers, qualified teachers, and professional assessors) evaluations of the functionality of a digital application for identifying teacher PD and development needs, and to obtain feedback on whether the application met its stated purpose. The purpose of TAPP is to support teachers in their PD while guiding them to enhance their skills and make informed decisions about their future career progression. The TAPP combines the concept of a Learning Professional (Simons and Ruijters,

2014; Pedaste et al., 2019) and the possibilities of LA (Greller and Drachslers, 2012), supporting the teacher's professional self-development, critical self-analysis, self-efficacy, and collaboration using the functionalities of LA. TAPP is built on the six dimensions of Learning Analytics (Figure 2) outlined by Greller and Drachslers (2012), which enable the evaluation of specific didactic approaches and offer a supportive framework for fostering changes in pedagogical practices, that is, to support the development of the teacher as a learning professional. According to teachers and professional assessors, LA, in the form of real-time visual feedback, supports both the qualification applicant and the assessor, highlighting the teacher's strengths and competencies that need further development.

Framed through the Learning Professional lens (Simons and Ruijters, 2014; Pedaste et al., 2019) and the six dimensions of Learning Analytics (Greller and Drachslers, 2012), TAPP's core contribution is not its dashboard *per se* but the feedback loops it enables for professional growth. Participants across groups reported that real-time visualizations made strengths and growth areas legible, which in turn supported metacognitive regulation (planning–monitoring–evaluating) rather than mere compliance activity. Although all groups who were interviewed considered TAPP effective in identifying in-service training needs, the mechanism of value differed.

Non-qualified teachers highlighted TAPP's (1) high instructional value as influencing factors; (2) reduced ambiguity in understanding and better interpretation of qualification requirements or professional standards; (3) clearer mapping of self-development needs (based on the manifestation of competencies) and support for setting further development goals. (4) Strong external support structure that supports emerging professional identity and self-efficacy; the dashboard acts as a beginner-friendly boundary object that allows standards to be translated into concrete behavior. (5) Risks and needs identified: possible overreliance on score-like visuals; need for guidance to avoid "teaching to the dashboard." Need for data literacy support so that early-career teachers can interpret patterns (i.e., beam length), not just colors.

Qualified teachers assessed the impact and usefulness of TAPP for supported reflection and career development planning (e.g., moving between levels/roles). TAPP was also found to support self-regulated learning cycles for experienced practitioners – using analytics to calibrate self-assessments, select targeted in-service training and document growth trajectories. An important aspect was highlighted as a risk that analytics could become extra work without integration into assessment/training. Autonomy was considered very important: perceived monitoring by the assessor was a concern. In summary, the participants emphasized the importance of visuals as they transform complex standards into actionable cognitive cues – a classic LA opportunity that can increase self-efficacy when aligned with meaningful goals. Theoretical work on feedback to support learning suggests that the greatest benefits are obtained when feedback answers the questions: "Where am I going? How am I going? Where next?" The design of TAPP appears to address all three. However, analytics can also narrow the focus on what is being measured. To maintain developmental value, TAPP should (a) foreground explanatory narratives with outcomes, (b) link visuals to specific, evidence-based PD activities, and (c) encourage goal-setting and review cycles.

Teachers highlighted the potential for schools to use TAPP artifacts as inputs to teaching and learning, peer observation cycles, and in-school moderation. The assessors found that TAPP

functionality allows for standardization of qualifications while maintaining teacher agency through consent-based sharing. Evaluators would also like to see TAPP further developed, with moderation and audit trail functionality to document how analytics influenced, but did not determine, assessments.

Based on the two interconnected theories, the study highlighted TAPP functionality as follows: professional standards-compliant analytics and teacher-owned data were used as inputs. The mechanisms were: metacognitive feedback; social moderation; which, in turn, increased teacher self-efficacy. TAPP outputs included specific objectives and in-service training plans and evidence-based materials. Outcomes included better teaching decisions; calibrated self-assessment and smoother assessment processes. Impacts (yet to be proven): career development and retention of teachers. The study shows that the impact pathway of TAPP differs across stakeholders: support structure for unqualified teachers, self-regulation for qualified teachers, and calibration for assessors.

To move from perceived usefulness to demonstrable improvement, the next step should link TAPP to guidance, ensure ethical governance, and provide evidence of validity and outcomes that go beyond the dashboard. The practical significance of TAPP is also noteworthy; if the digital application is adapted, it can be utilized in the qualification application process across different countries. Previous studies (Kiilakoski and Basarab, 2022) have shown that the core competencies outlined in professional standards are largely similar across EU countries. Therefore, this digital application has the potential to be used Europe-wide, requiring only adaptation to the specific professional standards of each country. In both Estonia and other European countries, teacher qualifications are primarily assessed based on competencies and practical skills. Estonia's professional standards for teachers are aligned with the European Qualifications Framework, ensuring comparability and transferability with other European nations.

TAPP's functionality allows for collaborative support of teachers' PD, it can be used in intra-school collaborative discussions, evaluate the professional level of teachers within the school, and use the TAPP to evaluate teachers applying for work at the school.

The research conducted in Estonia (Pedaste et al., 2019) shows that teachers are committed to their work, are responsible for their actions, and are involved in a continuous process of self-analysis and development. Therefore, the TAPP is expected to further support and direct the analysis of teachers' basic knowledge, qualifications, competencies, cooperation, the fulfilment of the requirements of the position, and compliance with the requirements of the position.

Since this was the first test, there is still a lot of development ahead and the application is purely for educational use. Now, it is not yet clear whether the digital application will be managed by the Ministry of Education or the Vocational Training Chamber (an impartial organization that checks and awards qualifications).

7 Conclusion

In a context of rapid technological change and increasing time pressure on educators, learning analytics solutions can simplify complex, routine judgments and surface actionable insights. The LA approach piloted with the TAPP application shows promise not only for streamlining Estonia's teacher qualification process but also as a template that other systems could adapt to local policy, competency

frameworks, and professional standards. By integrating teachers' self-assessment data with visual feedback, TAPP supports evidence-based decisions about qualification levels and helps educators set concrete goals for professional growth.

In addition to assessment, the Learning Analytics in the TAPP supports targeted and evidence-based professional development by (1) providing personalized visual feedback that enables data-driven reflection (van Leeuwen, 2019) and the identification of competencies that need improvement. (2) Collaborative professional development, i.e., a pooled analysis of multiple teachers (peers/school leaders/professional assessors) highlights best practices and common issues, encouraging collaboration (Dawson et al., 2018). (3) Enables adaptive professional development pathways, i.e., analysis based on professional standards helps identify competencies that need to be developed, allowing for targeted in-service training and capacity building. Teachers can also track their progress over time, link it through self-assessment, and set goals for further development. TAPP functionality also allows for analysis of their professional development pathways (based on TAPP self-assessment reports).

The TAPP supports teacher retention and motivation by providing data-driven tools that can reduce burnout, improve job satisfaction, and promote long-term commitment to the profession. From an educational policy perspective, results from competency assessments show how applications developed in Estonia can align with national and international professional standards (e.g., EQF), helping policymakers design supportive qualification frameworks.

Combining the Learning Professional perspective with LA enhances teacher professionalism by making qualification and development decisions traceable to evidence gathered within the institution. All target groups valued TAPP's clear visuals—particularly the rose diagram, which helped them judge competence levels at a glance—and the ability to store longitudinal self-analyses in a secure environment. Reported benefits included privacy, time savings, supported self-analysis, and progressive visual feedback; interviewees who had previously used a paper-based process reported no substantive negative issues. These findings align with prior work showing that well-designed teacher dashboards aid sense-making and action, while institutional readiness and governance shape sustainable impact (Colvin et al., 2015).

As TAPP processes sensitive professional data, governance is essential. Ethics require transparency, informed participation, clear purpose limitations and safeguards that respect teacher autonomy and local regulations (e.g., the General Data Protection Regulation). Integrating these principles into design and policy is critical for scaling.

To further develop and refine the research, it is necessary to: improve validity and reliability, i.e., to examine and analyse how well self-assessments and dashboard indicators (including the Rose diagram) predict competency assessments and subsequent teaching outcomes. It is essential to assess the impact of TAPP on professional development, i.e., to test whether self-assessment and feedback supported by TAPP change teachers' behavior and teaching practices. It is necessary to test professional development recommendations triggered by analytical signals and measure their uptake, satisfaction and transfer into practice. Human-centred design, i.e., iteration of teacher-facing interfaces (warnings, explanations and suggested

actions) to support meaning-making and timely intervention (only 1 iteration has been carried out so far), also needs to be developed. Attention should also be paid to organisational readiness for sustainable implementation of TAPP (management, strategy and data management factors) in Estonia and potential transfer to other national contexts. Previous studies showing similarity of key competences across the EU (Leibur et al., 2023) confirm the need for configurable mappings, not one-off redesigns.

In summary, teachers highly appreciated both the opportunity of using LA and the functionality of the TAPP application, recognizing its role in supporting and improving competencies, professionalism, and feedback. Self-assessment within TAPP plays a crucial role in recognising and defining the work of teachers as Learning Professionals. TAPP fosters professional self-development, and its visual feedback can increase teachers' self-esteem, helping them feel competent and continue improving their practice.

A digital application supporting the qualification process is a novel solution in Estonia, streamlining and simplifying the entire procedure for greater convenience. Interviewees who had previously navigated the qualification application process using traditional methods were pleasantly surprised and satisfied. As a result, no negative feedback or problematic perspectives emerged during the interviews.

On the other hand, the following positive changes in the qualification application process were noted by all target groups: offering the presence of a secure environment and privacy, saving time and resources, enabling supported self-analysis, and giving progressive visual feedback. At the same time, various suggestions were made to increase the efficiency of the application and improve it.

Therefore, it can be said that teachers who apply through the TAPP application feel supported in the self-analysis process and can make choices regarding both the level of qualification and identify self-developmental needs, thus being able to make plans for further development. Carrying out a self-analysis supported by the TAPP application and applying for a qualification gives the teacher greater confidence and autonomy in their decisions. Also, it makes qualified teachers value themselves as teachers and continue their continuous professional development.

8 Limitation

While it was challenging to find enough interviewees who met the selection criteria, conducting individual interviews allowed for a detailed analysis of the evaluations provided by different target groups.

From a research ethics perspective, the study presents a limitation, as it fails to provide an overview of the long-term impact of the digital application on teachers' professional development. Another limitation is the absence of artificial intelligence functionality in the digital application. Artificial intelligence could serve as a supervisor and mentor, offering feedback to qualification applicants. However, this feature has not yet been implemented due to resource constraints. This limitation presents an opportunity for further enhancement and development of the digital application.

Due to limited resources, the application was not developed with its full functionality. The assessors' module still needs to be implemented; the TAPP's interface with external professional

environments (Figure 5) and the option to select a preferred language for using the application must be completed.

LA holds potential to advance educational practices but remains fraught with ethical and theoretical challenges. Protecting privacy, ensuring fairness, respecting autonomy, and embedding stakeholder accountability are ethical priorities. Theoretically, moving beyond reductionism, correlational limits, and context-insensitive models requires stronger integration with educational theory. A scientifically responsible approach to LA must be guided by ethics-by-design and critical theoretical reflection.

Despite the limitations, the research offers valuable insights into the evaluations of various target groups regarding the functionality and benefits of TAPP in supporting teachers' PD and the qualification application process.

Data availability statement

The datasets presented in this article are not readily available because where applicable, this refers only to raw, anonymized data. Requests to access the datasets should be directed to tiit.leibur@ut.ee.

Ethics statement

The studies involving humans were approved by Research Ethics Committee of the University of Tartu. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

TL: Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. KS: Supervision, Writing – review & editing.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2025.1639217/full#supplementary-material>

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