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DEVELOPMENT OF ARTIFICIAL INTELLIGENCE (AI)-BASED PERFORMANCE AND BEHAVIOR MEASURES FOR CLASSROOM TEACHING AND MANAGEMENT

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ABSTRACT

This research aims to develop artificial intelligence (AI)-based teaching performance and behavior measures to support classroom learning evaluation and management. Using a Research and Development (R&D) approach based on Design-Based Research (DBR), this research was conducted at the Faculty of Tarbiyah and Teacher Training (FTIK) IAIN Gorontalo through four stages: needs analysis, initial model design, limited trials, and improvement evaluation. Data was collected through classroom observations, audio-visual recordings, learning activity logs, and interviews with lecturers and students. The analysis was carried out qualitatively and computationally with pattern recognition and learning analytics techniques using multimodal data. The results of the study produced an annotated audio-visual dataset and a prototype of the Teacher Trainer Dashboard that is able to display indicators of teaching behavior visually, including teacher movements, speech styles, and interaction patterns in the classroom. Initial evaluations by eight researchers showed a positive response to the intuitive and non-judgmental design. This system is considered to be able to support teachers' professional reflection through objective and real-time feedback, without replacing the primary role of educators. Thus, the development of AI-based performance and behavioral measures contributes to the improvement of teacher professionalism and the application of ethical, adaptive, and evidence-based learning analytics in the Islamic education environment.

Keywords: *Artificial Intelligence, Teacher Behavior, Learning Analytics, Professional Reflection, Classroom Management*

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INTRODUCTION

Effective teaching is a key factor in determining the success of the learning process. The quality of teaching is not only measured by the ability to deliver material, but also by the quality of interaction between teachers and students, as well as the effectiveness of classroom management that is able to create an active, collaborative, and productive learning environment.[1] However, objectively assessing teaching performance is still a challenge because traditional observation methods are subjective, require a lot of effort, and are often influenced by observer perceptions. In this context, the development of artificial intelligence (AI) technology offers great potential in supporting the evaluation and improvement of teaching quality.[2]

The concept of performance in the classroom context includes learning outcomes, the quality of learning interactions, and the effectiveness of classroom management that can be supported by AI-based analytics. Systematic reviews show that AI has been used to monitor student attendance, behavior, engagement, and learning expression, with the potential to improve the efficiency of classroom management and personalized learning, while still facing ethical, privacy, and transparency challenges.[3] In this case, AI designs that focus on human–AI collaboration have been shown to deliver better learning outcomes when teachers retain the leading role while AI serves as an analytical companion and feedback provider.[4]

In the context of teaching languages and other subjects, recent studies emphasize the importance of a human-centered approach that places AI as an aid, not a substitute for teachers. This approach allows AI to support teaching adaptively, provide quick feedback, and tailor interactions based on students'

[1] André Renz, Swathi Krishnaraja, and Elisa Gronau, "Demystification of Artificial Intelligence in Education – How Much AI Is Really in the Educational Technology?," *International Journal of Learning Analytics and Artificial Intelligence for Education (Ijai)* 2, no. 1 (2020): 14, https://doi.org/10.3991/ijai.v2i1.12675.

[2] Izzatul Munawwaroh, Rizkiyah Hasanah, and Uthman S Lawal, "Artificial Intelligence-Based Learning and Its Impact on Educational Policy and School Management," *Ejip* 3, no. 2 (2024): 86–99, https://doi.org/10.71392/ejip.v3i2.38.

[3] Tim Fütterer et al., "Artificial Intelligence in Classroom Management: A Systematic Review on Educational Purposes, Technical Implementations, and Ethical Considerations," 2023, https://doi.org/10.31219/osf.io/wfazn; Deliang Wang, Cunling Bian, and Gaowei Chen, "Using Explainable <scp>AI</Scp> to Unravel Classroom Dialogue Analysis: Effects of Explanations on Teachers' Trust, Technology Acceptance and Cognitive Load," *British Journal of Educational Technology* 55, no. 6 (2024): 2530–56, https://doi.org/10.1111/bjet.13466.

[4] Kenneth Holstein and Vincent Aleven, "Designing for Human–AI Complementarity in K-12 Education," *Ai Magazine* 43, no. 2 (2022): 239–48, https://doi.org/10.1002/aaai.12058.

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needs.[5] Therefore, performance and behavioral measures developed through AI systems need to be aligned with the principles of teaching professionalism, teachers' trust in technology, and strengthening educational ethical values.[6]

The application of AI in the classroom is also closely related to the theory of technology acceptance and user trust. Factors such as perception of benefits, ease of use, and social norms affect the extent to which teachers and students accept this technology. Adoption models such as UTAUT (Unified Theory of Acceptance and Use of Technology) are widely used to explain how AI acceptance can be humanized in the context of higher and secondary education.[7] Other research shows that there are gender and age variations on the perception of the benefits and stresses of using AI in the classroom.[8]

In addition, various studies also remind that the use of AI for learning must balance benefits such as personalization and efficiency with challenges such as algorithmic bias, data privacy, and validity and fairness in evaluation.[9] In this context, AI plays an important role in improving the ability to measure teaching performance through real-time analytics and continuous feedback, but still requires a design framework that maintains the role and trust of teachers and maintains ethical control over data and privacy.[10]

The performance and behavioral dimensions measured through AI include three main aspects. First, the instructional performance dimension, which includes the effectiveness of material delivery, the quality of interaction, and the ability to

[5] Laura Hanifah and Nyak M Ismail, "Human-Centered Ai in Language Classrooms," *Proceedings of ICE* 3, no. 1 (2025): 239–46, https://doi.org/10.32672/pice.v3i1.3481.
[6] Wang, Bian, and Chen, "Using Explainable <scp>AI</Scp> to Unravel Classroom Dialogue Analysis: Effects of Explanations on Teachers' Trust, Technology Acceptance and Cognitive Load."
[7] Theerawut Tantiathimongkhon and Kriangkrai Satjaharuthai, "Factors Influencing the Acceptance of Ai-Powered Virtual Classrooms in Higher Education," *Jie* 24, no. 2 (2025), https://doi.org/10.55003/jie.24211.
[8] Abdulla A Darayseh and Nazan Mersin, "Integrating Generative AI Into STEM Education: Insights From Science and Mathematics Teachers," *International Electronic Journal of Mathematics Education* 20, no. 3 (2025): em0832, https://doi.org/10.29333/iejme/16232; Eulyong Choi and Soonshik Suh, "Elementary School Teachers' Perception Survey on Smart Device Based Teaching &Amp; Learning and AI Education," *J Field-Based Lesson Stud.* 4, no. 2 (2023): 79–100, https://doi.org/10.22768/jfls.2023.4.2.79.
[9] Nor S Sharifuddin and Harwati Hashim, "Benefits and Challenges in Implementing Artificial Intelligence in Education (AIED) in ESL Classroom: A Systematic Review (2019-2022)," *International Journal of Academic Research in Business and Social Sciences* 14, no. 1 (2024), https://doi.org/10.6007/ijarbss/v14-i1/20422; Patrick C Kyllonen et al., "Charting the Future of Assessments," *Ets Research Report Series* 2024, no. 1 (2024): 1–62, https://doi.org/10.1002/ets2.12388.
[10] Holstein and Aleven, "Designing for Human–AI Complementarity in K-12 Education."

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manage learning dynamics. Second, the dimension of student behavior includes involvement, participation, attention, and self-regulation skills that can be observed through multimodal data such as video, audio, sensors, or learning activity logs.[11] Third, the dimensions of learning outcomes and academic performance, where AI can enrich formative and summative evaluations with comprehensive data to map learning progress holistically.[12]

To support these measurements, multimodal data is an important component in building AI models. Data from video, audio, learning system logs, and sensors can be used to detect student engagement, the direction of view, and the dynamics of interactions in the classroom. The analytics architecture used typically combines image processing, text and voice analysis, and activity log analytics to generate a picture of learning behaviors and classroom interaction patterns. In order to be widely accepted, the AI model developed needs to be transparent and explainable so that teachers understand the basis of the recommendations and suggestions given.[13]

In addition to technical validity, the application of AI in education must also pay attention to ethical and data privacy aspects. The validity of behavioral measures requires the convergence of multiple data sources to reduce sensory bias, while the protection of teacher and student privacy must be ensured through transparent data use policies.[14] Research related to surveillance pedagogy highlights that AI-based behavioral surveillance can cause psychological stress in students if

[11] Islam Alkabbany et al., "An Experimental Platform for Real-Time Students Engagement Measurements From Video in STEM Classrooms," *Sensors* 23, no. 3 (2023): 1614, https://doi.org/10.3390/s23031614; Zouheir Trabelsi et al., "Real-Time Attention Monitoring System for Classroom: A Deep Learning Approach for Student's Behavior Recognition," *Big Data and Cognitive Computing* 7, no. 1 (2023): 48, https://doi.org/10.3390/bdcc7010048; Zefang Yu et al., "From Raw Video to Pedagogical Insights: A Unified Framework for Student Behavior Analysis," *Proceedings of the Aaai Conference on Artificial Intelligence* 38, no. 21 (2024): 23241–49, https://doi.org/10.1609/aaai.v38i21.30371.

[12] Suyan Tan et al., "Statistical Measurement of Behavioral Effects Based on Multimodal Data," *National Accounting Review* 6, no. 4 (2024): 573–89, https://doi.org/10.3934/nar.2024027; Kyllonen et al., "Charting the Future of Assessments."

[13] Lichen Zhang et al., "Artificial Intelligence Empowering Higher Education: Exploration of Teaching Mode Innovation and Quality," *International Journal of Research and Innovation in Social Science* IX, no. IIIS (2025): 6302–10, https://doi.org/10.47772/ijriss.2025.903sedu0458.

[14] M S T J V Cubio, "The Influence of Privacy, Bias, and Surveillance Concerns on Teachers' Willingness to Use Artificial Intelligence in Education," *International Journal of Research and Innovation in Social Science* IX, no. IIIS (2025): 3192–3208, https://doi.org/10.47772/ijriss.2025.903sedu0240; Fütterer et al., "Artificial Intelligence in Classroom Management: A Systematic Review on Educational Purposes, Technical Implementations, and Ethical Considerations."

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not designed with clear boundaries.[15] Therefore, the principles of privacy, consent, and fairness should be the primary cornerstone in the design of AI systems for learning.[16]

While various potentials have been identified, the success of the application of AI for teaching evaluation is highly dependent on teacher acceptance and readiness. Factors such as perceived benefits, ease of use, technology training, and institutional support play an important role in building trust in these systems.[17]Training programs that increase teachers' self-efficacy towards AI are also an urgent need so that educators can make optimal use of this technology.[18] In addition, successful implementation requires clear institutional policy support to govern the use, storage, and security of student data.[19]

In practice, the application of AI also makes a real contribution to language teaching and classroom management. In English learning, for example, AI is able to increase student motivation and participation through instant feedback and adaptive interaction, as long as its design maintains the primary role of the teacher.[20] On the other hand, in classroom management, AI helps teachers identify student behavior in real-time, provides early warning of decreased engagement, and helps adjust teaching strategies.

This research was carried out at the State Islamic Institute (IAIN) Gorontalo, especially at the Faculty of Tarbiyah and Teacher Training (FTIK), with the aim of developing AI-based teaching performance measures and behaviors that are relevant to Indonesia's social and cultural characteristics. This approach emphasizes the importance of partnerships between humans and AI, with teachers remaining in a central role as managers of the learning process, while AI serves as a support

[15] Muhammad Nawaz et al., "Surveillance Pedagogy: The Psychological and Pedagogical Risks of AI-Based Behavioral Analytics in Digital Classrooms," *Aijss* 4, no. 3 (2025): 1995–2010, https://doi.org/10.63056/acad.004.03.0508.
[16] Choi and Suh, "Elementary School Teachers' Perception Survey on Smart Device Based Teaching &Amp; Learning and AI Education."
[17] Tantiathimongkhon and Satjaharuthai, "Factors Influencing the Acceptance of Ai-Powered Virtual Classrooms in Higher Education."
[18] Putu M S Suardewa, I P I Kusuma, and Kadek S Dewi, "The Impacts of Preservice English Teachers' Self-Efficacy of Using AI Towards Their Intentions of Teaching Writing Skills Using AI," *Jurnal Pendidikan Bahasa Inggris Undiksha* 12, no. 1 (2024): 110–19, https://doi.org/10.23887/jpbi.v12i1.80827.
[19] Sharifuddin and Hashim, "Benefits and Challenges in Implementing Artificial Intelligence in Education (AIED) in ESL Classroom: A Systematic Review (2019-2022)."
[20] Hanifah and Ismail, "Human-Centered Ai in Language Classrooms."

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system that provides analytical data, recommendations, and evidence-based learning reflections.[21]

Thus, the development of AI-based performance and behavior measures is expected to make an important contribution in improving the professionalism of educators in Indonesia. This system not only provides objective measurement and real-time analytics, but also assists teachers in self-reflection, designing adaptive teaching strategies, and managing classrooms with a more efficient, ethical, and equitable approach.

RESEARCH METHODS

This research uses a Research and Development (R&D) approach with the aim of developing artificial intelligence (AI)-based teaching performance and behavior measures to support classroom evaluation and management. This approach combines qualitative and quantitative methods sequentially (sequential mixed methods).[22] The qualitative stage was used to identify performance indicators and teaching behavior through interviews and observations at the Faculty of Tarbiyah and Teacher Training (FTIK) IAIN Gorontalo, while the quantitative stage was focused on testing the validity and reliability of the developed AI model.

The design of this study adapts the Design-Based Research (DBR) framework which includes four stages, namely needs analysis, initial model design, limited trials, and improvement evaluation.[23] As follows:

[21] Holstein and Aleven, "Designing for Human–AI Complementarity in K-12 Education."
[22] Lawrence A. Palinkas, "Mixed Method Designs," in *Implementation Science* (London: Routledge, 2022), 118–22, https://doi.org/10.4324/9781003109945-35; Candauda Arachchige Saliya, "Mixed Methods Strategy," in *Doing Social Research and Publishing Results* (Singapore: Springer Nature Singapore, 2022), 313–16, https://doi.org/10.1007/978-981-19-3780-4_23.
[23] Luís Tinoca et al., "Design-Based Research in the Educational Field: A Systematic Literature Review," *Education Sciences* 12, no. 6 (June 16, 2022): 410, https://doi.org/10.3390/educsci12060410.

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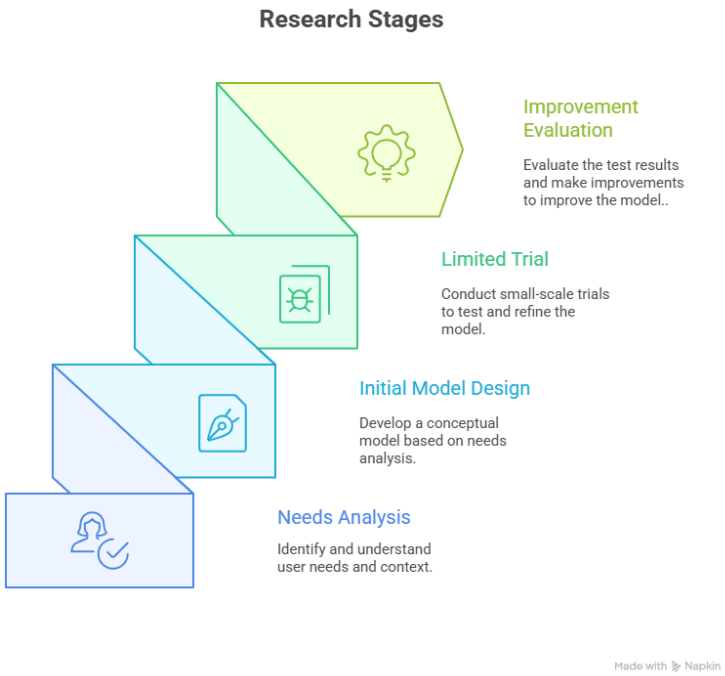

Figure 1. Development Stages

Data was obtained from classroom observations, video and audio recordings, logs of learning activities, and interviews with lecturers and students. All of the multimodal data was used to analyze teaching interactions, student engagement, and the effectiveness of classroom management with the support of AI technology.

Data analysis was carried out qualitatively to extract behavioral categories and performance indicators, as well as computationally through multimodal data processing using pattern recognition techniques and learning analytics. Validation is carried out by involving experts and comparing the results of AI analysis with manual observations to ensure accuracy and clarity of interpretation. The results of this study are expected to produce an AI-based performance and behavior measurement model and learning analytics dashboard that can be used as a reflection and decision-making tool for educators, while still paying attention to the principles of ethics, privacy, and fairness in the use of technology in the educational environment.

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RESULTS AND DISCUSSION

Result

1. Annotated Audio-Visual Data Collection

Based on the data collection and annotation process described in the previous section, this study produced an audio-visual *dataset* that is curated and synchronized in time, containing recordings of teaching interactions in higher education classrooms within IAIN Gorontalo. This data is collected through the integration of several recording devices (cameras and microphones) that are able to capture the teacher's actions as well as student responses simultaneously.

The teaching activities in the recordings were annotated using a combination of manual *labeling* by the researcher and an AI-based computer vision system. All annotations are stored in *plain text* format to ensure ease of management and interoperability between analysis software. Although student video data is included as a context for classroom interaction, the data is not annotated due to limited human resources and research ethics involving students.

This dataset is the first step in building a local database for AI research in the field of Islamic education in Indonesia, in line with the direction of research put forward by Dharma that the development of AI-driven learning analytics is very important to support reflective learning and improve the quality of teaching in religious universities. This dataset can also be accessed by other researchers upon request, in accordance with the data management procedures applicable at the research institution.[24]

2. AI-Based Measures for Teaching Behavior

This research develops a set of measures based on artificial intelligence (AI) that is able to identify and measure teacher behavior quantitatively. These measurements were made through computer vision analysis and speech analysis from audio-visual sensor data obtained in the classroom. The main focus of the analysis was directed at non-verbal and paralinguistic features, such as teacher position, body movements, use of learning aids (such as slides or whiteboards), as well as vocal attributes such as loudness, tone, speaking speed, and intonation.

Descriptors related to the content or content of the teaching material are manually annotated to explore the teaching style and delivery patterns of the material, but the verbal content is not used in the training system to maintain

[24] Dharma Raj Ojha, "Impact of AI Technologies on Teaching, Learning, and Research in Higher Education," *Journal of Jayaprithvi Multiple Campus* 1 (July 31, 2025): 121–33, https://doi.org/10.3126/jjmc2.v1i1.81444.

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academic confidentiality and research ethics.[25] This content-based approach is planned to be further developed after obtaining ethics clearance from *the Institutional Review Board (IRB).* A similar approach has previously been applied in AI-based education research by Qiuyu Zheng, who showed that mapping non-verbal behaviors can improve the quality of feedback to teachers without assessing the content of the material directly.[26]

2.1. Computer Vision

To analyze the actions and movements of teachers during the learning process, this study uses a combination of computer vision models. Teacher position tracking was carried out using the YOLOv8 object detection network with pre-trained *weights* to detect human locations and poses. The guru was identified based on the highest foot coordinates of all humans detected in the first video frame.

To maintain tracking consistency, the DeepOCSORT algorithm is used for *the re-identification (ReID) process*, supplemented with several improvements to address tracking failures due to position changes or visual disturbances in the classroom. These improvements include the use of the teacher's previous position history, the maintenance of the student ID list to prevent reassignment errors, and the implementation of exit detection to anticipate when teachers leave the room temporarily.

The teacher's actions are then labeled through a combination of manual and automated methods, including activities such as writing on the board, pointing to a board or screen, cuing to the board, performing common hand movements, and changing slides. For the introduction of this action, the ST-GCN (Spatial-Temporal Graph Convolutional Network) model was used which had been trained beforehand to extract skeletal information from the video. This model resulted in a classification accuracy of 83.33% for writing activities on the board, 65.06% for pointing at the board/screen, and 88.57% for movement towards the board.

In addition, slide change detection was performed using a Segment Anything (SAM) visual model with a more efficient MobileSAM variant, while hand movements were recognized using *pre-trained weights* mmpose to extract hand coordinates and determine motion patterns. All detected actions, including

[25] Gang Zhao et al., "Design and Implementation of Knowledge Extraction Tool for Teaching Video Based on Verbal Behavior Characteristics," in *2023 13th International Conference on Information Technology in Medicine and Education (ITME)* (IEEE, 2023), 375–79, https://doi.org/10.1109/ITME60234.2023.00081.

[26] Qiuyu Zheng et al., "Automated Multimode Teaching Behavior Analysis: A Pipeline-Based Event Segmentation and Description," *IEEE Transactions on Learning Technologies* 17 (2024): 1677–93, https://doi.org/10.1109/TLT.2024.3396159.

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their *timestamps*, are stored in a structured JSON format. This format ensures that the dataset can be used for advanced analysis with other machine learning systems.

The application of this multi-model approach is in line with *the trend of AI in Education (AIED)* as explained by Arwa, where the use of computer vision allows classroom observation to be carried out objectively, efficiently, and continuously, especially for teacher training and pedagogical behavior evaluation.[27]

2.2. Speech Analysis

In addition to visual analysis, this study also assesses teachers' vocal dynamics by extracting acoustic features and developing high-level vocal metrics called *speaking styles*. Using Praat's software, features such as loudness, pitch, rhythm, intonation, and prosody are measured to determine speech speed, vocal clarity, and voice monotony levels.

In the Indonesian context, teachers' clear, structured, and balanced intonation speaking styles have a great influence on student engagement Therefore, this system was developed to help teachers evaluate their vocal delivery during teaching. A two-level segmentation system was applied to distinguish between teacher speech and pause, with the removal of speech below 125 milliseconds as it was considered meaningless. The crude level of analysis (60-second interval) provides an overview of vocal dynamics, while the detailed level (10-second interval) provides a more in-depth analysis of changes in speaking style.

The extracted features are then grouped into three main categories:

- Statistical summaries, such as sound hardness (dB), pitch variability, *formant* frequency, and *voicing probability*;
- Contextual features, including speech length, pause duration, and speech speed;
- Linguistic features, including vocal clarity (*cepstral peak prominence*), *jitter*, *shimmer*, intonation, and prosody

To assess the quality of speaking, the Multiple Criteria Decision Making (MCDM) model with two weighting approaches was used: *Equal Weights (EW)* and *Reciprocal Standard Deviation Weights (RW).* This approach allows more varied features to have a smaller contribution to the final score, resulting in more stable and proportional results.

This two-layer analysis provides feedback on two levels: *a coarse-grained* overview of teacher speaking style trends and *fine-grained* insights into key

[27] Arwa Almubarak et al., "An AI-Powered Framework for Assessing Teacher Performance in Classroom Interactions: A Deep Learning Approach," *Frontiers in Artificial Intelligence* 8 (September 3, 2025), https://doi.org/10.3389/frai.2025.1553051.

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acoustic features.[28] The results help teachers reflect on vocal delivery and improve the effectiveness of communication in the classroom. This approach is also in line with Qikai Lu's findings that AI-based vocal analysis is able to strengthen *reflective teaching* and teacher professional development in the digital age.[29]

3. Teacher Trainer Dashboard

The Teacher *Trainer Dashboard prototype* is a proof-of-concept development *that* is designed to visualize measures of artificial intelligence (AI)-based teaching behavior. The main purpose of this dashboard is to provide reflective support for teacher professional development, especially in the context of teacher training in religious higher education environments such as IAIN Gorontalo. This dashboard consists of two main displays, namely *the Summary Screen* and *the Review Screen*, which function as a tool to analyze teaching behavior, communication style, and the dynamics of teachers' movements during the learning process.

3.1. Summary Screen

The summary screen provides an overview of teaching behavior, teachers' spatial movements, and vocal and body movement characteristics recorded during learning. The screen is divided into several main visual panels that are integrated with each other.

Figure 4: Summary screen (1)- teaching behaviors

[28] Michał Okrasa et al., "Supporting Self-Development of Speech Delivery for Education Professionals," in *Proceedings of the 21st International Conference on Mobile and Ubiquitous Multimedia* (New York, NY, USA: ACM, 2022), 251–53, https://doi.org/10.1145/3568444.3570588.

[29] Qiuyan, "Optimization Analysis of Teachers' Professional Growth Path Based on Artificial Intelligence Technology," *Region - Educational Research and Reviews* 6, no. 11 (December 31, 2024): 95, https://doi.org/10.32629/rerr.v6i11.3159.

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The first panel, **Teaching Actions**, features a doughnut-shaped diagram that shows the proportion of time teachers spend on various teaching actions such as performing hand gestures, writing on the board, pointing at screens, and interacting with students. The outer ring displays the overall percentage of time for each activity, while the inner ring displays the division of time between the area near the board and the interaction area with the student. This visualization is important because video-based reflection on teaching actions can increase teachers' metacognitive awareness of their own teaching behavior.[30]

The second panel, **Teaching Style**, shows a balance between active and passive teaching methods inferred from observed actions. Passive teaching usually leads students to one correct answer (*convergent thinking*), while active teaching encourages students to connect concepts to real-world contexts (*lateral thinking*) as affirmed in divergent thinking theory. This data is obtained from manual annotations resulting from observation of teachers' activities in the classroom.[31]

The third panel, **Speaking Style**, describes the characteristics of teachers' vocals compared to norms drawn from the literature.[32] An effective speech speed is set between 125–160 words per minute (wpm), with an ideal average of 140 wpm as stated by Gyanendra that this range allows for optimal clarity and engagement in lecture delivery. For vocal clarity, a *Speech Transmission Index* (STI) threshold of 0.75 is used, where scores above 0.5 are considered acceptable and above 0.75 are considered optimal. As for the monotone of the voice, the normal value is set at 1.0 based on the intonation score; A value below 0.4 indicates a monotonous speaking style, while above 1.6 indicates expressive and engaging delivery.

The fourth panel, **Speaking & Pauses**, displays the ratio between the teacher's speaking time and pause time during learning. This visualization allows for quick interpretation of conversational dominance and gives an idea of the balance between speaking and listening.[33] This is in line with this, the balance

[30] Tova Michalsky, "Integrating Video Analysis of Teacher and Student Behaviors to Promote Preservice Teachers' Teaching Meta-Strategic Knowledge," *Metacognition and Learning* 16, no. 3 (December 31, 2021): 595–622, https://doi.org/10.1007/s11409-020-09251-7.
[31] Adizova Nigora Bakhtiyorovna, "VIEWS ON THEORETICAL ISSUES OF DIVERGENT THINKING IN SCIENTIFIC RESEARCH," *International Journal of Pedagogics* 03, no. 06 (June 1, 2023): 17–21, https://doi.org/10.37547/ijp/Volume03Issue06-05.
[32] Gyanendra Prasad Joshi et al., "Influence of Multimedia and Seating Location in Academic Engagement and Grade Performance of Students," *Computer Applications in Engineering Education* 28, no. 2 (March 26, 2020): 268–81, https://doi.org/10.1002/cae.22190.
[33] Seng Chee Tan, Aik-Ling Tan, and Alwyn Vwen Yen Lee, "Breaking the Silence: Understanding Teachers' Use of Silence in Classrooms," *Pedagogies: An International Journal* 20, no. 3 (July 3, 2025): 331–48, https://doi.org/10.1080/1554480X.2024.2341258.

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between speaking and pausing is very important in building productive dialogue interactions in the classroom

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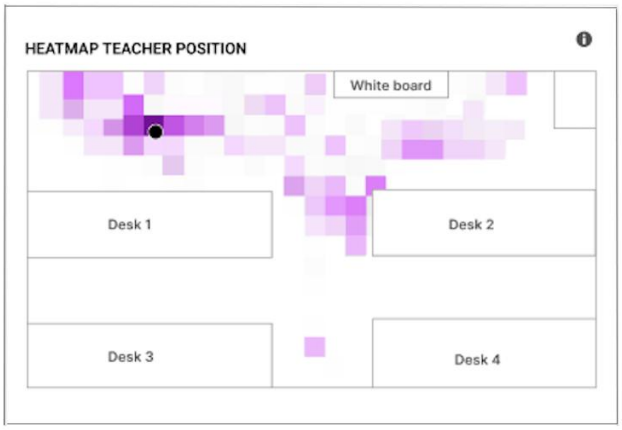

Figure 5: Summary screen (2)- spatial movemen

Next, Figure 5 on the summary screen illustrates the spatial movement patterns of teachers in the classroom through *heatmap* visualization. Warmer colored areas indicate locations where teachers spend more time. These visualizations help analyze classroom dynamics, such as whether teachers tend to be near the board, move between students frequently, or have a balanced distribution of movements. This analysis is important for evaluating teachers' engagement with students and the effectiveness of classroom management.[34]

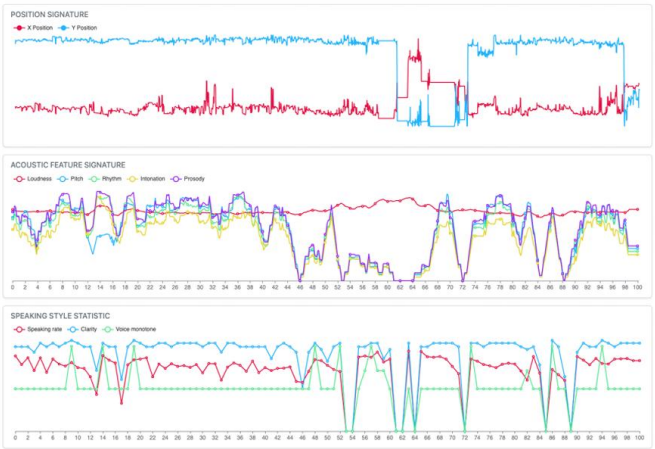

Figure 6: Summary screen (3)- speech & movement charac teristics

[34] M. Huang, Y. Zhang, and W. Tang, "Comparative Analysis of Classroom Teaching Behavior Based on Teaching Video," *IET Conference Proceedings* 2022, no. 9 (October 11, 2022): 203–7, https://doi.org/10.1049/icp.2022.1473.

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Figure 6 shows a dynamic visualization of the teacher's X-Y position during the learning session. The X-axis represents left-right movements, while the Y-axis represents front-back movements. Thus, this dashboard allows tracking of teachers' movement paths in the form of *time-series*, providing insight into the engagement strategies implemented. The panel also features the low-level vocal characteristics (acoustic features) as well as the high-level speaking style described earlier.

3.2. Review Screen

The review screen provides an interactive platform to review learning sessions through video playback that is synchronized with teacher behavior data. This integration allows educators to revisit their delivery style while simultaneously observing positional patterns, gestures, and vocal characteristics. This view is divided into two main parts, namely the left side and the right side.

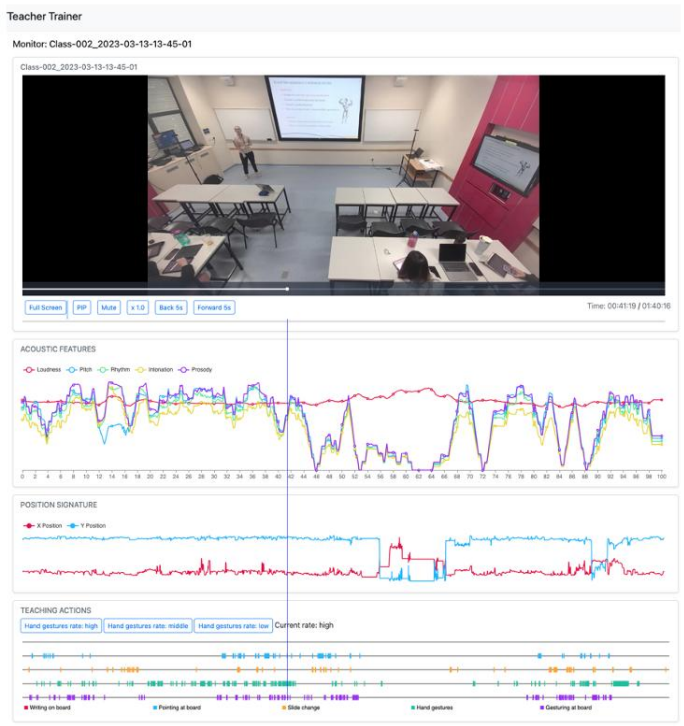

Figure 7: Review screen (left)- video playback & position and verbal signatures

Figure 7 shows a learning video that is synchronized with visualizations of teacher positions, acoustic features, and speaking styles. This information comes from the summary screen, but is updated in real-time using dynamically moving vertical blue bars. Playback navigation features include speed settings (1x–3x), *fast-forward*, *rewind*, and *Picture-in-Picture (PIP) mode* to review videos while

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accessing other panels. The use of reflective video with flexible navigation can strengthen the teacher's understanding of his pedagogical interactions.[35]

BEHAVIOR FEATURES

Time (mins)	Event	Description
0	[0,7]	[0,7]
1	[4,7]	Slide change, Hand gestures
1	[2,4,7]	Pointing at board, Slide change, Hand gestures
2	[2,4]	Pointing at board, Slide change
2	[2,7]	Pointing at board, Hand gestures
2	[2,4,7]	Pointing at board, Slide change, Hand gestures
6	[2,4,7]	Pointing at board, Slide change, Hand gestures
9	[4,7]	Slide change, Hand gestures
9	[2,7]	Pointing at board, Hand gestures
9	[2,4]	Pointing at board, Slide change
9	[4,7]	Slide change, Hand gestures
9	[2,4,7]	Pointing at board, Slide change, Hand gestures
9	[2,4,7]	Pointing at board, Slide change, Hand gestures
10	[2,7]	Pointing at board, Hand gestures
10	[2,4,7]	Pointing at board, Slide change, Hand gestures
11	[4,7]	Slide change, Hand gestures

Figure 8: Review screen (right)- latest teacher movement and behavioral features

Figure 8 shows traces of the teacher's position over the last minute, providing a time-sensitive spatial portrait and highlighting areas with high activity or sedentary behavior. Underneath, there is a timed text summary that displays teaching events such as writing on the board, the use of gestures, pauses, and changes in speaking style or position. These annotations help teachers find key moments in learning for reflection and instructional improvement.

[35] Chelsey M. Bollinger and Juhong Christie Liu, "Reflective Learning With Video-Based Annotations," 2022, 223–40, https://doi.org/10.4018/978-1-7998-9004-1.ch010.

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3.3. Evaluation

The prototype of this dashboard has been evaluated informally by eight researchers from the National Institute of Education (NIE) who are members of the *Learning Strategy Group* and *the Learning Sciences and Innovation Research Programme*. The results of the evaluation showed a very positive response. The evaluators assessed that this dashboard has a non-judgmental reflective approach and has the potential to be an effective teacher training tool. They also highlight the advantages of automated audio–video analysis and AI-based event detection over traditional manual methods that are more time-consuming. The feedback is the basis for improving the screen design, in order to improve visual clarity and user experience.

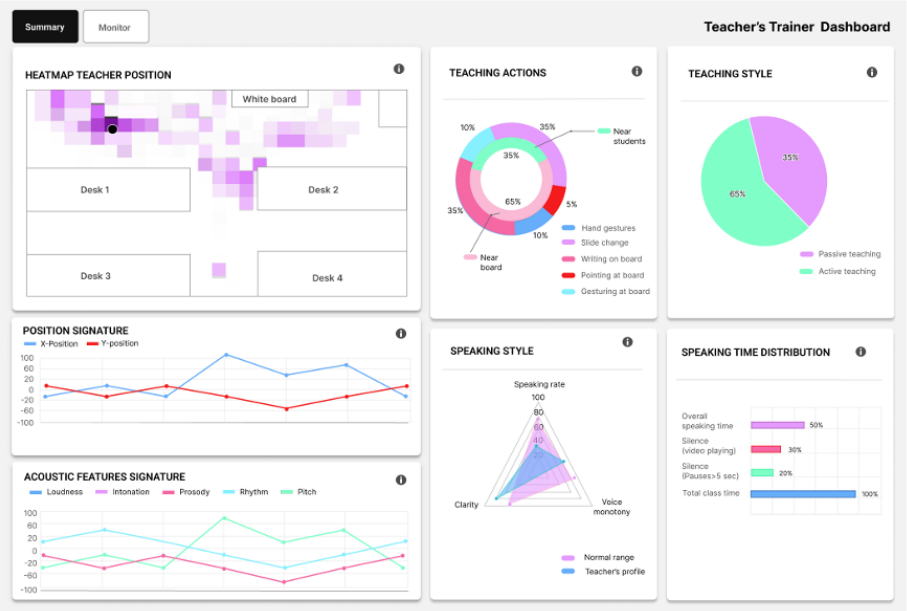

Figure 9: Summary screen

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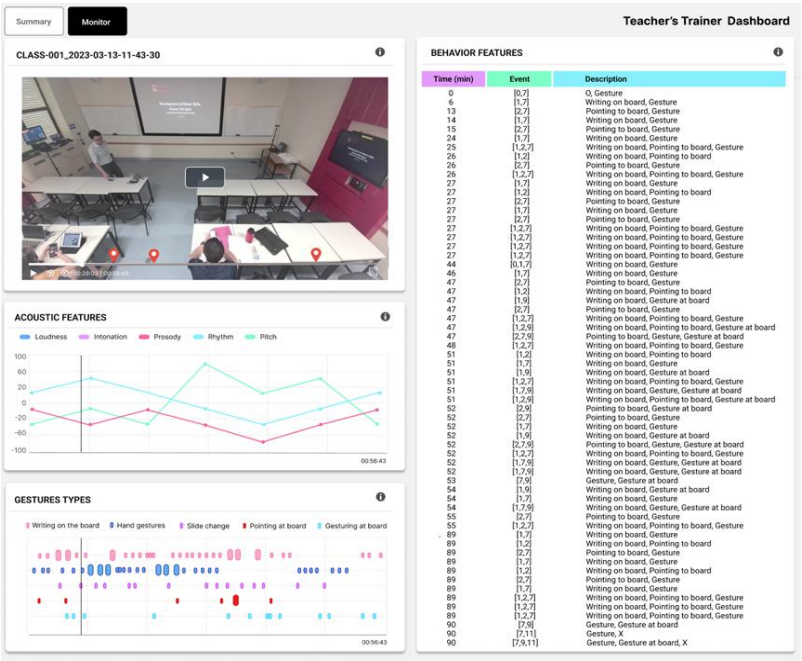

In the context of Indonesian education, especially at IAIN Gorontalo, the implementation of a dashboard like this has great prospects to support teachers' professional reflection through objective analysis of teaching behavior. This is in line with the principles *of Reflective Teaching* and *Evidence-Based Practice* in modern education which emphasizes the use of real data for continuous learning improvement.[36]

CONCLUSION

This study explores the use of artificial intelligence (AI) to generate measurable insights into teacher behavior through multimodal sensor data. By leveraging the curated dataset, the study successfully identified key visual and vocal indicators in classroom teaching practice, as well as demonstrated how AI can provide objective and real-time feedback to non-verbal instructional strategies. The prototype *dashboard* built with *computer vision* and speech processing techniques was well received by teacher evaluators because of its intuitive and non-judgmental design. Although the system does not generate a direct performance appraisal, it

[36] Ponsawan Suphasri, "Reflective Practice in Teacher Education: Issues, Challenges, and Considerations," *PASAA* 62, no. 1 (July 2021): 236–64, https://doi.org/10.58837/CHULA.PASAA.62.1.9.

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does provide a structured visual summary of teaching behavior, thus supporting meaningful reflection and ongoing professional development for teachers.

The system's ability to automatically detect actions such as writing on the board, performing hand gestures, as well as movement in the classroom, allows teachers to review and assess key moments in their learning process. However, the evaluators emphasized the importance of adding high-level indicators, such as the teacher's ability to ask questions, encourage, and encourage student participation, in order to capture instructional intent more comprehensively. Although this phase of the research still focuses on teacher behavior, the framework developed is easily expanded to include metrics related to students, such as engagement levels and *cognitive load*. This will support a more holistic understanding of classroom dynamics. Further research will focus on expanding the scope of behavior, providing real-time feedback, as well as integrating content-based analytics, while keeping ethical considerations in mind.

Despite its current limitations, this project demonstrates the great potential of AI-based classroom behavior analysis and makes valuable contributions in the field *of educational analytics*, including annotated multimodal datasets, innovative behavioral measures, and functional prototypes for teacher behavior tracking. This contribution becomes particularly relevant in the context of education in Asia, including Indonesia, where pedagogical norms and evaluation criteria can differ from Western educational frameworks.

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