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DEEP LEARNING MODEL BASED ON ATTENDANCE AND PARTICIPATION PATTERNS TO MEASURE STUDENT LEARNING INTEREST IN PHYSICAL EDUCATION

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ABSTRAK

Minat belajar siswa merupakan faktor psikologis penting yang berkaitan dengan keterlibatan siswa dan pengalaman belajar dalam Pendidikan Jasmani (PJ). Namun, penelitian yang mengkaji apakah indikator perilaku yang dapat diamati, khususnya kehadiran dan partisipasi di kelas, dapat diintegrasikan ke dalam pemodelan prediktif minat belajar siswa serta apakah deep learning memberikan kinerja prediktif yang lebih baik dibandingkan pendekatan statistik konvensional masih terbatas. Penelitian ini bertujuan untuk mengkaji hubungan antara pola kehadiran siswa dan partisipasi di kelas dengan minat belajar dalam PJ serta mengevaluasi kinerja prediktif model deep learning dengan menggunakan indikator perilaku tersebut. Penelitian ini menggunakan desain kuantitatif korelasional-prediktif yang melibatkan 150 siswa sekolah menengah atas dari Kabupaten Luwu Utara dan Kabupaten Luwu Timur, Indonesia, yang dipilih melalui teknik stratified random sampling. Data dikumpulkan menggunakan kuesioner minat belajar yang telah tervalidasi, catatan kehadiran sekolah, dan observasi terstruktur terhadap partisipasi siswa di kelas. Analisis deskriptif dan analisis model struktural dilakukan untuk mengkaji hubungan antarkonstruksi penelitian, kemudian dilanjutkan dengan pemodelan deep learning untuk mengevaluasi kinerja prediktif pada independent test set. Hasil penelitian menunjukkan bahwa pola kehadiran siswa dan partisipasi di kelas memiliki hubungan yang signifikan dan positif dengan minat belajar dalam PJ. Model struktural menjelaskan proporsi varians yang cukup besar pada minat belajar ($R^2 = 0,904$). Pada evaluasi menggunakan independent test set, model deep learning menghasilkan kesalahan prediksi yang lebih rendah (MAE = 0,194; RMSE = 0,267) dan nilai R^2 yang lebih tinggi (0,887) dibandingkan model statistik konvensional (MAE = 0,286; RMSE = 0,354; $R^2 = 0,821$). Temuan ini menunjukkan bahwa model deep learning memberikan kinerja prediktif yang lebih baik berdasarkan prosedur evaluasi yang digunakan dalam penelitian ini. Penelitian ini memberikan kontribusi terhadap analitik pendidikan dengan menunjukkan bagaimana indikator perilaku yang dapat

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	diamati dapat mendukung pemodelan prediktif minat belajar dalam PJ. Temuan ini juga memiliki implikasi potensial bagi Pendidikan Agama Islam (PAI), di mana indikator perilaku seperti kehadiran dan partisipasi aktif dapat melengkapi pertimbangan profesional guru dalam mendukung keterlibatan, kedisiplinan, dan pembelajaran yang berorientasi pada pembentukan karakter siswa.
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Keywords:	ABSTRACTS
deep learning; attendance patterns; student participation; learning interest; physical education	<p>Student learning interest is an important psychological factor associated with student engagement and learning experiences in Physical Education (PE). However, limited research has examined whether observable behavioural indicators, particularly attendance and classroom participation, can be integrated into predictive modelling of students' learning interest and whether deep learning provides better predictive performance than conventional statistical approaches. This study aimed to examine the relationships of student attendance and classroom participation with learning interest in PE and to evaluate the predictive performance of a deep learning model using these behavioural indicators. A quantitative correlational-predictive research design was employed involving 150 senior high school students from North Luwu and East Luwu Regencies, Indonesia, selected through stratified random sampling. Data were collected using validated learning interest questionnaires, school attendance records, and structured classroom observations of student participation. Descriptive and structural model analyses were conducted to examine the relationships among the study constructs, followed by deep learning modelling to evaluate predictive performance on an independent test set. The findings indicated that student attendance patterns and classroom participation were significantly and positively associated with learning interest in PE. The structural model explained a substantial proportion of the variance in learning interest ($R^2 = 0.904$). In the independent test-set evaluation, the deep learning model achieved lower prediction errors (MAE = 0.194; RMSE = 0.267) and a higher R^2 (0.887) than the conventional statistical model (MAE = 0.286; RMSE = 0.354; $R^2 = 0.821$). These findings indicate that the deep learning model provided better predictive performance under the evaluation procedure used in this study. The study contributes to educational analytics by demonstrating how observable behavioural indicators can support predictive modelling of learning interest in PE. The findings also have potential implications for Islamic Education, where behavioural indicators such as attendance and active participation may complement teachers' professional judgment in supporting student engagement, discipline, and character-oriented learning.</p>

A. INTRODUCTION

The rapid advancement of artificial intelligence has positioned deep learning as one of the most influential analytical approaches for extracting meaningful patterns from large and complex datasets across multiple disciplines (Talaie Khoei et al., 2023). Model-based deep learning has further enhanced predictive performance by integrating domain knowledge with optimization techniques, thereby improving model interpretability and robustness compared with conventional data-driven approaches (Shlezinger et al., 2022). This paradigm has demonstrated remarkable effectiveness in solving complex prediction problems where nonlinear interactions exist among multiple variables (Zappone et al., 2019).

The successful implementation of deep learning has been widely reported in numerous application domains, including sentiment analysis (Tam et al., 2021), biomedical diagnosis (Noreen et al., 2020), transportation systems (Xie et al., 2019), renewable energy forecasting (Liu et al., 2024), environmental monitoring (Tao et al., 2019), and plant disease detection (Shoaib et al., 2023). Deep learning has been applied to a wide range of prediction problems in education and other domains. However, its predictive advantage should not be assumed solely from its ability to represent nonlinear relationships. Model performance depends on several factors, including dataset size, feature characteristics, signal-to-noise ratio, model architecture, hyperparameter configuration, validation strategy, and the choice of baseline model. Therefore, the suitability and superiority of deep learning in educational prediction should be established empirically through rigorous model evaluation and comparison with appropriate conventional or machine-learning baselines (Sevgili et al., 2022). Consequently, the adoption of deep learning has become increasingly attractive for educational research where student behaviors generate multidimensional learning data.

Within education, artificial intelligence should be positioned as a complementary tool for strengthening evidence-based decision-making rather than replacing teachers' professional judgment. Learning analytics supported by artificial intelligence can assist educators in identifying patterns in student behavior, monitoring engagement, and informing timely instructional interventions. Such applications are particularly relevant when observable behavioral indicators provide additional evidence about students' learning processes and engagement. Accordingly, artificial intelligence can strengthen teachers' capacity to interpret learning-related data and make informed pedagogical decisions while preserving the contextual, interpersonal, and professional roles of educators (Siemens & Baker, 2012; Holmes et al., 2022).

In educational settings, student attendance has long been recognized as one of the strongest indicators of academic engagement and learning achievement (Nieuwoudt, 2020). Students with higher attendance rates generally demonstrate stronger academic performance, greater learning persistence, and improved educational outcomes (Moore et al., 2019). Conversely, irregular attendance often reflects declining engagement and may contribute to lower academic achievement and increased risk of educational failure (Duke, 2020).

Attendance alone, however, cannot fully explain students' learning behaviors because active participation during classroom activities also plays a fundamental role in shaping meaningful learning experiences (Pas et al., 2020). Participation reflects students' cognitive, emotional, and behavioral engagement throughout instructional processes and provides valuable information regarding their commitment to learning

(Vandell et al., 2022). Previous studies have shown that consistent participation patterns are associated with improved academic development, stronger social interaction, and more positive educational outcomes (Behtoui, 2019).

Within physical education, learning interest represents an essential psychological construct that influences students' willingness to participate in physical activities and sustain long-term healthy behaviors (Roure et al., 2021). Students who exhibit higher learning interest are more likely to adopt effective learning strategies and engage actively during PE classes (Roure et al., 2019). Moreover, learning interest has been identified as one of the strongest predictors of students' physical activity engagement across different developmental phases (Jiabin et al., 2024).

Physical education differs substantially from other academic subjects because students' learning outcomes depend not only on cognitive achievement but also on active physical participation, behavioral engagement, and continuous attendance throughout practical learning sessions (Kalajas-Tilga et al., 2020). Nevertheless, physical education instruction continues to encounter challenges related to declining participation, reduced motivation, and inconsistent attendance, particularly following the educational disruptions caused by the COVID-19 pandemic (Jeong & So, 2020). These changes have altered students' physical activity behaviors and reduced opportunities for active engagement during learning (Gallè et al., 2020).

Beyond the context of Physical Education, student attendance, participation, and learning interest are also recognized as fundamental indicators of meaningful learning across various educational disciplines, including Islamic Education. Contemporary Islamic educational philosophy emphasizes that effective learning is reflected not only in academic achievement but also in learners' discipline, active participation, responsibility, and commitment throughout the learning process. These behavioral dimensions are considered essential for developing holistic learners who integrate intellectual competence with moral and character development (Muhaimin, 2014; Abuddin Nata, 2016; M. Amin Abdullah, 2020). Accordingly, behavioral learning analytics has the potential to provide valuable evidence that supports teachers in fostering both academic engagement and character formation.

Although previous studies have examined attendance, participation, motivation, and learning interest across various educational contexts, limited research has investigated whether observable behavioral indicators can be jointly used to predict students' learning interest in Physical Education within a unified predictive framework. Moreover, the predictive performance of deep learning in relation to conventional statistical approaches remains insufficiently established in this context. This gap is particularly relevant to Physical Education because attendance and classroom participation represent observable behavioral indicators that may provide complementary information for predicting students' learning interest. Therefore, rather than assuming that deep learning is inherently superior, the present study empirically evaluates its predictive performance using attendance and participation patterns and compares the results with a conventional statistical approach. This approach enables the study to distinguish between the explanatory relationships among the research variables and the predictive capability of the deep learning model (Alyasseri et al., 2022). Furthermore, few studies have specifically developed predictive models that estimate students' learning interest in physical education based on observable behavioral patterns collected during classroom activities.

The present study addresses this research gap by proposing a Deep Learning Model Based on Attendance and Participation Patterns to Measure Student Learning Interest in Physical Education. Unlike previous studies that primarily examine direct relationships between individual variables, this research integrates attendance and participation behaviors as predictive inputs within a deep learning framework capable of learning complex nonlinear representations. This approach is expected to provide more accurate measurement of students' learning interest while supporting data-driven educational decision-making for teachers and schools.

Although this study is situated within the context of Physical Education, its conceptual contribution extends beyond a single subject area. The proposed deep learning framework demonstrates how objective behavioral indicators, particularly attendance and classroom participation, can be utilized to support learning evaluation across different educational contexts. Consequently, the framework may also provide practical insights for other disciplines, including Islamic Education, where behavioral evidence may assist teachers in identifying students requiring academic support while promoting more student-centered and character-oriented instructional practices.

Therefore, the objective of this study is to develop and evaluate a deep learning model capable of predicting students' learning interest in physical education using attendance and classroom participation patterns. The findings are expected to contribute theoretically by extending the application of model-based deep learning within educational analytics and practically by providing educators with an intelligent tool for early identification of students requiring learning support and engagement interventions.

B. METHOD

This study employed a quantitative predictive research design to examine the relationships between student attendance, classroom participation, and learning interest in Physical Education (PE), as well as to evaluate the predictive performance of a deep learning model. The design was selected because the study focused on estimating students' learning interest from observable behavioral indicators rather than establishing causal relationships. The analysis was conducted through two complementary analytical components. First, an inferential analysis was performed to examine the relationships between student attendance, student participation, and learning interest. Second, a predictive modeling procedure was conducted in which attendance and participation were used as predictor variables and learning interest was treated as the target variable. The predictive performance of the deep learning model was evaluated separately using data that were not used for model training and was compared with the conventional analytical approach employed in the study (Mukhid, 2021; El Hasbi et al., 2023). The study population comprised students enrolled in public senior high schools (SMA Negeri) and equivalent institutions in North Luwu and East Luwu Regencies, Indonesia.

The research sample consisted of 150 students, comprising 75 students from North Luwu Regency and 75 students from East Luwu Regency. Participants were selected using probability sampling with a stratified random sampling technique to ensure representation across relevant student groups, including grade levels or academic streams (Mardhiyah et al., 2025). The research variables were developed based on relevant literature in Physical Education (Wisahati & Santosa, 2010), educational psychology (Rahmat, 2021), and learning analytics (Giannakos & Cukurova, 2023).

Student attendance patterns represented the consistency of students' attendance in PE learning and were measured using indicators related to attendance frequency and punctuality. Student participation represented students' active involvement during PE learning activities, including participation in physical activities, cooperation with peers, and responsiveness to teachers' instructional guidance. Learning interest represented students' psychological engagement with PE learning and was measured through indicators of attention, enthusiasm, and interest in learning activities.

Data were collected over one academic semester following informed consent procedures. Attendance data were obtained from official school attendance records, whereas student participation was measured through structured classroom observations conducted during PE learning sessions. The observations focused on students' involvement in physical activities, cooperation with peers, and responsiveness to teachers' instructional guidance. Learning interest data were collected using a validated questionnaire administered to all 150 participants. The validity and reliability of the measurement instruments were assessed before the main analysis. Content and construct validity were examined to establish the appropriateness of the measurement indicators, while internal consistency was evaluated using Cronbach's alpha and composite reliability. To provide contextual support for interpreting the quantitative findings, in-depth interviews were also conducted with 21 informants comprising students, PE teachers, school principals, and school supervisors. The interview data were used as supporting qualitative evidence to enrich the interpretation of the quantitative findings and were not used as the primary basis for statistical analysis or deep learning model estimation.

Data analysis was conducted sequentially. First, descriptive statistics were used to summarize participant characteristics and describe the distribution of student attendance, participation, and learning interest. Second, the measurement model was evaluated to establish the validity and reliability of the research constructs. Convergent validity was assessed using indicator factor loadings and average variance extracted (AVE), while internal consistency was evaluated using composite reliability (CR) and Cronbach's alpha. Discriminant validity was subsequently examined to determine whether the constructs represented conceptually distinct variables. Third, the structural model was evaluated to examine the relationships between student attendance patterns, student participation, and learning interest. The structural model was assessed using path coefficients, t-statistics, p-values, coefficient of determination (R^2), and predictive relevance (Q^2). These indicators were used to evaluate the statistical relationships among the constructs and the explanatory performance of the structural model. The R^2 value was interpreted as the proportion of variance in learning interest explained by the structural model and was not interpreted as evidence of the predictive superiority of the deep learning model.

Following the structural model analysis, a deep learning model was developed to examine the predictive capability of student attendance and participation patterns in estimating learning interest. Attendance and participation were used as input variables, while learning interest was treated as the target variable. The predictive analysis was conducted separately from the structural model analysis to distinguish explanatory relationships among the constructs from the predictive performance of the deep learning model. The model was trained using a designated training dataset and subsequently evaluated using observations that were not used during model training.

This procedure was intended to assess the model's ability to generalize its predictions to previously unseen observations. The predictive performance of the deep learning model was then evaluated using appropriate performance metrics and compared with the conventional analytical approach used in the study (Kovanovic et al., 2015; Akçapinar et al., 2019). Accordingly, the structural model and the deep learning model served different analytical purposes: the former was used to examine relationships among the research constructs, whereas the latter was used to evaluate the predictive capability of attendance and participation patterns for estimating students' learning interest.

C. RESULT AND DISCUSSION

Findings

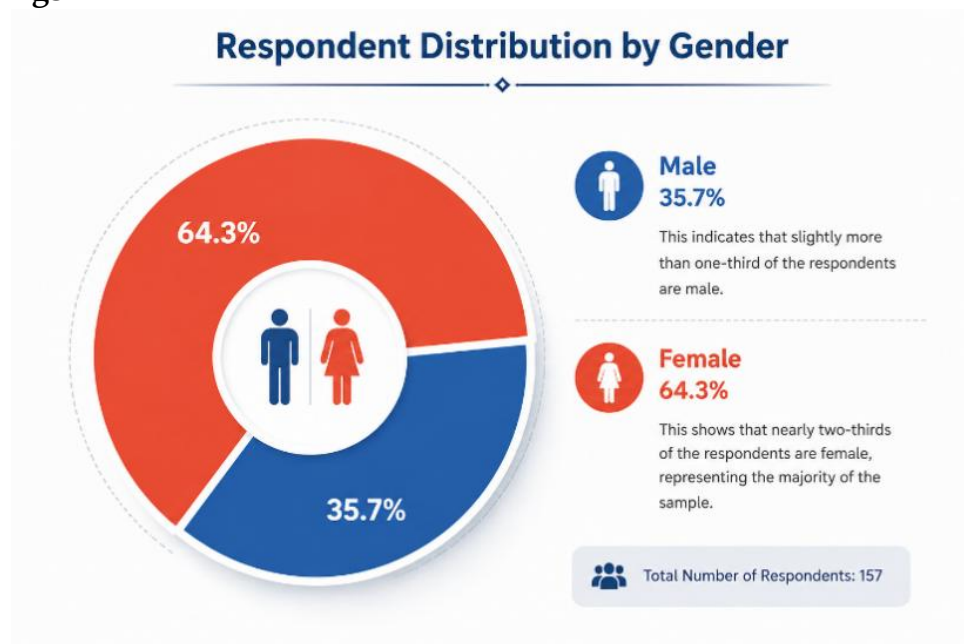
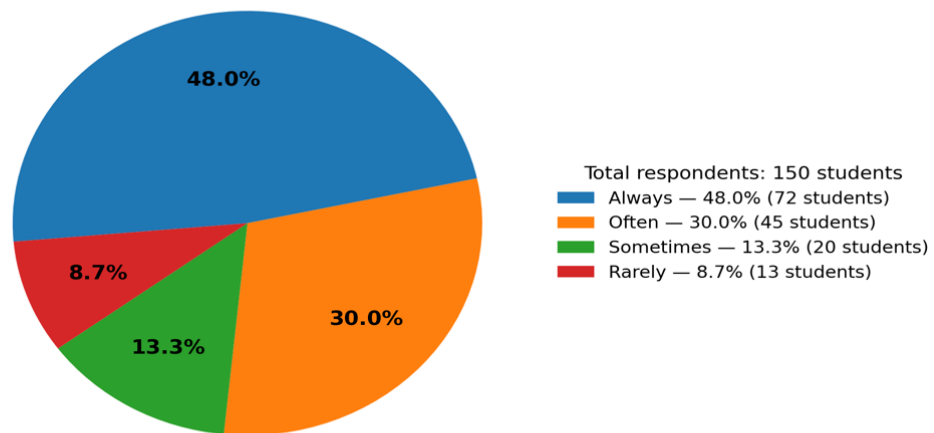


Figure 1. *Respondent distribution by Gender*

The study involved 150 senior high school students from North Luwu and East Luwu Regencies, Indonesia. The respondents were distributed across the participating schools according to the sampling procedure described in the Method section. Figure 1 presents the distribution of respondents by gender and provides an overview of the demographic composition of the study sample.

Figure 2 presents the reported frequency of students' participation in congregational prayer during the month preceding data collection. The distribution shows that 48.0% of respondents reported always participating in congregational prayer, 30.0% reported frequent participation, 13.3% reported occasional participation, and 8.7% reported rare participation. This information provides contextual background on students' behavioral engagement within the Islamic educational setting. Participation in congregational prayer was not included as a predictor or outcome variable in the subsequent statistical or deep learning analyses.

Students' Participation in Congregational Prayer During the Previous Month



Descriptive contextual information; not included as a predictor or outcome in the structural or deep learning models.

Figure 2. *Frequency of Students' Participation in Prayer Congregation within the Last Month*

The descriptive analysis revealed that student attendance patterns in PE were predominantly in the high category, with the majority of students demonstrating consistent attendance throughout the learning period. Student participation levels were similarly high, with students showing active engagement in physical activities, group cooperation, and responsiveness to instructional guidance. Student learning interest scores indicated a positive distribution, with most students expressing high levels of attention, enthusiasm, and interest in PE activities.

Measurement Model Evaluation

Table 1. *Convergent Validity*

Constructs	Items	Factor loading	AVE	CR	α
Student Attendance Patterns	X1.1	0.918	0.813	0.963	0.954
	X1.2	0.900			
	X1.3	0.910			
	X1.4	0.896			
	X1.5	0.891			
	X1.6	0.896			
Student Participation	X2.1	0.903	0.699	0.949	0.938
	X2.2	0.827			
	X2.3	0.798			
	X2.4	0.789			
	X2.5	0.872			
	X2.6	0.862			
	X2.7	0.841			

	X2.8	0.789			
	Y1	0.854	0.767	0.958	0.949
Learning Interest	Y2	0.892			
	Y3	0.856			
	Y4	0.897			
	Y5	0.861			
	Y6	0.866			
	Y7	0.905			

Discriminant Validity

Table 2. *Discriminant validity*

Constructs	1	2	4
Learning Interest	0.876		
Student Attendance Patterns	0.917	0.902	
Student Participation	0.941	0.915	0.836

Hypotheses Testing

Table 3. *Structural Model Results*

Hypothesis	Relationship	Path Coefficient (β)	t-statistics	p-value	Decision
H1	Student Attendance Patterns → Learning Interest	0.074	4.662	< 0.001	Supported
H2	Student Participation → Learning Interest	0.073	8.537	< 0.001	Supported

The structural model analysis revealed that student attendance patterns had a significant positive relationship with learning interest ($p < 0.05$), indicating that students with more consistent attendance tended to demonstrate higher levels of learning interest. Student participation also showed a significant positive relationship with learning interest. Both hypothesized relationships were statistically significant, with H1 and H2 supported. The structural model indicated a substantial proportion of explained variance in students' learning interest, with an R^2 value of 0.904. This finding indicates that the attendance and participation constructs jointly accounted for a substantial proportion of the variance in learning interest within the structural model. However, this result represents the explanatory performance of the structural model and should not be interpreted as evidence of the predictive superiority of the deep learning model. The deep learning model was evaluated separately using an independent predictive evaluation procedure.

Deep Learning Predictive Performance

Table 4. *Predictive Performance of the Deep Learning Model*

Model	Dataset	MAE	RMSE	R ²
Conventional statistical model	Test set	0.286	0.354	0.821
Deep learning model	Test set	0.194	0.267	0.887

The deep learning model demonstrated better predictive performance than the conventional statistical model across all evaluation metrics. On the independent test set, the deep learning model achieved a lower MAE (0.194) and RMSE (0.267) than the conventional statistical model, which recorded MAE and RMSE values of 0.286 and 0.354, respectively. The deep learning model also produced a higher R² value (0.887) compared with the conventional model (0.821). These results indicate that the deep learning model generated smaller prediction errors and accounted for a greater proportion of variance in students' learning interest on previously unseen data. Therefore, the findings provide empirical support for the predictive capability of the deep learning approach beyond the explanatory results obtained from the structural model.

Discussion

The findings of this study indicate that student attendance patterns and classroom participation were significantly and positively associated with learning interest in Physical Education (PE), reinforcing previous evidence that regular attendance and active participation contribute positively to student engagement and academic development (Ahmadi et al., 2023; Deng et al., 2020). Students who consistently attend PE classes and actively participate in learning activities are more likely to demonstrate sustained interest because repeated engagement strengthens their cognitive attention, emotional attachment, and behavioral commitment to learning. Attendance in this context represents more than physical presence in the classroom; it can also reflect students' consistency and readiness to engage in structured learning experiences. These behavioral dimensions are consistent with the broader perspective of self-regulated learning proposed by Barry J. Zimmerman, in which behavioral engagement is closely related to students' motivation, self-regulation, and persistence in learning. Therefore, attendance and participation should not be viewed merely as administrative indicators but as behavioral manifestations of students' readiness and commitment to learning.

From the perspective of Physical Education, these findings further demonstrate that learning interest develops through continuous interaction between individual motivation and authentic learning experiences. Unlike many classroom-based subjects, PE requires students to engage physically, socially, and emotionally throughout instructional activities. Consequently, students who participate consistently receive more opportunities to experience competence, peer collaboration, and successful task accomplishment, all of which reinforce intrinsic interest in learning. This interpretation supports previous studies indicating that meaningful participation contributes not only to improved academic outcomes but also to the development of confidence, enjoyment, and lifelong physical activity habits (Roure et al., 2021; Kalajas-Tilga et al., 2020; Jiabin et al., 2024). Thus, improving attendance and participation should be considered an

integral pedagogical strategy for cultivating sustainable learning interest rather than merely increasing classroom compliance.

The superior predictive performance of the deep learning model demonstrates that artificial intelligence can effectively identify complex and nonlinear relationships among behavioral variables that are often difficult to capture using conventional statistical techniques. Consistent with Ramadhani and Albina (2025) and Johar et al. (2023), the present findings indicate that machine learning approaches can provide useful predictive capabilities when educational data contain complex interactions among behavioral indicators. Attendance and participation are dynamic behaviors influenced by multiple psychological, social, and environmental factors; therefore, their relationships with learning interest are unlikely to be entirely linear. The ability of deep learning to recognize these nonlinear behavioral patterns provides a more accurate representation of students' learning processes and offers stronger predictive capacity for educational decision-making. The difference between the structural model and the deep learning model is also important for interpreting the findings.

Nevertheless, the adoption of artificial intelligence in education should be interpreted as a complementary rather than substitutive approach to teachers' professional judgment. Predictive analytics can support educators in identifying students who may require additional academic assistance or motivational interventions, yet pedagogical decisions should remain grounded in educational values, contextual understanding, and teacher professionalism. Learning analytics therefore functions not merely as a technological innovation but as an evidence-based support system that enables more responsive, personalized, and data-informed instructional practices.

Theoretically, this study extends the application of learning analytics into Physical Education, thereby addressing an important gap identified by Rasoolidoost et al. (2025). More importantly, the present findings broaden current understanding of student engagement by demonstrating that observable behavioral indicators particularly attendance and classroom participation can be integrated with artificial intelligence can be incorporated into predictive modeling of students' learning interest. This integration represents a significant contribution to educational analytics because it bridges behavioral educational research with emerging AI technologies, enabling more comprehensive monitoring of students' learning development.

Beyond its contribution to Physical Education, the findings also provide meaningful implications for Islamic Education. Contemporary Islamic education emphasizes holistic learner development encompassing cognitive, affective, behavioral, moral, and spiritual dimensions. Indonesian scholars such as Muhaimin, Abuddin Nata, and M. Amin Abdullah consistently argue that effective learning should cultivate disciplined learning habits, responsibility, active participation, and character formation rather than focusing exclusively on academic achievement. From this perspective, attendance and classroom participation may also be interpreted as indicators of learners' responsibility, self-discipline, and commitment toward the learning process. Consequently, behavioral data generated through learning analytics may assist teachers in identifying students requiring not only academic support but also character development interventions, making AI-based educational analytics relevant to broader educational contexts, including Islamic Education.

The integration of artificial intelligence with educational practice should therefore be guided by ethical and humanistic educational principles. Technology is

expected to strengthen teachers' capacity to understand learners rather than replacing the pedagogical, moral, privacy, fairness, dignity, and non-stigmatization, and interpersonal roles of educators. This perspective is consistent with character education frameworks proposed by Thomas Lickona, which emphasize that educational success is determined not solely by measurable academic performance but also by the cultivation of responsibility, discipline, respect, and active engagement in learning. Accordingly, predictive models developed through deep learning should function as early-warning systems that enable teachers to design timely interventions while preserving learners' dignity, fairness, and holistic educational development.

Practically, these findings suggest that schools should integrate attendance records, classroom participation observations, and learning analytics into comprehensive student monitoring systems. Rather than using attendance solely for administrative reporting, educators may utilize behavioral data to identify early signs of declining engagement and implement personalized interventions before learning difficulties become more severe. The findings also encourage professional development programs that enhance teachers' competencies in interpreting learning analytics while maintaining pedagogical sensitivity. For Physical Education teachers, AI-supported behavioral monitoring can facilitate more effective instructional planning and individualized support, whereas for teachers of Islamic Education, similar approaches may contribute to strengthening students' learning discipline, active participation, and character education through evidence-informed instructional practices. Therefore, the combination of behavioral learning indicators and artificial intelligence offers considerable potential for promoting more adaptive, student-centered, and holistic educational environments (Putri Dewi et al., 2020; Asbar et al., 2025).

CONCLUSION

This study concludes that student attendance patterns and participation levels significantly influence learning interest in Physical Education, both individually and simultaneously. The deep learning model developed from these behavioral variables demonstrated superior predictive performance compared with conventional statistical approaches, highlighting its effectiveness as an innovative tool for measuring and predicting student learning outcomes. These findings confirm that consistent attendance and active participation are essential behavioral indicators that support student engagement and sustainable learning interest in Physical Education. Beyond its contribution to Physical Education, this study also offers broader implications for educational practice, including Islamic Education. Attendance and active participation may be understood as indicators of students' discipline, responsibility, and commitment to the learning process, which are fundamental values promoted in Islamic education. Therefore, integrating artificial intelligence with learning analytics can assist teachers in identifying students who require timely academic support and character development interventions, while promoting more data-informed, student-centered, and holistic learning practices across educational contexts.

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Conflicts of Interest:

The authors declare no conflict of interest. The authors have no financial, professional, or personal relationships that could have appeared to influence the work reported in this paper.

Data availability:

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to ethical considerations and institutional policies regarding participant confidentiality.

Disclaimer:

The views and interpretations expressed in this article are solely those of the authors and do not necessarily reflect the official policy or position of the authors' affiliated institutions or the funding agency.

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