

# An Analysis of Academic Behavior Analytics in Blended Mode of Teaching and Learning

Omkar Agrahari<sup>1\*</sup> & Vinay Kumar Pathak<sup>1,2</sup>

<sup>1</sup>Department of Computer Application, School of Engineering and Technology, C S J M University, Kanpur, U P 208 024

<sup>2</sup>Department of Computer Science, Harcourt Butler Technical University, Kanpur, U P 208 002

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With the increasing adoption of online education, Blended Learning (BL) has become an essential instructional approach that integrates traditional face-to-face teaching with digital learning environments. This combination not only enhances communication between teachers and students but also improves the overall effectiveness and flexibility of the learning process. BL has gained global attention due to its potential to support student engagement and enable more accurate forecasting of academic performance. The survey aims to undertake a comprehensive review of the different methods of the BL model, like the self-blended model, rotation model, and other BL models. This survey is carried out by considering multiple BL models for academic behavior analysis. In this survey, 50 existing approaches are reviewed on the merits and demerits of the BL model to determine the academic behavior analysis of the BL model teaching and learning. In addition, the academic behavior analysis of the BL model is carried out based on multiple parameters. This review focuses on how these models influence learning patterns, motivation, participation, and performance outcomes across different educational contexts. The survey also highlights the practical challenges associated with implementing BL in real academic settings. Among the examined models, the self-blended model emerges as particularly effective for analyzing student academic behavior, as it allows learners more control over their study pace and content selection. The insights gained from this review can help educators design more effective teaching strategies and support institutions in improving the quality, adaptability, and long-term success of blended learning in modern education.

**Keywords:** Blended learning, Learning management system, Learning strategies, Online learning, Self-blended model

## Introduction

Communication technologies and Internet-based information have indicated their ability in the field of higher education. Most universities have suggested online tasks and provided programs for the students based entirely on online courses. Through these courses, distance students use the various platforms of resources, and they get education from their residences, and they can work together with their team members instead of working alone.<sup>1</sup> During the Coronavirus Disease (COVID) pandemic situation, higher education was greatly impacted around the world, so student uses online courses for their studies, which greatly reduced the spread of the virus. The unexpected modification of the online studies changes the mind condition of the teacher and student, some of the students were unable to use the online resources because of the improper net connection and the imperfect electronic devices.<sup>2</sup> The examination of the student's behavior and classroom presentation in the

online courses can help the staff to understand the online and offline learning behavior condition of every student and thus help them to increase their stability in the teaching quality, which enables the complete activity of the student and making them involved in their study which with full concentrations.<sup>3</sup> The online Learning Management System (LMS) helps to increase skill and effective learning communication among students and teachers; thus, the system can store a lot of information about communication among the students and teachers.<sup>4</sup> Thus, the LMS can give more support to the learning student through the screencasts, assignments, forums, and quizzes.<sup>5</sup>

Blended Learning (BL) has been considered as a solution to this problem through its potential to encourage learning, knowledge, and engagement, promote information resources, and fulfill the needs for higher education.<sup>6,7</sup> BL is called hybrid learning or mixed-mode instruction because it includes one or two learning approaches to old-style classroom teaching.<sup>8</sup> BL approach sets the logical outlines for

\*Author for Correspondence  
E-mail:omkaragrahari@gmail.com

the suitable use of online resources, digital tools, and technologies to support the purpose of Face-to-Face (F2F) communication among students and teachers. BL enables a stable and student-centric learning environment adopted by recent technologies.<sup>9</sup> By encouraging more students to select online resources and use internet access, the BL takes less time than the F2F courses and improves a student's retention rate than online courses to complete the studies. BL has become more popular in the field of universities and colleges.<sup>10</sup> BL is also referred to as pure F2F learning, or it is pure distance education.<sup>11</sup> BL could combine both online learning and F2F to give effective learning to the learners<sup>12</sup> BL embedded many types of approaches such as tutorial, online, problem-based, lecture, and clinical to promote the best learning environment, which enables the need and style of different types of learning.<sup>13</sup> BL has become more important because it decreases the demerits of both online learning and F2F due to the acceptance of the merits of both online learning and F2F learning.<sup>14</sup> BL provides an efficient and hopeful teaching system that helps educational institutions adopt learning and teaching efficiency throughout the world.<sup>15</sup>

In recent days, the challenging task of educational institutions is to find a teacher who knows about Massive Open Online Courses (MOOCs), and similarly, the difficult task to find a teacher who is not interested in executing the mode of the BL environment to their classes<sup>16</sup> the student also faced many challenges in adopting the new mode of learning in their higher education. The transmission of an online mode of education was a likelihood plan to maintain the courses given by the college and university and which provided the facilities to continue with their studies.<sup>2</sup> The most important part of the online mode of the learning process is the student performance because when the presentations of the student are not good, it affects the many factors of the learning mode such as the teaching environment and individual study behaviors. Many varieties of learning modes have been developed to enhance the capability to forecast academic performance.<sup>17</sup> Nowadays, learning analytics has created a way for the structural framework for the course characteristics, which involves the improvement of data collection, time intervention,<sup>18</sup> the prediction of the learning performance of students,<sup>19-21</sup> and the examination of the educational data. The framework of learning analytics is the

branch of the exactness of education for the examination and forecasting of the performance of the student, and enables time interventions based on the learning student profiles.<sup>8</sup> Student engagement can be referred to as the effort, participation, curiosity, interest, attention, and passion of the students in their studies. The relationship between the student's investment in learning and the commitment to learning can help achieve the goals and tenacity to learn. It predicts the students to learn for academic achievement and designs more efficient teaching to give the opportunity to receive regular feedback from the students.<sup>22</sup>

This survey details the different methods that are employed in academic behavior analytics using the BL model in the teaching and learning process. Here, the BL model is categorized into the self-blended model, the Rotation model, and the other BL models. In this survey, 50 articles are reviewed, and these articles are taken from various journals, like Elsevier, Institute of Electrical and Electronics Engineers (IEEE), Hindawi, Journal of Engineering and Technological Sciences (JETS), Research Gate, International Research Journal of Engineering and Technology (IRJET), Springer, International Journal of Engineering and Technology (IJET), Taylor and Francis, Multidisciplinary Digital Publishing Institute (MDPI), Frontier, openreview.net, and International Journal of Educational Advancement (IJE). In addition, the papers are evaluated based on the performance metrics, employed data, year of publication, and utilized tool.

#### **Literature Survey**

This section gives detailed clarification about the different types of approaches for the classification of the BL by using academic behavior analytics. BL is also called hybrid learning, and it is the association of online learning with the traditional classroom approaches in the educational policy. The BL course takes part in the F2F activities and the online course. The BL has many models in these self-blended models, rotation model, and other based models are explained below.

#### ***Self-blended Model***

This blended learning model associates in-person instruction with online learning, and the students take self-directed online courses in addition to their traditional F2F learning. This section gives a review of different kinds of models presented for academic behavior analysis based on the self-blended model. Some of the self-blended models are explained below.

The predictive model was proposed for the forecast of the risk of the BL courses. This method provided the difference between the course grade and the online activities to classify the importance of the correlation. This method provided high robustness; nevertheless, it failed to explore the time consumption of the student and did not integrate the visualization of the different kinds of learning and teaching processes.<sup>1</sup>

The Discover, Learn, Practice, Collaborate, and Assess (DLPCA) model was introduced for learning and teaching in pandemic situations. The main advantage of this model was to convert traditional F2F learning into online coaching in a critical situation. The method did not consider extending the lifetime of the internet connection. It did not achieve communication between the student and the staff and failed to improve the attention of the student during the online classes.<sup>2</sup>

The academic performance enhancement through homework late/non-submission detection was implemented for the prediction of the student's academic performance in learning. This method is mainly used to reduce the stress of the student for submitting homework submission behaviors. This method failed to explore a variety of learning courses in the field of student homework.<sup>4</sup>

The Artificial Neural Network (ANN) model was introduced to store the information about the student in the Moodle server and used it to forecast the student's achievement in the field of learning based on the four activities. The advantages of this method are the enhanced efficiency of the ANN to improve the number of students in the courses and to forecast the success of the learners. This Method did not validate more of the samples in the course of learning.<sup>17</sup>

The Massive Open Online Courses (MOOCs) and the Online Assessment System (OAS) were devised to conduct various examinations for the learners and measure the final performance of the academic behavior. This method provided a good accuracy and high stability output for the performance of the student in learning.<sup>8</sup>

The Purposive sampling technique was established to discover the advanced technique of learning and teaching approach. This method highly improves the quality of education in the institutions. Moreover, this model improved the reasoning idea of elementary students and encouraged the real skills and the

exercise of the learners. This method failed to explore the Blended Learning Approach (BLA).<sup>23</sup>

The evaluation index system was proposed to construct the BL model for the organization of the learning behavior through analysis. This model has three parts they are after-class, before-class, and in-class, to achieve the performance of the teaching effect. This method can enhance the knowledge, comprehensive ability, and skills of the students in the courses. In this method, the student learned through the sources of electronic devices and videos to improve the teaching process.<sup>24</sup>

The Structural Equation Model (SEM) was developed to analyze the association of self-efficacy in students to satisfy the course of learning. This method detected the fulfillment result from the discovery in the blended course, and it may be executed in institutions. This method provided a low computational cost and an efficient method to achieve the student expectations, experience, and stimulation of the student in the learning process. This method can be used to improve academic performance, student behavior, motivation, and persistence in their goals.<sup>25</sup>

The Perceived Precision Teaching (PPT) model was developed to improve the activities of the students. PPT was continuous, which may be used to relate the learning motivation and the self-efficacy effectively. Motivation and self-efficacy are related to the social presence, teaching, and cognition of the students. This method provided a low cost and used the resource at a good rate. This method failed to explore the approaches in different modes of learning.<sup>10</sup>

The Randomized Controlled Trial (RCT) model was discovered for the detection of the efficiency of BL versus the Didactic Learning (DL) approach in the learning strategy of the courses. This method provides that the BL is more efficient than the DL because the BL enhances the skills and knowledge of the medical students.<sup>13</sup>

The Teacher Professional Development (TPD) model was proposed to analyze the efficiency of the BL model on the hands-on method for secondary school teachers using the quasi-experimental design. This method improves cost-effectiveness and improves the performance of the instructors and school leaders in the learning courses.<sup>14</sup>

The MOOC and Discrete Mathematics with Graph Theory (DMGT) were implemented for the exploration of student involvement in the BL model's field. This method can be used by the learners to

select an interesting course for their studies. This method did not include formal tools for learning to improve the effectiveness of teaching and learning.<sup>16</sup>

The Classification and Regression Tree algorithm (CART) model was introduced to examine the efficiency of the BL approach. This method highly uses the information about education in the process of teaching. Furthermore, the model can optimize the resources used for learning. This method failed to explore the data examination of the instrumental exercises.<sup>26</sup>

The Open Educational Resource (OER) model was developed to improve the learning of undergraduate degrees. This method is used to indicate the adoption of the new form of learning. In addition, the quality of the learning is measured by the recording of the learner's performance and is combined with the course of online learning in undergraduate learning. The method provided an asset of low-cost consumption in the quality of the learning-teaching process. This method failed to analyze a large set of students at a time.<sup>27</sup>

The sequential explanatory mixed method was devised to improve the digital form of learning to fulfill the needs of the student. The main advantage of the method was the variety of modalities used in the learning. This method did not predict the navigation of the engagement of the student in the process of designing the longitudinal research.<sup>22</sup>

The Emerging Learning Technology Model was developed to determine the most efficient and correct models for personalized learning in higher education. This method has been implemented to support a variety of technologies for the process of learning. In addition, this method can be used to indicate that personalized learning quality increases in higher education, which may be supported by the references model of the technology. This method failed to examine the authorization effectiveness in higher education.<sup>28</sup>

The traditional method of Architectural Professional Practice determined the opportunity for the online mode of learning for the student. This method was used to perform the examination of the student's age, gender, and working hours, used for evaluating the relationship between the stability of the online mode of learning. The method explored the changes in the students' performance in learning using different types of modes. This method failed to determine the significance of relationships in learning.<sup>29</sup>

The Communicate, Active, Collaborate, Problem-based Solving, Learning, and Assessment (CACPLA) model was established to determine the transformation of the physical classrooms to full online instruction for some specific studies in learning. This method can design both asynchronous and synchronous components in the online mode of learning. In addition, the method can be used in the analysis of online teaching as a robust foundation for pedagogical decisions. It failed to explore the classes in the pandemic situations.<sup>30</sup>

The Moodle platform was devised for the examination and exploration of teaching between the student who participated in the learning, and the activity of teacher can be determined. This approach can help to increase the technology correctly and create the interaction of a new mode of learning. The teaching mode was enhanced effectively by using the relationship between the student and the teacher, and this method improved the superiority of the learning in the field of education.<sup>31</sup>

The Dutifulness, Reliability, and True Score Model was implemented to improve the accuracy and performance of the student through the graph examination. This method can be used to determine the problem arising in the rating peers because it may be considered a critical problem in the field of the BL, and may demonstrate the information present in performances. This method failed to investigate the game-based form in the method to redesign the peer grading work in the striking form.<sup>32</sup>

The attention data acquisition model was established to analyze the behavior of the students by their attention performance. This method provided the confidence of correlation in the field of classroom learning for the behavior and was used to enhance the teaching mode in the educational informatization to improve the ability of the students. This method also promotes the skill of the student in the form of solving problems, analyzing, and discovering advanced technologies in learning.<sup>33</sup>

The Unified Theory of Acceptance and Use of Technology (UTAUT) was established to investigate the influence of the critical situation of the learners during the COVID-19 disease to detect the presentation of learning in the BL modes. This method promoted the student's presentation and can indicate the social presence, cognitive, and teaching of the learners.<sup>34</sup>

The predictive model was introduced to determine the positive and the negative impact of the

performance of the student in the learning courses. The main advantage of the method was to indicate student failure in the BL through the binary logistics of the student. This method was used to indicate the risk factors of the regression model through the coefficients. In addition, the method can be used to generate the student's performance in learning. This method failed to explore physical attendance to decrease the participation of the learners.<sup>35</sup>

The scaffolding of students' peer-learning self-regulation strategy was devised to integrate the online environment into the BL model. This method provided the collection of dynamic elements to motivate and facilitate the small group of peers-learning for the student. This method failed to explore the outcomes of the BL in online learning.<sup>15</sup>

The Technological, Pedagogical, and Content Knowledge (TPACK) model and the Unified Theory of Acceptance and Use of Technology (UTAUT) model were designed to forecast the presentation of the teacher and the student in higher education. This method can be used by the teacher to gain more knowledge about the studies and can adopt many approaches to the courses. In addition, this approach can be used to monitor student activities and enhance the control of the activities of the BL by measuring the skill and knowledge of the staff in the teacher's surroundings.<sup>36</sup>

The programming courses were introduced to learn about the BL on student presentation and satisfaction. Two types of methods were used, the qualitative method and the Quantitative method, to improve the result by encouraging the student presentation. The model helped the student to participate in the various forms of learning and improved the learner's stability in the programming courses. This method failed to be explored in the advanced programming courses to improve the learning activities.<sup>37</sup>

The E-Learning Activities Recommender System (ELARS) and collaborative learning were implemented to design an efficient learning and teaching of students. This method can be used to indicate the student's performance and satisfaction in the learning and the real setting. This method provided the advanced technologies to improve the course domain in computer science. Furthermore, this model can be determined by any form of F2F instruction level in the course.<sup>38</sup>

The blended Design-Based Learning (bDBL) approach was established to explore an efficient design of the intrinsic motivations and the design competencies.

This method can be applied to the course to understand the motivational field of engineers. This method was used to analyze the design competencies and the intrinsic motivations through post and pre-self-reporting. This method included group interviews to provoke the performance of the students. This method failed to include the full online settings and F2F delivery to determine the difference between the student learning outcomes from the course.<sup>39</sup>

The Small Private Online Course (SPOC) and the flipped classroom model were implemented to evaluate the factors which may affect the course input and the students' engagement in the assessment tools and the learning process. Hence, this method needs the combination of in-person meetings and online pre-recorded content to make the students interested in the learning process. The model did not consider the availability of curriculum resources and the student enthusiasm for in-classroom.<sup>40</sup>

The Borich Needs Assessment Model (BNAM) was proposed for the establishment of the teaching and planning of learners, and provided job opportunities to the learners. This approach provided better performance for the student in their academic presentation of the learning when compared to the other conventional approaches. The approaches failed to explore entrepreneurship and innovative projects for improving the performance of the learners.<sup>41</sup>

The IPSIT model was proposed for the identification of the activities of the learners and the resources, and provided the announcement of the learners' activities. The approach can also identify the learner's feedback about the courses of teaching and learning. The method did not consider the careful implementation of the teaching and the learning.<sup>42</sup>

A Modular Object-Oriented Dynamic Learning Environment was designed for the implementation of courses in different institutions for the learners. The approach is used in many institutions because of its multiple uses. The approach failed to consider the improvement of the educational designs for the process of making it easy for the student to learn.<sup>43</sup>

#### **Rotation Model**

The popular form of the BL model is the rotation model. In this method, the student may participate under the teacher's discretion and the predetermined schedule. This section gives a detailed review method for the academic behavior analysis for BL using the rotation model. Some of the rotation models are illustrated below.

The Genetic Algorithm (GA) and the Error Correcting Output Codes (ECOC) method were proposed for the achievement of misclassification risk and provided robustness to improve better performance. It demonstrates the best classification of the performance in the learning. It did not explore the association of the Genetic Algorithm (GA) and Error-Correcting Output Codes (ECOC) algorithm. In addition, the method did not collect more teaching-related data and did not explore the data quality of the learning.<sup>3</sup>

The multiclassification framework and the ternary bitwise calculator were established to forecast the success of the student in learning. This method encouraged student participation, and it also executed a variety of instrumental interventions in the field of learning. This method failed to enhance the presentation of the algorithm used in the approach.<sup>44</sup>

The predictive model was devised for executing the student-centered teaching method, which could be based on the flipped classroom and Small Private Online Course (SPOC) to evaluate and improve the performance of the students in learning. This method can be used to enhance the online learning of the student. This method failed to improve analysis in the introduction of abnormal students to improve the information about the learning intervention.<sup>45</sup>

The flipped model was introduced for the analysis of the active and inactive education of the student in the courses of learning courses. This method used advanced technologies and materials to recover the value and capability of the learning-teaching process of the courses. It failed to recover the activities of the learners to improve the autonomous work, emotional intelligence, and cooperation of the learner.<sup>46</sup>

The interactive teaching method was designed for the accompaniment of the learning knowledge in the engineering design course. This method can be used to join the speeches presented using the devices, manage the fonts and the read lecture materials, and save the information in the device. This method is mainly used in the technology classes of the students and directly provides the engagement of the class activities in the device.<sup>47</sup>

The Visual Geometry Group 16 (VGG16) classification model was implemented to investigate the teacher and student behavior using blended classroom teaching for the process of acknowledgement. This method provided the expression of the auxiliary judgment rules to encourage the error acceptance degree and the correctness of the acknowledgement in the

programming action. This method did not include a large number of students for the appointment in the learning course.<sup>48</sup>

#### **Other Approaches**

The randomly used BL models that do not fall under the self-blended or rotation model categories are given below.

The Conceptual level, Intelligent level, Action level, and Process level (CIAP) model was discovered for recovering the student's record in literacy sustainably. This method provided various optimization for the learning assessment. Moreover, the method considered generating the environment logically. This method failed to explore the basis of the empirical and community of inquiry of the learning.<sup>49</sup>

The Modular Object-Oriented Dynamic Learning Environment was designed for producing asynchronous videos. This method is used to mitigate the risk arising in the educational field during critical situations. This method did not consider the design of the learning-friendly and educational wanted to make it easy for the students to teach and learn through the courses.<sup>9</sup>

The Community of inquiry Learning framework (CoL) and Team-Based Learning (TBL) were implemented for analysis of the empirical evidence of the web learning communities used to improve the student level, especially in the students' involvement in the courses through community design. This method helped to improve the involvement of the student by better form of teaching the courses in a very short period and in which students can achieve good grades in their studies. This method failed to control the time for the study.<sup>50</sup>

The personalized course model was introduced to analyze the BL that has been used to indicate the belongings of the teachers and students. The method explored the quality of the learning. The method also increased the achievement of the student and increased the capacity for learning. Through this method, the student got a lot of information about the contents and the ideas, used to explore in their mini project in the final semester.<sup>51</sup>

The blended synchronous course was implemented to determine the difference between the examination level and presentation of the learners, who come to the class to attend the classes and the learners who study through the online classes, both of whom use the online tool for studying. This method improves

student engagement in the course of learning. This method can be measured by the large range of student behaviors during the classes.<sup>52</sup>

The Multinomial Logit Model (MLM) was established to design the probability of the choice of learning activities of the students during daily hours over several academic years. The student log access was categorized by an abstraction called activity that classifies the log access to the virtual learning environment into semantically meaningful classes. This method was used to analyze the use of the application in managing the university and helps to improve the feedback of the stakeholders. In addition, the method was effective in providing insight into the effect of the individual stakeholder's behavior and the learning outcomes in the course.<sup>53</sup>

The blended learning adoption model was developed to explore the institutional BL adoption in the grounded theory methodology creativity. This method can be used to determine the improvement and the effect of learning on the students in the course. This method can be used in the institution to transform into the BL for the delivery model to increase the outcomes.<sup>54</sup>

The Flipped classroom approach was developed to increase the participation of the learners by giving them a lot of time to join the active classes. This method measured the level of the student through academic success, which may be used to improve the classes. In addition, the method was not explored with other software engineering subjects to improve the results. The approaches help to produce the plan for in-class activities to increase the skill of the student and the online element, provide feedback, and the student can participate in more activities without any limitations.<sup>55</sup>

The contemporary blended model was proposed to detect the difference between active learning and the learning style to increase the BL performance in higher education students. The relation among the variables was examined using the Pearson Coefficient Correlation, and the impact of the mediator variable was examined with the help of the Structural Equation Modelling (SEM). Further, a two-stage approach was adopted for testing the framework, and a structural model was employed. Finally, the compatibility of the data was tested using Confirmatory Factor Analysis (CFA). The data used to measure the model's fitness and the concepts were dependent on being used in the hypothesis analysis. The execution of the advanced

method can change the style and the concept of the student.<sup>56</sup>

The predictive model was implemented to predict the success of the student in BL. This method differentiated the dataset and the counts of interactions for the learning process. This method explored the Synthetic Minority Over-sampling Technique (SMOTE) for balancing the datasets to increase the efficiency of the method to improve the learning process.<sup>57</sup>

The Substitution and Augmentation within Enhancement; Modification, and Redefinition (SAMR) within the Transformation model was designed to analyze the educational objectives in the school and the institute for specific Purposes subjects. This method explored the smart technologies in the process of BL to assist the learner and the teachers in the summarization of the feedback. Furthermore, it can achieve the tertiary level of education and upper secondary successfully.<sup>58</sup>

The predictive model was implemented to promote the prediction of the BL using data fusion and data mining based on multimodal data from multiple sources. At first, a summary dataset in categorical and numerical formats was created by applying preprocessing and data fusion, and then white box classification techniques were employed. This method helped the instructors with the remedial actions with students at risk of failing or dropping out. This method did not include exploring the features of each source of data in the learning sources.<sup>59</sup>

### Research Gaps and Limitations

The drawbacks and the research gaps related to the approaches that are demonstrated by the academic behaviour of the student in the BL model are illustrated below.

The drawbacks of the method using a self-blended model are explained below. The predictive model<sup>1</sup> did not explore the performance development in the analytics of the visual dashboards. The DLPCA<sup>2</sup> model failed to investigate the causes of the emergencies of the learner who cannot physically attend class due to sickness, and changing weather conditions can disrupt the classes. The ANN model<sup>17</sup> did not investigate the computational time for the courses. The MOOCS and the OAS approach<sup>8</sup> did not consider the time consumption. The Purposive sampling technique<sup>23</sup> did not investigate the educational system's complexity evaluation index

system<sup>24</sup> causing a higher time consumption to do the process. The SEM<sup>25</sup> model failed to reduce the workload of the student in higher education. The PPT<sup>10</sup> failed to extend the process of the BL to precious learning. The RCT model<sup>13</sup> failed to identify a cost-effective strategy for the teaching process. The TPD model<sup>14</sup> failed to investigate the influence of the model on pre-service teachers. The MOOC and DMGT<sup>16</sup> failed to include deeper text analysis and discover key concepts and themes shared by the students in the process. The CART<sup>26</sup> failed to integrate information technology and data-driven approaches into teaching practices. The OER<sup>27</sup> model failed to teach a large number of the students.

The sequential explanatory mixed method<sup>22</sup> failed to reveal the full effect of support for relatedness, because an emotional design may only work for a period. The Emerging Learning Technology Models<sup>28</sup> lack the alignment between digital pedagogies and personalized learning. The traditional methods of architectural Professional Practice<sup>29</sup> caused complexity in the learning process. The CACPLA<sup>30</sup> did not conduct the classes during the emergency causes. The Moodle platform<sup>31</sup> failed to cause time consumption. The DRT<sup>32</sup> model failed to improve the allocation of the rational rules. The attention data acquisition model<sup>33</sup> causes internal causes more problems in isolation. The (UTAUT)<sup>34</sup> failed to explore the demographic data. The predictive model<sup>35</sup> failed to examine the probability of emerging risk factors in the learning process. The TPACK<sup>36</sup> failed to explore the student's learning outcome. The predictive models<sup>57</sup> failed to improve the presentation of the model.

The drawbacks of the method using a rotation model are explained below.

The ECOC and the GA<sup>3</sup> are not effective in MOOC and the PTA for increasing learning. The GA and the multi-classification frame<sup>44</sup> failed to optimize the binary classification in the learning process. The predictive model<sup>45</sup> failed to explore the learning approach in abnormal students. The flipped model<sup>46</sup> failed to improve the cooperative, autonomous work of the student and the emotional intelligence of the learner. The interactive teaching method<sup>47</sup> did not determine the delay of the performance in the process. The VGG16 classification model<sup>48</sup> affects the action representation of the local gestures.

The drawbacks of the method using other models are explained below. The CLAP<sup>49</sup> model did not consider the number of background knowledge to

improve the performance. The Modular Object-Oriented Dynamic Learning Environment<sup>9</sup> did not consider the difficult task of both the learners and the teachers. The CoL and TBL<sup>50</sup> could not enhance the student experiment in the performances. The personalized course model<sup>51</sup> failed to acquire an expert level of knowledge. The blended synchronous course<sup>52</sup> did not implement the other courses at the time of working. The MLM model<sup>53</sup> failed to improve the temporal educational data analysis. The blended learning adoption model<sup>54</sup> did not include the validation process. The Flipped classroom approach<sup>55</sup> has a high computational cost. The contemporary blended model<sup>56</sup> failed to investigate qualitatively the students' perspectives. The predictive models<sup>57</sup> failed to improve the performance of the student in the learning process. The Modification and Redefinition within the Transformation model<sup>58</sup> failed to enable a continual approach to new skills development. The predictive models<sup>59</sup> have checked the generalization of the current quality causes time consumption.

### Classification of the BL Model

In the survey, the various methods for BL considering academic behavior analytics are categorized as the self-blended model, the Rotation model, and other BL methods, and this is illustrated in Fig. 1. Further, the detail of these models is illustrated in the following section.

### General Outline with Steps

The general outline utilized for the BL using academic behavior analytics is shown in Fig. 2. The framework shows the different elements like instrumental design, instrumental outcomes, and community of inquiry.

### Instrumental Design

The exercise of making and sending the learning knowledge is called the Instructional Design (ID),

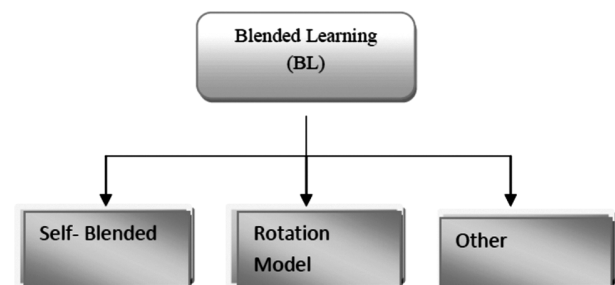


Fig. 1 — Classification of the BL by using academic behavior analytics

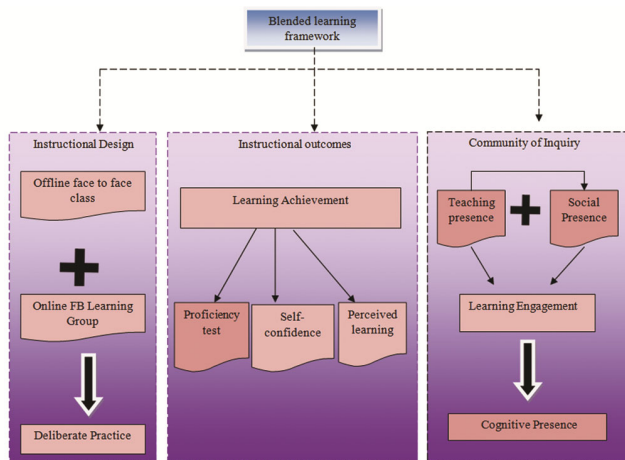


Fig. 2 — Classification of the BL by using academic behavior analytics

which may be real, resourceful, and attractive. It is an association of teaching, the mindset of the student, and information to increase the learning strategies of a particular set of learners. The ID has three main pillars: the Magic Triangle of Learning, Learning activities, and Assessments.

#### **Offline F2F Class**

The F2F classes are also called Offline classes, which may be used to provide inspiring surroundings that may be associated with academic and real-world learning. The Learners cooperated with their staff and other learners through the debate, and they got a chance to get hands-on learning, likefield trips, participate in experiments, and teachers. The main goal of the F2F is to improve the obedience, punctuality, respect, concentration, and discipline of the student.

#### **Online FB (Facebook) Learning Group**

Online group learning is used to make a community learning for the student in which the learners and the teachers can be involved and cooperate with each other for better performances in the academic year. The student can join with their staff and other learners, discover schools, and get exercise and work out. Some of the online groupings on Facebook are Creative High School English, Amazing Educational Resources, Meta for Education Group, and Sight Word Reader.

#### **Deliberate Practices**

The meaningful and efficient approach for the student to increase the stability of learning is called Deliberate practice. It needs many workouts to improve the learning of the student through regular

workouts, correcting mistakes, and changing the goal into a key part of their life.

#### **Instrumental Outcomes**

The plan is called an Instrumental outcome. For example, the concept of the book may indicate the instrumental outcomes. The instrumental and psychological aspects are referred to as the characteristics which may be used to achieve a particular goal. These characters are meaningful and encouraged by external prizes like financial compensation, recognition, and praise.

#### **Learning Achievement**

The percentage of achievement of the student in the educational field is called Learning Achievement. It is used to determine the student program and evaluate the performance of efficient learning and teaching. The internal and external factors are used to achieve success in learning, which involves the hard work of the student, the student's observation of their ability, and their aims.

#### **Proficiency Test**

Examinations are conducted to test the learner by testing the learner's knowledge and skills taught by the course. It is mainly used to determine the particular learner's knowledge and skill in a particular field of language, activity, and study. The proficiency tests are dissimilar from the placement tests; they help the incoming student's decision on the skill to take.

#### **Self-confidence**

The level of confidence and the knowledge of the learners to accept themselves is called self-confidence. It defines the self-control of the learner's life and is used to analyze the weaknesses and strengths of the learners. Human beings with self-assurance must have the strength for themselves, and have the ability to set the correct goals for themselves, which increases the communication skills of the learner.

#### **Perceived Learning**

The student's self-report of gaining the knowledge and the skill of the learning is based on self-analysis and the image. It is dissimilar from real learning, which may be the outcome of the hard dimension of the learning that may determine the resolution of the knowledge and skills of the learners. The ability used to understand smell, see, taste, feel, and hear, which may be semi-permanent and permanent, is called perceived learning.

**Community of Inquiry (COI)**

The collection of the learners involved in the process of the conceptual inquiry and the empirical inquiry in the difficult situation is called a COI.

**Teaching Presence**

The association, strategy, track of the courses, and innovation have the main improvement in the educational outcomes for the learners. The main components of the teaching presence are direct instructional activities, facilitation of discourse, strategy, and instructional design.

**Social Presence**

The grade of observing the other learner's communication, skill, and knowledge is called the social presence. It is also referred to as a person's sense of the real by the middle of the statement.

**Learning Engagement**

The capacity of the competitors in the teaching and learning process, in an inspired and interactive way, is called Learning engagement. It includes the dynamic and the excitement of the competitor and the enthusiasm to give his/her attention to the learning. The enthusiasm and duty taken for the learning trip is called engaged learning.

**Cognitive Presence**

The number of the teacher and the student to desire and conform to the sense based on the continued message in a community of inquiry is called Cognitive presence. The different kinds of communication, such as critical thinking, may distinguish the one-way distribution of information.

**Data Collection**

The review process was established by considering various articles published in various journals obtained from search databases, like Web of Science and Google Scholar. The papers were obtained from reputed journals based on searching with keywords like "Learning analytics", "blended learning", "active learning" and so on. Furthermore, the papers published from the year 2014 based on the keywords were taken into consideration. The review work is established by considering the currently available online learning tools, with a focus on blended learning. These papers are published by various publishers like Elsevier, IEEE, Hindawi, JETS, Research Gate, Springer, IJET, Taylor and Francis, MDPI, Frontiers, openreview.net, and IJEA.

**Evaluation of the Results**

The examination of the academic behavior of the BL model is explained in the sections below. The examination of the section is based on multiple parameters, like datasets used, employed tools, techniques, year of publication, and evaluation metrics.

**Analysis based on the Dataset**

The examination based on the varieties of datasets used in the BL model for learning and teaching is illustrated in Fig. 3. Multiple datasets can be used to demonstrate the academic behavior of the BL model, like Real-time monitoring, Likert scale questions dataset, Likert five-level scale dataset, ECOC, Random Forest and XGBoost dataset, 2 class to 5 class dataset, Multilayer Perceptron (MLP) Module of IBM SPSS Statistics 21 dataset, grade 2 to grade 4 dataset, accumulated data set and duration dataset, Berlin Questionnaire dataset, feedback questionnaires dataset, Bned Loud Cloud dataset, VOC 2007 dataset, and the DB1to DB12 dataset and so on. Here, the commonly used dataset the real-time monitoring is working in 39 papers.

**Analysis based on the Utilized Tool**

Here, the classification of BL by academic behavior analytics used a different tool for multiple uses, they are LMS, Virtual classroom tool, video-based learning, and other tools. The analysis in terms of the tools which are utilized for the academic behavior of BL is shown in Fig. 4. Out of 50 papers, the Moodle LMS tools utilized in 9 papers, the LMS tool is used in 11 papers, the Virtual classroom tool is used in 1 paper, the blackboard LMS is used in 1 paper, video-based learning is used in 17 papers, and other BL tools are used in 11 papers.

**Analysis of the Methods**

The method employed for the academic behavior analysis in the BL models is provided in Fig. 5. In this

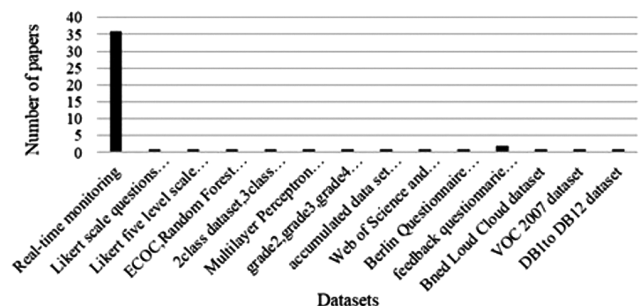


Fig. 3 — Analysis of the model based on the datasets

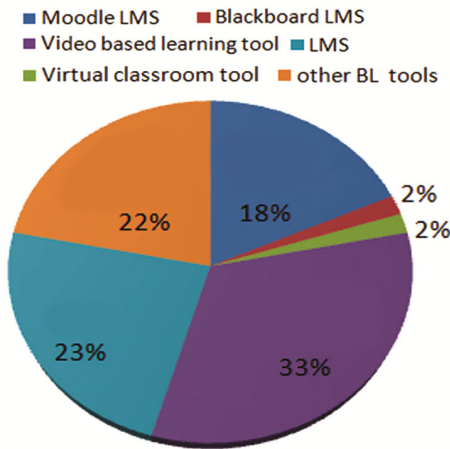


Fig. 4 — Analysis in terms of tools utilized in the academic behavior of the BL

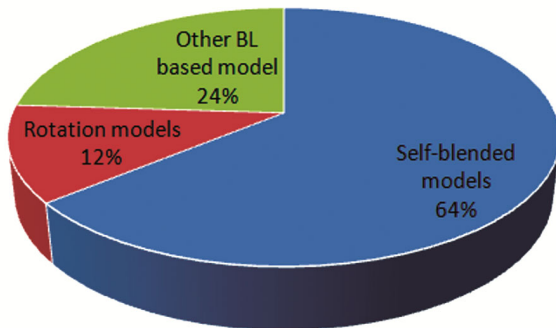


Fig. 5 — Analysis in terms of the method used in the BL model

survey, the academic behavior analysis in the BL models is categorized into three models: there are self-blended model, the rotation model, and the other BL-based model. In the 50 articles, 32 articles use the self-blended model, 12 articles use the other BL-based models, and 6 articles use the rotation model, respectively. The self-blended model is commonly used by researchers for analyzing the academic behavior of the BL models.

**Analysis based on Year of Publication**

In this section, the analysis of the BL model's academic behavior is employed based on the publication years of the chosen 50 articles. The analysis in terms of publication years is given in Fig. 6. This figure displays that the 14 articles were published in the year of 2021.

**Analysis of the Method based on the Evaluation Measures**

The analysis of the multiple metrics can be taken from the 50 research papers, for the academic behavior analysis of the BL model is discussed in this section. There is multiple assessment measures used

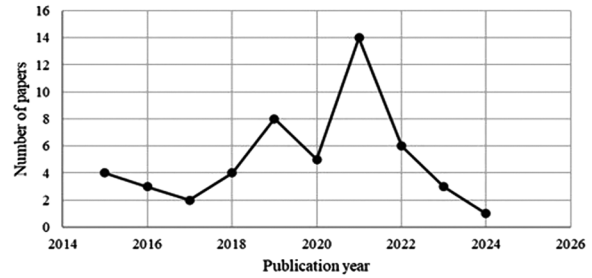


Fig. 6 — Analysis of publication years in the BL models

Table 1 — Analysis in terms of evaluation measures of the BL models

| Evaluation measures     | Published papers                          |
|-------------------------|---|
| Accuracy                | Ref <sup>1,8, 10, 17,44</sup>             |
| Mean standard deviation | Ref <sup>2,13-16, 25, 26, 45, 49,50</sup> |
| Recognition rate        | Ref <sup>48</sup>                         |
| Risk factor             | Ref <sup>35</sup>                         |

in the 17 articles in Table 1. The metrics assessed in the 17 articles are accuracy, mean standard deviation, recognition rate, and risk factor. The mean standard deviation is commonly used in the 10 papers.

**Conclusions**

In this survey, the various approaches available for academic behavior analytics based on the BL model were reviewed in detail. Here, a total of 50 articles focus on academic behavior analytics using BL models, including the self-blended model, rotation model, and other BL models. The evaluation of the various works was established by using various criteria, like evaluation metrics, methods, published year, used dataset, and the employed tools. Furthermore, most of the articles were taken from the year 2021, and last, the most commonly used metric was the Mean standard deviation. This survey contributes to a better understanding of current trends and challenges in academic behavior analytics for BL and provides a foundation for developing more intelligent, inclusive, and data-driven learning frameworks. In future, a new model will be developed to improve the precision of academic behavior assessment by integrating adaptive learning systems, emotion recognition, and multimodal data analysis.

**Reference**

- Zacharis N Z, A multivariate approach to predicting student outcomes in web-enabled blended learning courses, *Internet High Educ*, 27 (2015) 44-53, DOI: 10.1016/j.iheduc.2015.05.002.
- Lapitan Jr L D, Tiangco C E, Sumalinog D A, Sabarillo N S & Diaz J M, An effective blended online teaching and

- learning strategy during the COVID-19 pandemic, *Educ Chem Eng*, **35** (2021) 116–131, DOI: 10.1016/j.ece.2021.01.012.
- 3 Xie S T, He Z B, Chen Q, Chen R X, Kong Q Z & Song C Y, Predicting learning behavior using log data in blended teaching, *Sci Program*, **1** (2021) 4327896, DOI: 10.1155/2021/4327896.
  - 4 Akram A, Fu C, Li Y, Javed M Y, Lin R, Jiang Y & Tang Y, Predicting students' academic procrastination in blended learning course using homework submission data, *IEEE Access*, **7** (2019) 102487–98, DOI: 10.1109/ACCESS.2019.2930867.
  - 5 Conijn R, Snijders C, Kleingeld A & Matzat U, Predicting student performance from LMS data: A comparison of 17 blended courses using moodle LMS, *IEEE Trans Learn Technol*, **10(1)** (2016) 17–29, DOI: 10.1109/TLT.2016.2616312.
  - 6 Mulenga R & Shilongo H, Hybrid and blended learning models: innovations, challenges and future directions in education, *Acta Pedagog Asiana (APGA)*, **4(1)** (2024) 1–13, DOI: 10.53623/apga.v4i1.495.
  - 7 Fahd K, Miah S J & Ahmed K, Predicting student performance in a blended learning environment using learning management system interaction data, *Appl Comput Inform*, **21(2)** (2025) 220–231, DOI: 10.1108/ACI-06-2021-0150.
  - 8 Lu O H, Huang A Y, Huang J C, Lin A J, Ogata H & Yang S J, Applying learning analytics for the early prediction of students' academic performance in blended learning, *J Educ Techno Soc*, **21(2)** (2018) 220–232.
  - 9 Bhadri G N & Patil L R, Blended learning: An effective approach for online teaching and learning, *J Eng Educ Transform*, **35(1)** (2022) 2394–1707, DOI: 10.16920/jeet/2022/v35is1/22008.
  - 10 Yin B & Yuan C H, Precision teaching and learning performance in a blended learning environment, *Front Psychol*, **12** (2021) 631125, DOI: 10.3389/fpsyg.2021.631125.
  - 11 Fresen J W, Embracing distance education in a blended learning model: Challenges and prospects, *Distance Educ*, (2020) 108–124, DOI: 10.1080/01587919.2018.1457949.
  - 12 Law K M, Geng S & Li T, Student enrollment, motivation and learning performance in a blended learning environment: The mediating effects of social, teaching, and cognitive presence, *Comput Educ*, **136** (2019) 1–2, DOI: 10.1016/j.compedu.2019.02.021.
  - 13 Ilic D, Nordin R B, Glasziou P, Tilson J K & Villanueva E, A randomised controlled trial of a blended learning education intervention for teaching evidence-based medicine, *BMC Med Educ*, **15** (2015), DOI: 10.1186/s12909-015-0321-6.
  - 14 Ho V T, Nakamori Y, Ho T B & Lim C P, Blended learning model on hands-on approach for in-service secondary school teachers: combination of E-learning and face-to-face discussion, *Educ Inf Technol*, **21** (2016) 185–208, DOI: 10.1007/s10639-014-9315-y.
  - 15 Rasheed R A, Kamsin A & Abdullah N A, An approach for scaffolding students peer-learning self-regulation strategy in the online component of blended learning, *IEEE Access*, **9** (2021) 30721–38, DOI: 10.1109/ACCESS.2021.3059916.
  - 16 Bralić A & Divjak B, Integrating MOOCs in traditionally taught courses: achieving learning outcomes with blended learning, *Int J Educ Technol High Educ*, **15** (2018) 1–6, DOI: 10.1186/s41239-017-0085-7.
  - 17 Zacharis N Z, Predicting student academic performance in blended learning using artificial neural networks, *Int J Artif Intell Appl*, **7(5)** (2016) 17–29, DOI: 10.5121/ijaia.2016.7502.
  - 18 Hwang G J, Definition, framework and research issues of smart learning environments—a context-aware ubiquitous learning perspective, *Smart Learn Environ*, **1** (2014) 1–4, DOI: 10.1186/s40561-014-0004-5.
  - 19 Hwang G J, Chu H C & Yin C, Objectives, methodologies and research issues of learning analytics, *Interact Learn Environ*, **25(2)** (2017) 143–146, DOI: 10.1080/10494820.2017.1287338.
  - 20 Xue Y, Singh V, Singh S, Kant K, Pandey S, Kumar A, Alam MS, Tiwari SM, Joshi K & Kaushik VD, Blockchain framwork for learner performance prediction using life-brain storm-based light GBM coupled neural network, *J Sci Ind Res*, **83(6)** (2024) 652–668, DOI: 10.56042/jsir.v83i6.9904.
  - 21 Lu J, Singh V, Singh S, Kumar A, Pandey S, Verma D K & Kaushik V D, Predicting student performance with adaptive aquila optimization-based deep convolution neural network, *J Sci Ind Res*, **82(11)** (2023) 1152–1164.
  - 22 Chiu T K, Digital support for student engagement in blended learning based on self-determination theory, *Comput Human Behav*, **124** (2021) 106909, DOI: 10.1016/j.chb.2021.106909.
  - 23 Marie S M, Improved pedagogical practices strengthens the performance of student teachers by a blended learning approach, *Soc Sci Hum Open*, **4(1)** (2021) 100199, DOI: 10.1016/j.ssaho.2021.100199.
  - 24 Liu Y, Blended learning of management courses based on learning behavior analysis, *Int J Emerg Technol Learn*, **16(9)** (2021) 150–165, DOI: 10.3991/ijet.v16i09.22741.
  - 25 Prifti R, Self-efficacy and student satisfaction in the context of blended learning courses, *J Open Distance e-Learn*, **37(2)** (2022) 111–125, DOI: 10.1080/02680513.2020.1755642.
  - 26 Wang Y, Wu J, Chen F & Li J, Analyzing teaching effects of blended learning with LMS: an empirical investigation, *IEEE Access*, (2024), DOI: 10.1109/ACCESS.2024.3352169.
  - 27 Sandanayake T C, Promoting open educational resources-based blended learning, *Int J Educ Technol High Educ*, **16(1)** (2019) 1–6, DOI: 10.1186/s41239-019-0133-6.
  - 28 Alamri H A, Watson S & Watson W, Learning technology models that support personalization within blended learning environments in higher education, *Tech Trends*, **65(1)** (2021) 62–78, DOI: 10.1007/s11528-020-00530-3.
  - 29 Lane M, Osborne L & Crowther P, A blended learning approach to the teaching of professional practice in architecture, *Educ Sci*, **5(2)** (2015) 166–178, DOI: 10.3390/educsci5020166.
  - 30 Obada D O, Bako R B, Ahmed A S, Anafi F O, Eberemu A O, Doodoo-Arhin D, Oyedeji A N, Salami K A, Samuel B O, Samuel E T & Obada I B, Teaching bioengineering using a blended online teaching and learning strategy: a new pedagogy for adapting classrooms in developing countries, *Educ Inf Technol*, **28(4)** (2023) 4649–4672, DOI: 10.1007/s10639-022-11330-y.
  - 31 Bi X & Shi X, On the effects of computer-assisted teaching on learning results based on blended learning method, *Int J*

- Emerg Technol Learn*, **14(1)** (2019), DOI: 10.3991/ijet.v14i01.9458.
- 32 Du X, Wang X & Ma Y, A graph analysis method to improve peer grading accuracy for blended teaching courses, *IEEE Access*, **9** (2021) 166781–91, DOI: 10.1109/ACCESS.2021.3136352.
- 33 Shu J, Hu Q & Zhi M, Research on the learning behavior of university students in blended teaching, *Int J Inf Educ Technol*, **9(2)** (2019) 92–98, DOI: 10.18178/ijet.2019.9.2.1180.
- 34 Bamoollem B & Altarteer S, Remote emergency learning during COVID-19 and its impact on university students perception of blended learning in KSA, *Educ Inf Technol*, **27(1)** (2022) 157–179, DOI: 10.1007/s10639-021-10660-7.
- 35 Georgakopoulos I, Chalikias M, Zakopoulos V & Kossieri E, Identifying factors of students' failure in blended courses by analyzing students' engagement data, *Educ Sci*, **10(9)** (2020) 242, DOI: 10.3390/educsci10090242.
- 36 Anthony Jr B, Kamaludin A & Romli A, Predicting academic staffs behaviour intention and actual use of blended learning in higher education: model development and validation, *Technol Knowl Learn*, **28(3)** (2023) 1223–1269, DOI: 10.1007/s10758-021-09579-2.
- 37 Demaidi M N, Qamhieh M & Afeefi A, Applying blended learning in programming courses, *IEEE Access*, **7** (2019) 156824–33, DOI: 10.1109/ACCESS.2019.2949927.
- 38 Hoic-Bozic N, Dlab M H & Mornar V, Recommender system and web 2.0 tools to enhance a blended learning model, *IEEE Trans Ed*, **59(1)** (2015) 39–44, DOI: 10.1109/TE.2015.2427116.
- 39 Leung J K, Chu S K, Pong T C, Ng D T & Qiao S, Developing a framework for blended design-based learning in a first-year multidisciplinary design course, *IEEE Trans Ed*, **65(2)** (2021) 210–219, DOI: 10.1109/TE.2021.3112852.
- 40 Chen M, Ye L & Weng Y, Blended teaching of medical ethics during COVID-19: practice and reflection, *BMC Med Educ*, **22(1)** (2022) 361, DOI: 10.1186/s12909-022-03431-6.
- 41 He G, Blended teaching mode of art course based on objective achievement scale, *Int J Emerg Technol Learn*, **15(13)** (2020) 289–302, DOI: 10.3991/ijet.v15i13.14987.
- 42 Naveen H M, IPSIT model: An indian framework for blended learning, *Int J Emerg Technol Learn*, **8(9)** (2021) 773–781.
- 43 Bhadri G N & Patil L R, Blended learning: An effective approach for online teaching and learning, *J Eng Educ Transform*, **35(1)** (2022) 53–60, DOI: 10.16920/jeet/2022/v35i0/167834.
- 44 Chen L Q, Wu M T, Pan L F & Zheng R B, Grade prediction in blended learning using multisource data, *Sci Program*, **1** (2021) 4513610, DOI: 10.1155/2021/4513610.
- 45 Xu Z, Yuan H & Liu Q, Student performance prediction based on blended learning, *IEEE Trans Ed*, **64(1)** (2020) 66–73, DOI: 10.1109/TE.2020.3008751.
- 46 Yangari M & Inga E, Educational innovation in the evaluation processes within the flipped and blended learning models, *Educ Sci*, **11(9)** (2021) 487, DOI: 10.3390/educsci11090487.
- 47 Alkhatib O J, An interactive and blended learning model for engineering education, *J Comput Educ*, **5(1)** (2018) 19–48, DOI: 10.1007/s40692-018-0097-x.
- 48 Xu T, Deng W, Zhang S, Wei Y & Liu Q, Research on recognition and analysis of teacher–student behavior based on a blended synchronous classroom, *Appl Sci*, **13(6)** (2023) 3432, DOI: 10.3390/app13063432.
- 49 Shi Y, Peng F & Sun F, A blended learning model based on smart learning environment to improve college students' information literacy, *IEEE Access*, **10** (2022) 89485–89498, DOI: 10.1109/ACCESS.2022.3201105.
- 50 Cabrera I, Villalon J & Chavez J, Blending communities and team-based learning in a programming course, *IEEE Trans Ed*, **60(4)** (2017) 288–295, DOI: 10.1109/TE.2017.2698467.
- 51 Tadlaoui M A & Chekou M, A blended learning approach for teaching python programming language: Towards a post pandemic pedagogy, *Int J Adv Comput Res*, **11(52)** (2021) 13, DOI: 10.19101/IJACR.2020.1048120.
- 52 Samson P J, Student behaviors in a blended synchronous course, *J Geosci Educ(JGE)*, **68(4)** (2020) 324–333, DOI: 10.1080/10899995.2020.1768002.
- 53 Drlik M & Munk M, Understanding time-based trends in stakeholders' choice of learning activity type using predictive models, *IEEE Access*, **7** (2018) 3106–3121, DOI: 10.1109/ACCESS.2018.2887057.
- 54 Ahmed A B & Bokolo A J, Towards an institutional blended learning adoption model for higher education institutions, *Technol Knowl Learn*, **27(3)** (2022) 765–784, DOI: 10.1007/s10758-021-09507-4.
- 55 Gren L, A flipped classroom approach to teaching empirical software engineering, *IEEE Trans Ed*, **63(3)** (2020) 155–163, DOI: 10.1109/TE.2019.2960264.
- 56 Razali F, Sulaiman T & Ayub A F, Factors of learning towards creating blended learning curriculum using learning management system in higher education during Covid-19, *Int J Instr*, **15(4)** (2022) 723–744, DOI: 10.29333/iji.2022.15439a.
- 57 Buschetto Macarini L A, Cechinel C, Batista Machado M F, Faria Culmant Ramos V & Munoz R, Predicting students success in blended learning — evaluating different interactions inside learning management systems, *Appl Sci*, **9(24)** (2019) 5523, DOI: 10.3390/app9245523
- 58 Netolicka J & Simonova I, SAMR model and bloom's digital taxonomy applied in blended learning/teaching of general English and ESP, *Int J Educ Technol*, (2017) 277–281, DOI: 10.1109/ISET.2017.68
- 59 Raga R C & Raga J D, Early prediction of student performance in blended learning courses using deep neural networks, *Int J Educ Techn*, (2019) 39–43, DOI: 10.1109/ISET.2019.00018