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Prioritizing E-Learning Alternatives for University Students Through an Integrated AHP-TOPSIS Framework

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HIGHLIGHTS

- An integrated AHP-TOPSIS framework ranks five e-learning alternatives across accessibility, cost, interactivity, ICT availability, and academic quality.
- ICT availability and academic quality emerged as the most critical criteria for evaluating e-learning alternatives.
- Blended Learning ranked first for both undergraduate and postgraduate students at Banaras Hindu University.

ARTICLE INFO

Keywords: AHP, e-learning alternatives, Evaluation criteria, TOPSIS, University students.

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ABSTRACT

The growing reliance on e-learning in education and training has produced multiple instructional alternatives. This study aimed to prioritise five such e-learning alternatives, i.e., Blended Learning, Mobile Learning, Online Distance Learning, Flipped Learning, and Asynchronous Learning for university students using an integrated Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) framework. Data were collected from 132 undergraduate and postgraduate students across five constituent institutes of Banaras Hindu University, who rated each alternative on accessibility, cost, interactivity, ICT availability, and academic quality during 2024-25. AHP was used to derive criteria weights (based on experts' judgments), while TOPSIS ranked the alternatives using these weights from the actual users' (i.e., students) perspectives. Results showed that ICT availability (0.290) and academic quality (0.263) were the most influential criteria. Blended Learning ranked highest for both undergraduate and postgraduate students, while second-ranked preferences diverged, with undergraduates favouring Mobile Learning and postgraduates favouring Flipped Learning. These findings indicate that robust ICT infrastructure and academic quality are foundational to effective e-learning. The blended approaches, tailored with level-appropriate secondary delivery modes, offer the most learner-responsive strategy for institutions designing digital learning environments.

INTRODUCTION

The continuous growth of digital technologies has reshaped education systems which facilitated the increasing use of e-learning as a viable mode of education worldwide (Gupta & Sharma, 2020). According to the British Council (2025), "E-learning is the delivery of a learning programme by electronic means. It includes web-based learning, virtual classrooms, digital collaboration and delivery of content through the internet". The adaptable nature of e-learning permits students to get involved with educational content at their preferred time and place, thereby improving access to education and enhancing learning convenience (Balachandran & Mahalakshmi, 2023; Himmawan et al., 2025). The importance of e-learning became particularly evident during COVID-19 crisis, when schools and

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universities across the globe were compelled to suspend face-to-face instruction (Maatuk et al., 2022; Singh et al., 2024). This transition ensured the continuity of education during the global crisis and demonstrated the potential of ICT to support the educational process (Borah & Devarani, 2022).

Despite its widespread adoption, conventional online learning has several limitations. Limited interaction between instructors and learners, reduced student engagement, technological barriers, and inadequate opportunities for practical learning can negatively influence the learning experience (Guanzon & Kilag, 2024; Mishra & Kumari, 2024; Sanusi, 2025). Digital fatigue, which manifests as cognitive and emotional overload, often causes decreased focus and retention in online learning (Ritesh, 2024). It leads to reduced participation, which further increases learning challenges. These challenges highlight the requirement for more innovative and student-centred approaches that can retain the flexible nature of e-learning while overcoming its limitations. To address these challenges, several e-learning alternatives have gained considerable attention. These approaches offer different instructional strategies but share the common objective of improving accessibility, flexibility, interaction, content delivery and learner engagement. Blended learning combines classroom and online instruction; mobile learning supports learning through portable devices; flipped learning promotes active in-class engagement through pre-class study; and asynchronous learning enables learners to progress independently without real-time interaction.

But selecting the most appropriate pedagogical model among these diverse alternatives presents a multi-criteria decision-making problem, as institutions must navigate complex trade-offs between technical infrastructure, learner engagement, quality and outcomes (Adeniyi et al., 2024; Mizza et al., 2025). Also, the suitability of these alternatives may vary depending on learners' preferences and educational requirements, and the relative weight that students themselves attach to factors such as accessibility, cost, interactivity, infrastructural availability and academic quality. Most existing studies have examined individual e-learning modalities in isolation or relied on simple preference rankings. Thus, a gap existed in systematic, criteria-based comparisons that simultaneously account for multiple, often conflicting, decision points. Multi-Criteria Decision-Making (MCDM) techniques are well-suited to address this gap. Against this backdrop, this study aimed to evaluate and rank selected e-learning alternatives using AHP and TOPSIS frameworks in an integrated manner. This hybrid approach leverages the AHP's capability to calculate the relative weightage of diverse evaluation criteria while utilizing TOPSIS method to rank competing pedagogical models based on their proximity to an ideal solution (Mohammed et al., 2018). Combining SWOT with the analytical hierarchy process (AHP) was used by Afroz et al. (2021) to examine Agriclinics and Agribusiness Center (ACABC) Scheme.

METHODOLOGY

The study was conducted among students of five institutes of Banaras Hindu University, namely the Institute of Agricultural Sciences, Institute of Medical Sciences, Institute of Management Studies, Institute of Sciences, and the Institute of Environment and Sustainable Development during 2024-25. Students pursuing undergraduate and postgraduate programmes constituted the study population. An integrated AHP-TOPSIS framework was employed to evaluate and rank the e-learning alternatives, i.e., blended learning, mobile learning, online distance learning, flipped learning and Asynchronous learning.

In the first stage, the relative importance of the evaluation criteria was determined using the Analytic Hierarchy Process (AHP). A panel of 15 experts, comprising faculty from the Departments of Education, Extension Education and the Indian Institute of Technology (BHU), participated in the pairwise comparison exercise. Six experts were initially identified through institutional websites based on their reported use of e-learning alternatives for teaching, while the remaining nine were recruited using snowball sampling. All experts were experienced users of some of the selected e-learning alternatives. They compared the five evaluation criteria using a 9-point pairwise comparison scale (Saaty, 2008). The resulting criterion weights were subsequently used in the TOPSIS analysis.

In the second stage, the Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) was applied using the responses collected from the 132 students selected using convenience sampling with voluntary participation. To ensure a common understanding of the selected e-learning alternatives, each alternative was introduced through handouts and specially designed video demonstrations during visits to the student hostels. Subsequently, a structured questionnaire was administered, yielding 132 valid responses from the participating students. The respondents were asked to evaluate each alternative against five criteria: accessibility, cost, interactivity, availability of ICT infrastructure, and academic quality. Responses were recorded on a 10-point rating scale, where higher scores indicated better performance. For the cost criterion, the rating scale was reversed, ensuring consistency with the remaining benefit criteria (Hwang & Yoon, 2012). The mean performance score of each e-learning alternative under each evaluation criterion was used to construct the decision matrix. The matrix was normalized and weighted using the criterion weights derived from AHP. Positive and negative ideal solutions were identified, Euclidean distances from these ideal solutions were calculated, and the relative closeness coefficient of each alternative was determined. The e-learning alternatives were finally ranked in order of their closeness coefficients.

RESULTS

Table 1 indicates the relative importance assigned by experts to each evaluation criterion. The results depicted that the Availability of ICT received the highest priority weight (0.290),

Table 1. The criteria weights produced by AHP methods [n1= 15]

Criteria	Priority Weights	Λ (MAX)	Consistency Index (CI)	Consistency Ratio (CR)	Rank
Accessibility	0.201	9.14	1.03	0.092	III
Cost	0.118				V
Interactivity	0.125				IV
Availability of ICT	0.290				I
Academic Quality	0.263				II

followed by Academic Quality (0.263), Accessibility (0.201), Interactivity (0.125), and Cost (0.118). The consistency of the judgments was assessed using the Consistency Ratio (CR). Only matrices with CR < 0.10 were accepted. These findings suggest that experts considered the availability of technological infrastructure and the quality of academic content as the most critical factors influencing the effectiveness of e-learning alternatives.

Table 2 revealed that Blended Learning emerged as the most preferred e-learning alternative among undergraduate students, followed by Mobile Learning, Flipped Learning, Online Distance Learning and Asynchronous Learning. The higher preference for blended learning may be attributed to its ability to combine the advantages of face-to-face instruction with the flexibility of online learning, thereby providing a more balanced and engaging learning experience.

Table 2. Best e-learning alternative for UG Students [n2= 69]

S.No.	Alternatives	S_i^+	S_i^-	P_i	Rank
1.	Blended Learning	0.003	0.033	0.915	1
2.	Mobile Learning	0.027	0.249	0.903	2
3.	Online Distance Learning	0.025	0.007	0.228	4
4.	Flipped Learning	0.020	0.013	0.403	3
5.	Asynchronous learning	0.031	0.003	0.100	5

Table 3 summarizes the preferences of postgraduate students regarding the selected e- learning alternatives. Similar to the undergraduate students, Blended Learning emerged as the most preferred alternative. However, the subsequent rankings differed slightly, with Flipped Learning occupying the second position, followed by Online Distance Learning, Mobile Learning and Asynchronous Learning. This preference may reflect the greater emphasis placed by postgraduate students on independent learning, critical thinking, and pre-class preparation, which are key characteristics of the flipped learning approach.

Table 3. Best e-learning alternative for PG Students [n3= 63]

S.No.	Alternatives	S_i^+	S_i^-	P_i	Rank
1.	Blended Learning	0.015	0.651	0.978	1
2.	Mobile Learning	0.379	0.374	0.497	4
3.	Online Distance Learning	0.134	0.134	0.499	3
4.	Flipped Learning	0.293	0.359	0.551	2
5.	Asynchronous learning	0.651	0.009	0.014	5

DISCUSSION

The AHP analysis revealed significant differences in the relative importance assigned to the evaluation criteria by experts. Among the identified criteria, the availability of ICT infrastructure emerged as the most important factor, as ICT infrastructure is consistently identified as a crucial component for the success of e-learning systems. Studies emphasize that robust technological infrastructure and reliable internet access significantly enhance the performance of online learning platforms (Mardiyati et al., 2026). Furthermore, the availability of ICT is not only about having the necessary hardware and software but also ensuring that these resources are accessible to all students, which is vital for equitable learning opportunities (Ramchandra & Goswami, 2024).

The TOPSIS analysis revealed distinct preferences for e-learning alternatives among university students. Among both undergraduate & postgraduate students, Blended Learning emerged as the most preferred alternative as it offers increased accessibility by combining online resources with traditional classroom settings, allowing students to access materials anytime and anywhere, thus accommodating diverse learning needs and schedules (Junior et al., 2024; Ahmed, 2025). Furthermore, it promotes greater interactivity through the integration of face-to-face discussions with online tools such as discussion forums, collaborative activities, and multimedia resources, which facilitate active learner engagement (Smith & Brown, 2023). The approach also improves the availability of educational content by providing multiple channels and formats through which students can access learning resources at their own pace (Bhadri & Patil, 2022). In addition, blended learning has been associated with enhanced academic outcomes, as it enables personalized learning experiences that address individual student requirements and learning preferences (Siddiqui et al., 2024; Ahmed, 2025). The effective integration of digital technologies within blended learning environments further supports diverse pedagogical approaches, thereby improving the overall quality and effectiveness of higher education (Alammary et al., 2016). The findings revealed that mobile learning emerged as the second most preferred e- learning alternative among undergraduate students. This preference can be explained by the convenience and flexibility offered by mobile learning, allowing students to access educational materials and participate in learning activities anytime and from any location. Such flexibility is particularly beneficial for undergraduate students who often balance academic responsibilities with various extracurricular and personal commitments (Cin et al., 2022). In contrast, flipped learning was identified as the second most preferred alternative among postgraduate students. This may be associated with its learner- centered approach, which promotes active learning and enables students to review instructional content before face-to-face class activities. This facilitates students to acquire foundational knowledge before class and utilise classroom sessions for discussions, problem-solving and collaborative learning activities (Gardner & Vessalas, 2016). Furthermore, the integration of flipped learning with mobile learning has been suggested as an effective strategy for enhancing the overall learning experience, as it enables educational content to be delivered in a manner that is adaptable to learners' contexts, preferences, and learning environments (Louhab et al., 2019).

CONCLUSION

The present study applied a sequential AHP-TOPSIS work model to systematically prioritize e-learning alternatives for university students, addressing the gap left by previous studies that evaluate digital learning modalities in isolation. The AHP results established that the success of any digital learning initiative depends first on a reliable technological foundation and credible academic content, rather than on convenience alone. Thus, Investment in robust and equitably distributed ICT infrastructure should be treated as a precondition for any institutional shift toward digital

or hybrid pedagogy. The subsequent TOPSIS analysis showed that combining the structure and accountability of traditional classroom instruction with the wide reach and of online delivery is most preferable. It also indicates that e-learning preferences are not uniform but shift with the level and nature of academic engagement. Thus, curriculum designers seeking to introduce or expand e-learning provision should be more inclined to blended models as a default framework, while tailoring the secondary mode of delivery, according to distinct learning orientations of different student cohorts.

DECLARATION

Ethics approval and informed consent: Ethical norms were strictly followed while conducting this research according to the principles of social science research. Ethical issues were considered and waived in Departmental Research Advisory Committee, Department of Extension Education, BHU, Varanasi. All participants provided their informed consent for collection of response.

Conflict of interest: The authors have declared that no conflict of interest exists in the conduct of the research.

Data availability statement: Data is available upon reasonable request from the first author.

Authors' contribution: Suman Roy prepared the original manuscript; Saikat Maji supervised the study and contributed to the research design and interpretation of results; Shruti Mishra conducted the field investigation, data collection and statistical analysis; Abhishek Kumar assisted in literature review and editing. All authors read and approved the final manuscript.

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