

Educating Sustainable Wine Pairing with Smart Technology for North Indian Cuisines

Ankit Gupta^{1*}, Malini Singh¹, Kshitiz Sharma²

¹Amity School of Hospitality, Amity University, Noida, Uttar Pradesh, India, ²Department of Management Studies, Parul University, Goa, India. *Corresponding Author's Email: ankit.gupta6059@gmail.com, ankit.gupta@s.amity.edu

Abstract

This study explores how smart technologies, including Artificial Intelligence (AI) and mobile applications, can support sustainable wine-pairing education for wine amateurs interested in North Indian cuisines. Wine pairing often requires specialized knowledge, making wine and food terminology difficult for non-professional consumers. Smart technologies can simplify this process through accessible and personalized recommendations. The design methodology opted is quantitative, survey-based study was conducted using convenience sampling from wine amateurs. In addition, interviews with 30 industry experts were analyzed thematically, highlighting sensory and cultural compatibility, expert validation, sustainability and technology-supported education. As per study the findings indicate that a multifaceted smart-technology approach can produce positive and sustainable outcomes in wine-pairing education. AI algorithms can analyze user preferences and recommend suitable pairings, while Augmented Reality (AR) can facilitate immersive virtual tasting experiences. Natural Language Processing (NLP) can simplify complex wine terminology. These technologies enhance user engagement and individualized learning. AR-supported experiences guided by wine experts extend wine education globally. The study contributes an innovative AI-driven approach to personalized wine-pairing education, moving beyond generic recommendations. It demonstrates how technology can adapt global wine-pairing principles to North Indian gastronomic traditions and individual consumer palates. It also highlights opportunities for wine companies, technology providers and hospitality institutions to develop educational applications and online courses that make wine knowledge more accessible, culturally relevant, interactive and sustainable.

Keywords: Artificial Intelligence, North Indian Cuisines, Smart Technology, Sustainable, Wine Education, Wine Pairing.

Introduction

Educating wine amateurs about sustainable wine pairing with North Indian cuisine can be challenging because wine classification is complex and learners often have no hospitality background. Pairing principles are also influenced by culture, individual sensory perception and subjective preferences (1). Smart technologies, including artificial intelligence AI, machine learning (ML), recommendation systems and predictive analytics, have created new opportunities for education and may support sensory subjects such as wine and food pairing (2, 3). AR, VR, chat-bots and NLP can make wine characteristics and terminology more accessible and engaging (4, 5). Such technologies may also accommodate cultural and dietary preferences, helping learners develop personalized food-and-wine combinations while strengthening culinary and wine knowledge (6). This study examines the benefits, limitations and sustainability of smart

technology-supported wine education compared with traditional approaches. Books, professional courses and live tastings remain valuable but may be costly or inaccessible to wine amateurs in some countries (7). Virtual learning, tours and interactive applications can extend access, while data-driven tools can assist learners in interpreting complex wine and food characteristics (2, 8). The study therefore investigates the current use, benefits, challenges and future potential of AI and ML in teaching wine pairing with North Indian cuisine (9). Wine amateurs differ in age, professional background, experience and prior knowledge (10). Common learning difficulties include maintaining attention during conventional instruction (11). Technology-supported training can address some of these challenges by presenting food and wine characteristics within cultural contexts and providing interactive guidance through pairing

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applications and virtual sommelier sessions (12–14). Additional learning difficulties include understanding numerous grape varieties and wine styles, interpreting multilingual wine labels and pronunciation and recognizing aroma, flavour and texture (15). North Indian cuisine creates particular pairing challenges because rich and spicy flavours can dominate lighter wine aromas (16). Wines such as Cabernet Sauvignon, Shiraz, Chardonnay and Sauvignon Blanc therefore need to be considered according to the sensory characteristics of individual dishes. Sustainability is another important consideration. Locally produced and organic wines, regional ingredients, sustainable agricultural practices and domestic wine-food pairings may reduce transportation and distribution impacts (16, 17).

Large datasets containing winemakers' notes, chemical composition, consumer responses and sommelier reviews can contribute to pairing recommendations (18, 19). Predictive and analytical tools can assess flavor profiles, ingredients, historical information and established pairing principles (16, 20). However, expert judgment remains essential because technological systems may not adequately interpret sensory, cultural and contextual factors (16, 21, 22). AR glasses, CAVE environments, virtual tastings and vineyard tours, NLP chat-bots and mobile applications can further support terminology, pronunciation, feedback and interactive learning. These alternatives may also reduce dependence on costly wine tourism (23, 24). Wine labels influence product understanding and preferences (21, 25), while applications such as Vivino provide personalized wine and pairing information (25). As culinary practices evolve, these systems require accurate, regularly updated and appropriately validated data.

Proposed Model Framework

As presented in Figure 1 the proposed framework integrates smart technology with sustainable wine and food-pairing education for wine amateurs, particularly for North Indian cuisine (26). AI recommendation systems using collaborative and content-based filtering can suggest pairings based on wine characteristics, ingredients and individual preferences. AR and VR can provide interactive, paper-reducing learning through virtual tastings and expert interaction (27–29). Predictive methods, including Gradient Boosting Machines and XG-Boost, can identify pairing patterns, while NLP models such as BERT and GPT can support explanations, questions, pronunciation and translation. Clustering and classification techniques, including K-means, can group wines and foods according to characteristics, regions and dietary preferences. Mobile learning applications can further support grape identification, tasting notes, label scanning and pairing decisions.

Figure 1 model framework suggest how expert input from sommeliers and chefs remains important for validating recommendations, updating pairing principles and addressing limited reviews or experimental evidence (30). Compared with textbook and conventional ICT-based learning, smart tools can provide flexible access to current wine, cuisine and pairing information alongside virtual tastings and expert feedback (31–34). For North Indian cuisine, the framework combines sensory knowledge of complementary and contrasting flavors with sustainability measures such as Indian wines, digital tasting materials, responsible packaging and access to suitable local purchasing options (16, 35). Continuous learner evaluation and expert feedback can refine recommendations, user satisfaction, learning outcomes, and strengthen pairing knowledge and decision-making over time.

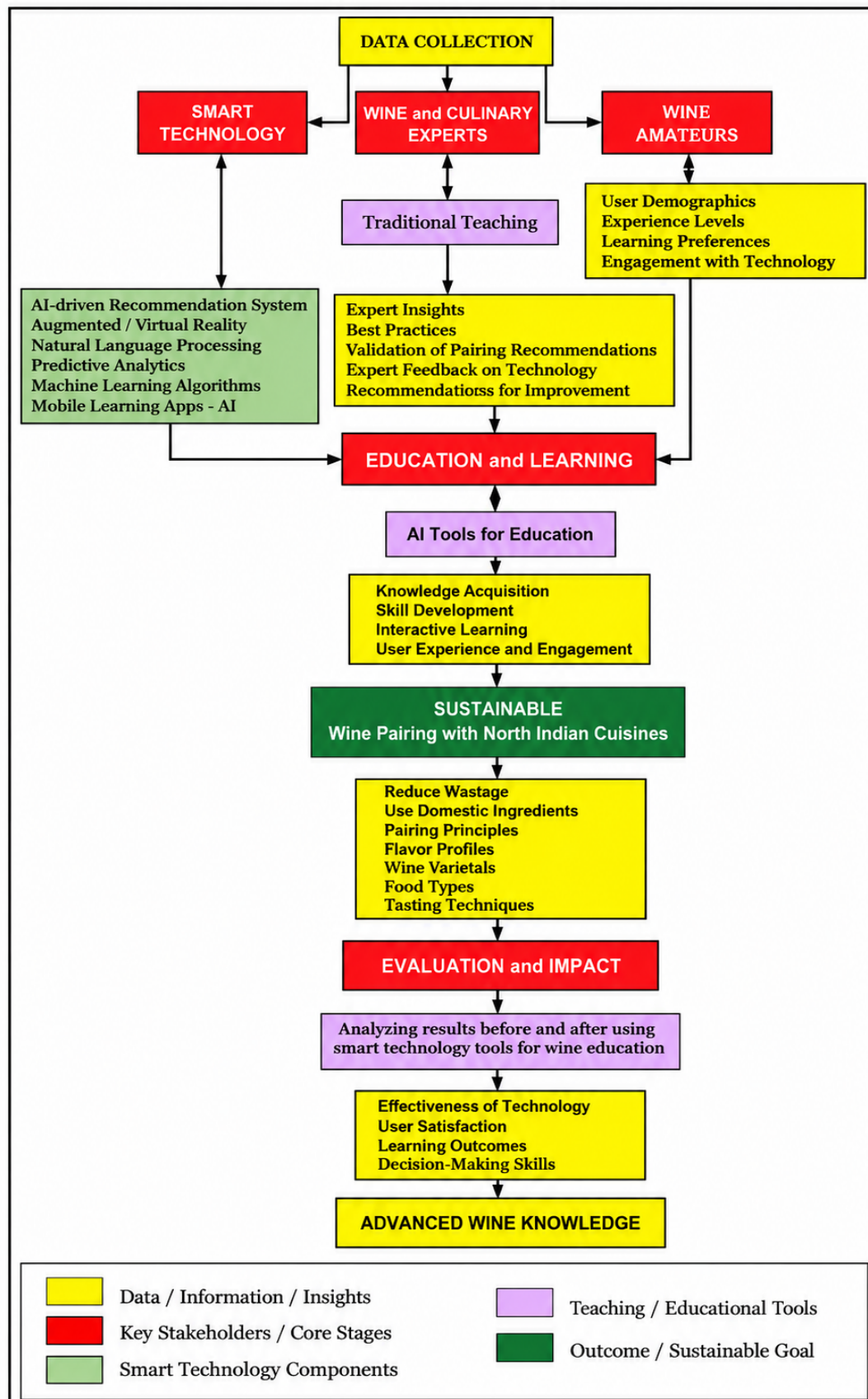


Figure 1: Data Collection Connect with Sustainable Wine Pairing by Smart Technology, Wine Experts and Wine Amateur

Research Gap

Existing studies have explored wine–food pairing through sensory science and, more recently, AI/ML-based recommendation systems (36). However, most AI studies focus on consumer recommendations rather than using AI as a pedagogical tool for wine-pairing education. Research also shows limited representation of culturally specific cuisines, particularly North Indian cuisine, in computational wine-pairing models. The complex interaction of spices, chili, acidity, fat and cooking techniques in North Indian foods requires context-specific pairing frameworks. Furthermore, sustainability has been discussed in hospitality education, but its integration with wine and food-pairing education remains underexplored (37). There is also limited empirical evidence on whether AI-supported pairing education improves students' sensory knowledge, pairing skills, critical thinking and confidence. Therefore, a research gap exists in developing and validating a sustainable, AI/ML-supported wine-pairing education framework specifically contextualized to North Indian cuisine. The novelty of this study lies in integrating smart technology, sustainability, expert validation and culturally specific North Indian cuisines within a single wine-pairing education framework for wine amateurs.

Research Objectives

- (a) To analyse the learning complexities wine amateurs are facing while wine pairing with North Indian cuisines.
- (b) To examine the role of smart technology (i.e., AI driven algorithms, AR, VR and NLP) to create immersive experiences for sustainable wine pairing education with north Indian cuisines to wine amateurs.

$$n = [Z^2 \times p \times (1 - p)] / E^2 \quad [1]$$

Substituting the values gives $n = [(1.96)^2 \times 0.5 \times 0.5] / (0.05)^2 = 0.9604 / 0.0025 = 384.16$. Rounding up, the required minimum sample size is 385 respondents.

A total of 385 responses were received, of which 360 complete responses were included in the final analysis.

Demographic Profile of Respondents

The demographic profile presented in this section is based on 360 complete samples. Approximately 63% students and wine amateurs out of all samples rest are professionals from industry or

- (c) To determine the underlying challenges in the implementation of smart technology for sustainable wine and food pairing education among wine amateurs and develop a framework for the solution.

Methodology

Research Design

A quantitative survey based on convenience sampling to gather 385 responses from wine amateurs is applied here. To understand user perceptions, challenges and the practical implications of AI and ML integration in educational contexts. This research utilizes a mixed-method approach.

The collected data were analyzed using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA). Descriptive and inferential statistical analyses were performed according to the study objectives and statistical significance was considered at $p < 0.05$. In addition, qualitative data were coded and analysed thematically. Interviews of 30 experts from the industry were conducted to explore expert perspectives on pairing principles, sustainability and the application of smart technology to wine-pairing with north Indian cuisines in a sustainable way using domestic ingredients and wines.

Sample Size

Because the population of wine amateurs is very large, it was treated as infinite and the sample size was calculated with Cochran's formula. The calculation used a 95% confidence level, which corresponds to a Z-score of 1.96 and a 5% margin of error ($E = 0.05$). The proportion (p) was set at 0.5, since the true proportion is unknown and this value gives the greatest variability. The formula is given below in Equation [1]:

other sectors. In which 76% have just completed or pursuing bachelors. Only 23% samples out of these wine amateurs have done any professional wine pairing course and approx. 18% attended any master classes rest have just gained knowledge from other sources. Approx 53%

samples stated wine pairing is a complex subject and only 13% feel it's easy. Out of all 83% amateurs gain their knowledge through books, classes and YouTube videos. No wine amateur claims they follow wine applications to gain knowledge source as a strong base. In a palate sensory subject still 76% amateurs believe traditional methods are effective to understand pairing principles. 53% amateurs are facing challenge because there is a lot of contradiction in pairing principles by different authors and sommeliers and as per region and dietary preferences same principles don't work. 38% have challenges like terms are very lengthy or wine courses are very expensive to do. As it's a palate sensory subject most of the amateurs stated always sommeliers and chefs required, AI can't replace sommeliers. More than 72% amateurs stated as per them they have average to good wine knowledge but when tested accurate results will come out. But 36% have not even tasted wine in last 3 months which reflects they have just theoretical knowledge. 33% amateurs stated wine pairing with North Indian cuisine is completely possible which is a big chunk. Approximately 25% stated people psychologically think or are prejudiced while pairing those wines can't go well with North Indian cuisines. Only 28% people according to spices, food richness, cooking techniques stated food flavors are so strong that there is no wine to match. Only 16% wine amateurs are using technology to understand wine pairing like AR, VR though 64% wine amateurs believe AR, VR or AI tools are very good in engaging and learning. AI-algorithms, VR and Chat-bots are the best of the AI tools for learning covering more than 74%. But 76% wine amateurs still choose sommeliers' advice as important apart from learning from such tools. While learning through smart technology tools two major challenges are to judge the aroma of specific wine by bottle and to derive pairing principles of wine with food. Best part about AI is that it can resolve and answer lengthy terms or give suggestions with accurate pronunciations to us. 35% wine amateurs strongly stated any technology can't resolve the problem of making wine pairing notes on a wine bottle that being done in a tasting class is expensive and it can't reach to a depth where sommeliers can explain a wine bottle. Limitations and doubts shown by wine amateurs

are 24% believe there is a sense of effective results.

Due to complexity of subject 33% wine amateurs are not completely trusting AI. Upgradation in food industry, data bias-ism or some factors are also there as a limitation. In future approximately 38% wine amateurs want to see wine pairing with bottle label and images, 23% want visual aids to be more, 20% want recipe suggestions and approximately 18% want more wine quizzes to learn wine and food pairing with north Indian cuisines.

Results

Hypothesis Testing

The results indicate that smart technology can support the education of wine amateurs with sustainable wine pairing with north Indian cuisines techniques using AI and ML tools presents the opportunity to enhance educational experience and confidence levels for wine amateurs. Sustainable pairing using domestic wines and ingredients also showed positive motivation for learning, as correlation scores = 0.7 between 0 to 1 which reflects the relationship is positive at high level. Smart technology reflects tailored educational approach with ease of usage and high interaction speed. But major challenges are differences in culture, dietary preferences and limited technology literacy amongst wine amateurs. Data privacy concerns and loss of culinary heritage is also a challenge to train amateurs on these which impacts 80 to 85% of the population. To enable them complex pairing principles more effectively and to raise satisfaction scores AI tools like NLP chat-bots, AR, VR and mobile applications help in understanding terminology and pronunciations in an effective way.

H1: Smart Technology tools AI and ML can significantly suggest pairing options and simplify learning methods how to apply wine pairing principles with north Indian cuisines if there are variation in individual taste palate and dietary preferences.

Paired sample comparison was applied to compare the mean scores of wine pairing with north Indian cuisines so what satisfaction gained by wine amateurs and difference in learning method satisfaction before and after the usage of smart technology tools.

Table 1: H1 - Paired Sample Comparison of Wine Pairing

Metric	Before using Smart Technology	After using Smart Technology	Difference	Statistical Difference
Suggest wine pairing with North Indian Cuisines (Mean Scores)	6/10	9/10	+3	$p < 0.01$
Simplify Learning Methods Satisfaction (%)	67%	88%	+21%	$p < 0.05$

Table 1 represents the comparison of wine-pairing knowledge and learning satisfaction before and after the use of smart technology.

H1 results indicate a significant improvement as reflected by mean scores to suggest wine pairing with North Indian cuisines from 6/10 to 9/10 after smart technology usage and the difference is 3 points ($p < 0.01$). Additionally, it also simplifies

learning methodology for wine amateurs and satisfaction% increases from 67% to 88% representing a (21%) point increase ($p < 0.05$) in the understanding of wine amateurs. These findings support the proposed positive role of smart technology in pairing guidance and learning satisfaction.

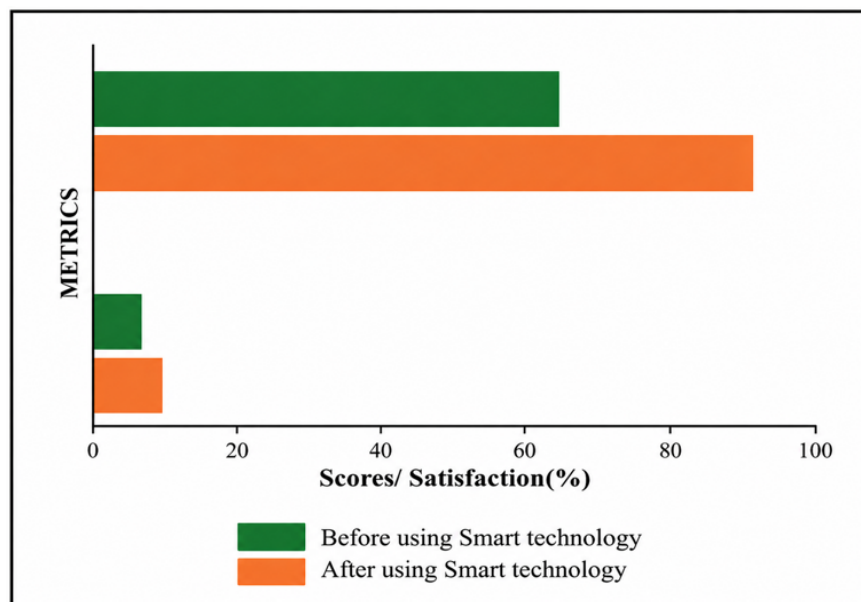
**Figure 2:** H1 Impact of AI and ML on Pairing Suggestions and Simplifying Learning Methods

Figure 2 highlights the positive impact of AI and ML tools on wine-pairing recommendations and learning satisfaction. Mean pairing scores increased from 6/10 to 9/10 ($p < 0.01$), while learning satisfaction improved from 67% to 88% ($p < 0.05$). These findings support H1, confirming the effectiveness of smart technology in enhancing wine-pairing guidance and simplifying learning methods.

H2: Educational experience and confidence levels of wine amateurs in pairing wines with North Indian cuisines in a sustainable way are improved by the usage of smart technologies (AI, AR, VR, NLP).

Pearson's Correlation analysis was used to examine the relationship between educational experience and confidence levels across the reported usability parameters after the use of smart technology. This analysis illustrates the parameters associated with improved educational outcomes in wine pairing.

Table 2 represents the relationship between educational experience and confidence levels across different AI-supported usability metrics, as measured using Pearson's correlation, with $p < 0.05$ indicating statistical significance.

Table 2: H2 Pearson's Correlation between Educational Experience and Confidence Levels Following the Use of Smart Technologies

Usability Metrics Mean Scores	Educational Experience	Confidence Levels	Correlation Scores	Statistical Significance
Upgradation in pedagogies keeps engagement high with AI supports	8.5/10	8.4/10	0.44	$p < 0.05$
Ease of usage with AI tools supports	9.0/10	8.9/10	0.577	$p < 0.05$
Motivation as using sustainable pairing method with AI supports	8.8/10	8.7/10	0.70	$p < 0.05$
Speed of Interaction with AI supports	8.7/10	8.5/10	0.81	$p < 0.05$

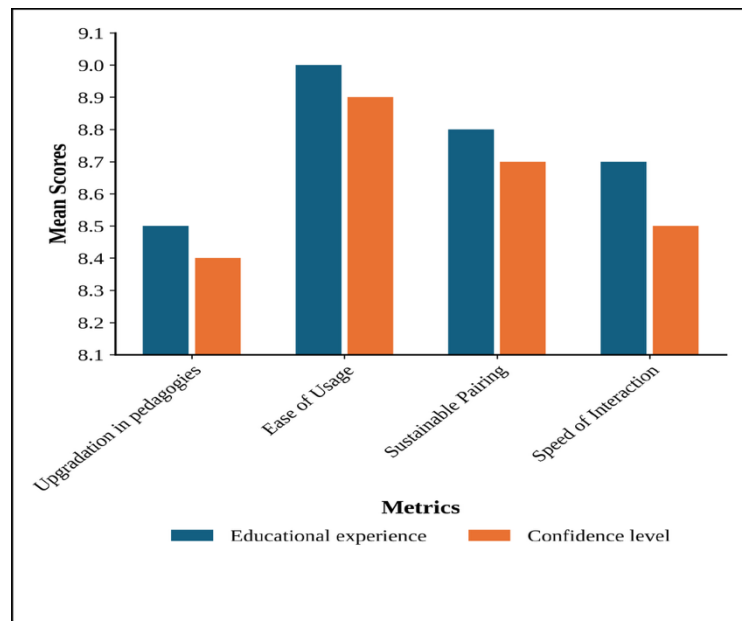
**Figure 3:** Chart H2 represent Impact of Usability Parameters on Educational Experiences and Confidence Level with AI Support

Figure 3 illustrates the positive impact of AI-supported usability parameters on educational experiences and confidence levels among wine amateurs. Educational experience scores ranged from 8.5 to 9.0, while confidence levels ranged

from 8.4 to 8.9. Ease of usage recorded the highest scores in both categories, highlighting the effectiveness of smart technologies in enhancing learning, engagement, and sustainable wine-pairing practices.

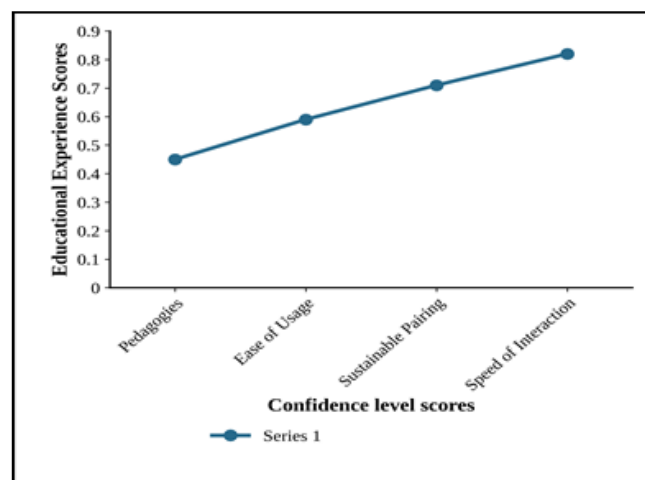
**Figure 4:** H2 Correlations of Educational Experiences and Confidence-level Score

Figure 4 illustrates a positive correlation between educational experiences and confidence levels among wine amateurs using AI-supported tools. Correlation values range from 0.44 to 0.81 ($p < 0.05$), indicating statistically significant positive relationships. Speed of interaction ($r = 0.81$) and sustainable pairing ($r = 0.70$) show the strongest correlations, supporting H2 and highlighting the role of smart technologies in enhancing learning and confidence.

Mean scores and correlation values indicate positive correlation between educational experiences and confidence across the reported parameter levels, the values are between 0 to 1. Usability metrics such as upgradation in pedagogies, ease of usage of AI tools, motivation due to sustainable pairing and speed of interaction with smart technology tools reflect a mean between 8.5/10 to 9/10 for educational

experiences. As mean scores are between 8.4/10 to 8.9/10 of confidence level with the same parameters for wine amateurs it represents a positive array. There is a strong correlation between sustainable pairing and speed of interaction especially with positive learning experiences and confidence among wine amateurs.

H3: User unwillingness limited technological literacy and disconnection from cultural elements are major challenges to the successful application of smart technology for sustainable wine and food pairing education framework.

Table 3 presents the impact of User Unwillingness, Limited Technological Literacy and Cultural Elements on sustainable wine pairing and the overall education framework, with $p < 0.05$ indicating statistical significance.

Table 3: Testing H3 Challenges Affecting the Application of Smart Technology in Sustainable Wine-Pairing Education

Challenges	Impact Score Out of 10	Challenge In Sustainable Wine Pairing Report %	Overall Impact on Education Framework %	Statistical Significance
User Unwillingness	7/10	70%	82%	$p < 0.05$
Limited technology literacy	6.6/10	80%	85%	$p < 0.05$
Cultural Elements	7.9/10	85%	80%	$p < 0.05$

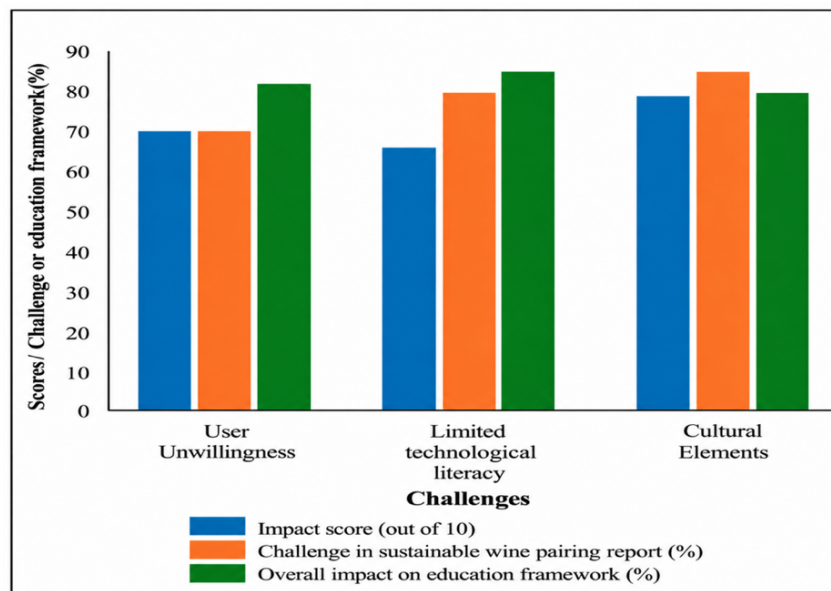


Figure 5: H3 Represents Challenges for Sustainable Pairing and Education Framework

Figure 5 data indicates three challenges in advancing sustainable wine pairing: User resistance, Inadequate technology literacy and Cultural Elements. User unwillingness has an adverse impact score of 7/10 and is notably

reported in the research (70%), presenting an important obstacle to an instructional framework, influencing them strongly up to 82%. Limited technology literacy, assessed 6.6/10, also reduces involvement and affects educational

achievements by up to 85%. Cultural elements represent the most significant challenge, with a score of 7.9/10 and 85% relevance, emphasizing the significance of culturally responsive teaching techniques. Overall, these problems emphasize the importance of personalized tactics to increase user participation and understanding of sustainable wine pairing practices.

Thematic analysis of the 30 expert interviews identified recurring views concerning sensory and cultural compatibility, expert validation, sustainability and technology-supported wine education. Experts emphasized that pairing with North Indian cuisine requires consideration of spice intensity, ingredients, cooking techniques, dietary preferences and individual sensory responses. Smart technology was considered useful for supporting pairing recommendations and learning; however, professional judgement remained important for validating combinations and addressing sensory and bottle-specific factors. Sustainability was associated with domestic wines, regional ingredients and digital learning resources. Experts also emphasized the importance of accurate data and technological literacy for effective adoption.

Discussion

Findings suggest that smart technology can strengthen wine and food-pairing education when learners possess adequate digital literacy and receive appropriate guidance. Previous research in hospitality-related education has shown that digital literacy improves access to information, educational resources, communication, feedback and learning outcomes, although technological complexity and unequal access remain important barriers. In the present context, wine amateurs should therefore develop basic familiarity with AI, ML, AR, VR, NLP and related applications before these tools are extensively incorporated into pairing education.

Smart technology may also support differences in learners' knowledge, cultural backgrounds, dietary preferences and learning pace. Earlier research has identified the potential of AI and predictive analytics for personalized and student-centered learning while also highlighting concerns related to bias, infrastructure, privacy and ethical implementation (38). These observations are relevant to wine education

because learners differ considerably in sensory experience, familiarity with grape varieties, food preferences and knowledge of regional cuisines. However, personalization depends on the accuracy and diversity of the underlying data; incomplete or culturally restricted datasets may produce unsuitable recommendations.

The findings further favor a blended approach rather than complete dependence on technology. A recent study reported better learning outcomes when students combined their existing knowledge with Chat GPT-supported learning instead of relying exclusively on either approach (38). A similar principle can be applied to wine education. AI and ML supported systems can process wine characteristics, ingredients, historical pairing information and individual preferences, but sommeliers and culinary experts remain important for evaluating sensory compatibility, preparation methods, cultural context and bottle-specific conditions. This is particularly relevant to North Indian cuisine, where spice intensity, richness, sweetness, ingredients and cooking techniques can complicate conventional pairing principles.

Excessive dependence on technology also requires consideration. Educators have expressed concerns regarding over-reliance on AI, its influence on critical thinking and problem-solving, changing educational roles and the possibility of inaccurate information (39). These concerns support the need for expert validation and reliable datasets within the proposed framework. Smart technology should therefore assist learners in interpreting wine and food characteristics rather than replacing sensory evaluation and professional judgment.

AR and VR can support virtual tastings, vineyard experiences and graphical demonstrations, while NLP-based tools can assist with terminology, pronunciation, translation and learner queries. Mobile applications can further provide tasting and pairing information. Their adoption, however, may vary according to digital literacy, perceived usefulness, affordability and previous technological experience (40). Further investigation is required to understand why some wine amateurs are reluctant to use smart technologies.

Sustainability provides another important dimension to the proposed framework. Digital tasting materials and virtual learning may reduce

dependence on printed resources and unnecessary travel, while domestic wines and regional foods may encourage more locally oriented pairing practices. Environmental benefits, however, should not be assumed solely from geographical proximity, as production practices, packaging, storage, transportation and distribution also contribute to environmental impact. Overall, the findings support a human-technology framework in which smart tools improve access, interaction and personalized learning, while sommeliers and culinary experts provide the sensory, cultural and practical validation required for wine pairing with North Indian cuisine.

Wine amateurs need dual process, and they will adopt smart technology in an effective way if initially AI and ML tools literacy with usage should be taught. Smart technology tools based on algorithms helps in choosing right pedagogies as per individual students' culture and dietary preferences which helps to encourage wine amateurs' educational experiences and raise their confidence levels with accuracy. As these tools are easy to use and the increased speed of them to access the data and information with graphics, we can motivate them to use such AI based tools such as AR, VR, NLP as much possible. As sustainable pairing brings motivation for wine and food pairing so to adopt it further to next levels to achieve purpose with confidence. Search out why some wine amateurs are not willing to work with some smart technology tools while pairing. The quality of AR and VR can be raised to give even better hands-on experience to learn in an engaging and enjoying manner. Need to work on mobile applications and to redesign the content so wine amateurs start using it. AI and ML tools can bridge the cultural gaps by culinary traditions into wine and food pairing education by giving ingredients knowledge at vast level and add content in their curriculum. To avoid Data Biasism some soft-wares need to be designed which will filter the fake data and information based on evidence. Still, we need expert sommeliers and chef's advice as reference with AI can't work on micro level bottle to bottle (41).

The qualitative findings further supported this blended approach. Thematic analysis of the expert interviews highlighted sensory and cultural compatibility, expert validation, sustainability and

technology-supported education as recurring themes. Experts emphasized the importance of spice intensity, ingredients, cooking techniques, dietary preferences and sensory responses when pairing wines with North Indian cuisine. These findings reinforce the need for professional judgement alongside technology-generated recommendations, particularly where cultural and sensory factors may not be adequately represented by algorithms.

Conclusion

The study indicates that smart technology can complement conventional wine and food-pairing education by providing interactive, accessible and learner-oriented approaches. AI- and ML-supported applications can assist with pairing recommendations, while AR and VR can provide visual and virtual learning experiences. NLP-based tools can further support wine terminology, pronunciation, translation and learner queries. These applications are particularly relevant to North Indian cuisine, where diverse ingredients, cooking techniques, spice levels, dietary preferences and cultural practices make wine-pairing decisions complex.

The expert interviews further supported this approach, highlighting sensory and cultural compatibility, sustainability, expert validation and technology-supported learning as important considerations in wine-pairing education.

The findings also indicate that technology alone may not be sufficient for developing sensory and pairing competence. Sommeliers and culinary experts remain important for validating recommendations and interpreting sensory characteristics, individual preferences, bottle conditions and cultural factors that may not be adequately represented by algorithms. Therefore, a blended approach combining smart technology, sensory practice and expert guidance appears more appropriate for wine amateurs. Sustainability may further be supported through digital learning resources, consideration of domestic wines and regional foods and responsible packaging and distribution practices. Wine and food-pairing decisions are influenced by individual taste, mood, occasion, sensory ability and cultural preferences; therefore, technology-based recommendations may not always reflect individual choices. Smart tools may also fail to

identify bottle-specific conditions such as improper storage, oxidation, or vintage variation and have limited ability to interpret learners' emotions and understanding. Data bias, digital literacy and the cost of AR and VR may further restrict accuracy and accessibility. Hence, expert validation by sommeliers and culinary professionals remains important.

Future research should evaluate technology-supported wine education through pairing accuracy, knowledge retention, confidence, engagement and technology acceptance. Pairing models could incorporate regional ingredients, cooking techniques, molecular and sensory characteristics, vintage, storage and transportation conditions. Further development of AR, VR, NLP, mobile applications and portable wine-analysis devices may improve interactive and bottle-specific learning. Larger sensory studies involving wine amateurs, sommeliers, chefs and consumers are required to validate pairings with North Indian cuisine. Sustainability should also be assessed through measurable indicators related to local sourcing, packaging, transportation and digital learning resources.

Abbreviations

AI: Artificial Intelligence, AR: Augmented Reality, ML: Machine Learning, NLP: Natural Language Processing, VR: Virtual Reality.

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Author Contributions

Ankit Gupta: Conceptualization, Literature Review, Methodology, Data Collection, Data Analysis, Interpretation of Results, Manuscript Preparation, Malini Singh: Conceptualization, Supervision, Critical Review, Supervision, Kshitiz Sharma: Supervision, Methodological Guidance, Critical Review of the Manuscript. All authors reviewed and approved the final version of the manuscript.

Conflict of Interest

The authors declare that they have no known financial, personal, or institutional conflicts of interest that could have influenced the research, analysis, or presentation of the findings.

Data Availability

Primary data were collected through structured interviews with selected respondents. Participation was voluntary and the responses were collected solely for academic research purposes. The collected data were subsequently organized, coded and analyzed using appropriate statistical techniques. Data availability is subject to participant confidentiality and applicable institutional requirements.

Declaration of Artificial Intelligence (AI) Assistance

Chat GPT (Open-AI) and Grammarly were used to assist with language refinement, grammatical correction, improvement of clarity and formatting of selected sections of the manuscript. Chat GPT was also used for minor visual and presentational enhancement of charts and figures, including removal of background elements, bullets and other non-data graphical components to improve readability and presentation. These modifications did not alter the underlying data, numerical values, statistical results, or interpretation of the findings. No AI tool was used for primary data collection or statistical analysis. All AI-assisted text and visual modifications were reviewed and verified by the authors, who take full responsibility for the accuracy, integrity and originality of the final manuscript.

Ethics Approval

The study involved voluntary interviews conducted for academic research purposes. The research was undertaken in accordance with applicable ethical principles, with due consideration given to informed participation, confidentiality and privacy of the respondents. As the authors' institution does not have a formal Institutional Ethics Committee for this category of academic research, formal institutional ethical approval was not applicable to the present study. No personally identifiable or sensitive personal information was collected or processed. Therefore, institutional ethical approval was not applicable to this study.

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