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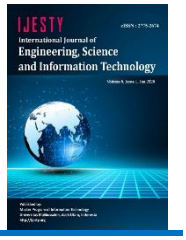

An Integration of Multicultural Perspective in Musical Theatre Education Using Pattern Mining

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Abstract

Musical theatre education has traditionally focused on Western techniques, limiting students' exposure to the cultural diversity inherent in the art form. Current curricula frequently lack systematic methods for incorporating non-Western traditions, resulting in an underrepresentation of practices like Chinese musical theatre. To address this limitation, this study suggests developing a culturally inclusive curriculum framework based on the Multicultural Musical Theatre Dataset (MMTD) with the Hybrid Rule-Based & Similarity Matching Algorithm (HRSMA). The HRSMA combines rule-based pattern extraction through frequent pattern mining with similarity-based classification via Jaccard Similarity. This hybrid approach allows for accurate categorization of various musical theatre styles into structured curriculum themes, ensuring balanced cultural representation. Experimental results validate the model's effectiveness, with 92.5% accuracy, 91.8% precision, 93.2% recall, along with an F1-score of 92.5%, indicating both efficiency and robustness in style classification. Beyond classification, the framework promotes pedagogical inclusiveness by systematically incorporating multicultural practices into theatre education. This approach goes beyond traditional Western-centric models to boost student creativity, broaden cultural understanding, and encourage critical thinking. The combination of frequent pattern mining with similar measures demonstrates creativity in balancing cultural inclusion with data-driven curriculum design. Furthermore, the findings demonstrate the practical advantages of this approach for both educators and students. At the same time, students are exposed to a broader range of cultural expressions, which fosters a deeper appreciation for global heritage and strengthens their artistic adaptability. This dual focus ensures that the curriculum remains both academically rigorous and culturally inclusive. To summarize, the proposed HRSMA-based framework offers a reproducible, methodical, and innovative approach to broadening the scope of musical theatre education. Incorporating global cultural practices improves classification accuracy while also promoting a cosmopolitan learning environment that values diversity, encourages engagement, and strengthens appreciation for world cultural heritage in performing arts training.

Keywords: *Multicultural Musical Theatre, Curriculum Development, Hybrid Rule-Based & Similarity Matching Algorithm, Frequent Pattern Mining, Cultural Inclusivity in Education.*

1. Introduction

Multicultural musical theatre is popular as a performing arts teaching education and it leads the students to numerous cultural stories, musical repertoire and theatrical forms of expression [1]. Popularizing diversity and inclusiveness, as well as cultural awareness, everybody in the world enjoys musical theatre, as several different cultural aspects are used to enrich the field artistically. Nevertheless, it is hard to select appropriate cultural components on learning musical theater due to a huge variety of musical traditions, performance methods and thematic depictions [2]. Teachers and curriculum developers should follow some methodologies on how to incorporate culturally relevant and pedagogically effective material in the theatre curriculum [3].

Although the development of cultural inclusivity has become more in demand in musical theatre education, present methods of designing their curriculum often lack a structured framework of selecting relevant multicultural content. The traditional methods are prone to subjective choice by the teachers, and thus may be culturally biased, skewed or effectively, missing good cultural elements. Also, it lacks automated or semi-automated systems that translate data intelligence-based ideas into the enhancement of curriculum development in multicultural musical theatre [4].

Diversified approaches to curriculum development in the performing arts have drawn the attention of many studies [5][6]. Others rely on advice given by experts, whereby teachers select cultural topics and musical trends based on their specialties [7]. Some people apply machine learning and data mining techniques to investigate trends in music, thematic relationships and history of music [8][9]. Several studies apply rule-based systems to identify culturally relevant piece parts in music pieces [10]. Even though the combination of these former approaches is used to plan curricula, they cannot address the complexity and the changing specifics of musical multicultural theatre. The existing methods are not standardized, and they lead to the inconsistent structure of selecting and employing multicultural elements in musical theatre curriculum. Techniques of manual selection by the educator often cause cultural biasness to emerge, in that, it oversamples

dominant stories at the expense of marginalized ones. Moreover, the existing approaches fail to exploit frequent pattern mining techniques in processing big data of compositions of musical theatres regarding identifying cultural diversity. The absence of automated similarity-matching methods is another disadvantage because it may help to propose suitable cultural elements based on preset educational objectives. To address these concerns, a paper will, therefore, propose the Hybrid Rule-Based & Similarity Matching Algorithm (HRSMA), a smart process of developing multicultural musical theatre curriculum. HRSMA is an amalgam of a regulated rule system that defines cultural selection rules to the similarity-matching algorithm that identifies thematic and musical similarities between different cultural compositions. The algorithm ensures a balanced representation of cultures and enhances the curricular responsiveness to a host of learning needs by combining these tactics.

HRSMA employs Frequent Pattern Mining (FPM) to mine typical cultural themes, melodies and theatrical elements out of a repository of musical theatre compositions which are giant in size. It employs semantic similarity matching techniques to cluster the compositions which possess similar cultural and thematic properties. Besides, the rule-based system also ensures that curriculum recommendations do not conflict with pre-set cultural diversity and educational quality standards. These techniques add elements of structure, impartiality, and automation when it comes to the establishment of a diverse and balanced curriculum.

The following paper supplies a new framework that utilizes HRSMA in the furtherance of the multicultural musical theatre curriculum in a way that is optimized. It involves Frequent Pattern Mining to identify important cultural elements in musical scores and designs a smart and similarity-based matching machine to recommend culturally diverse scores in educational programs. The effectiveness of HRSMA is also being evaluated on bases of precision, recall, F1-score, or accuracy to confirm its effectiveness.

The primary aim of the study in question is to develop a smart algorithm that in a systematic manner will enhance the multicultural curriculum design of musical theatre, preserving cultural inclusiveness and the validity of learning. Primary objectives are to implement a rule-based system provision of cultural inclusion criteria; application of frequent pattern mining techniques of identifying meaningful cultural elements, enhancement of curriculum flexibility through a similarity-provision matching mechanism, and evaluation of the efficiency of HRSMA through machine learning classification criteria.

The study given is the first one to integrate technology employed in the Frequent Pattern Mining with similarity matching and Hybrid Rule Based Methods to automate and optimize the selection of the multicultural musical theatre elements. Unlike prior works, HRSMA guarantees a standardized, bias-free, and data-driven method for curriculum development, rendering it a unique contribution to performing arts education study.

The proposed method is used in performing arts education institutions to create inclusive musical theatre curricula. It is also useful in cultural study and archival studies for analyzing and categorizing various musical theatre traditions. Furthermore, educational technology platforms can incorporate this framework into intelligent curriculum suggestion systems to increase inclusivity in musical theatre education.

The rest of this paper is organized as follows. Section 2 provides a literature review of existing works on multicultural musical theatre curriculum design. Section 3 describes HRSMA's methodology, which includes frequent pattern mining and similarity matching methods. Section 4 covers the experimental setup and performance evaluation metrics. Section 5 contains the findings and analysis of HRSMA's efficacy. Section 6 summarizes the research and suggests possible future research directions.

2. Literature Review

Academic research on musical theatre education and performance is remarkable, and contains concerns like performance anxiety, pedagogy, the effect of celebrity in musical theatre education and performance, injury and multicultural effects. The existing literature provides information about the future impact of these factors on the experience of students and professionals in the field.

Mahony et al. [11] examined whether Acceptance and Commitment Coaching (ACC) is effective in the reduction of music performance anxiety (MPA) in Performing arts students. They discovered that the non-clinical, group-based ACC intervention, improved psychological flexibility and reduced MPA related shame implying that the training of music teachers in ACC may be an alternative to the use of psychotherapy.

Blustein et al. [12] analyses music theory textbooks used by music theatre students with all their challenges of theoretical study and the practice needs of the performance. The study also emphasized the need to have specialized and skills-oriented curricula that suit the specific needs of musical theatre professionals.

The changing nature of celebrity theorized by Pretorius [13] examines that in musical theatre, especially during casting, reality television hits have been considered in influence. The study provided a historical insight into the ways in which the concept of celebrity has developed and the implications that it has for the industry and the expectations of consumers.

In a five-year research, Stephens et al. [14] aimed to analyze the injury prevalence and intensity in the pre-professional students in musical theatre dance. Their findings unmasked the evidence which demonstrated that the first-year students experienced the highest volumes of injuries and there was a drop in nature in subsequent years despite the increase in the workload indicating the importance of conditioning and injury prevention strategies.

Von Germeten [15] has examined the totality of original cast recordings as a form of pedagogy, which serves, as vocal instructions, vocal style proficiencies, training techniques, and performance modes. The research highlighted the importance of recorded material in the education of musical theatre performers.

Dobrota [16] studied multicultural music education in higher education, specifically, the factors that influence students' world music preferences. The study found no significant influence of educational background or leisure music activities on students' musical preferences, implying that exposure to various musical styles should be systematically incorporated into curricula.

Lu [17] investigated the increasing popularity of Western musical theatre in China, emphasizing its similarities with conventional Chinese theatre. The research discovered that 69% of Chinese respondents were willing to watch British or American productions, indicating a growing middle-class interest in cultural consumption. Digital platforms increase audience engagement by enabling them to co-create meaning through discussions. To maintain interest, the research recommends collaboration among theater producers, arts marketers, and policymakers.

Sun [18] investigated the difficulties of cross-training in Western classical and musical theatre vocal styles, as opera and Broadway gradually combine components. The research emphasizes differences in registration, resonance, and belting methods, and advocates for college-level vocal programs that incorporate both styles. Kvammen and Hagen [19] examined the utilization of the Alexander Technique (AT) in

musical theatre and discovered that it improves body awareness and rehearsal routines. Their research suggests that AT-based learning may benefit education beyond theatre.

Kvammen and Hagen [20] also investigated collaborative teaching in musical theatre education, focusing on artographic awareness—the intersection of artist, researcher, and teacher roles. Their study at Kristiania University College discovered three key factors: sharing pedagogical methods, co-teaching, and rethinking teaching practices. The research concludes that collaboration fosters reflective practice and improves teaching methodologies in musical theatre programs. Table 1 shows the summary of related works.

Table 1. Summary of Related Works

Study	Focus Area	Key Findings	Limitations
[11]	Managing Music Performance Anxiety (MPA)	ACC training decreases MPA, enhances psychological flexibility, and may be as efficient as psychotherapy.	Small sample size (N=6); long-term impact beyond 3 months unknown.
[12]	Music Theory for Musical Theatre	Specialized curriculum is needed because of compressed instructional time; concentrate on practical musicianship.	No empirical study on student results.
[13]	Celebrity Casting in Musical Theatre	Celebrity impact on musical theatre audiences and industry dynamics.	No quantitative data; theoretical discussion only.
[14]	Dance Injuries in Musical Theatre	Higher injury rates in Year 1; lesser limb overuse injuries are most common.	Single-institution research; results may not generalize.
[15]	Original Cast Recordings in Performance Training	OCRs shape vocal styles, behaviours, and pedagogy.	No empirical proof of OCRs' direct influence on learning.
[16]	Multicultural Music Education in Higher Education	Emphasizes the significance of cultural diversity in musical curricula.	No implementation tactics are offered.
[17]	Chinese Consumption of Western Musical Theatre	69% of Chinese audiences Favor British/American productions; digital engagement improves audience interaction.	Heavy dependence on survey data; absences empirical monitoring of audience behaviour.
[18]	Cross-Training in Classical & Musical Theatre Singing	College-level training should contain both vocal styles to prepare singers for diverse careers.	No quantitative evaluation of student vocal progression.
[19]	Embodied Learning via Alexander Technique	AT enhances body awareness and rehearsal routines in musical theatre students.	Qualitative research lacks measurable performance enhancements.
[20]	Collaborative Teaching & Orthographic Awareness	Co-teaching and pedagogical sharing enhance theatre education technologies.	Results are institution-specific; generalizability is restricted.

Despite growing awareness of cultural diversity in musical theatre education, existing research shows important restrictions in incorporating non-Western theatrical traditions into curricula. Previous studies have shown that audiences are increasingly engaged with Western musical theatre, but there are no structured curriculum tactics for integrating non-Western styles. Research on cross-training between classical and musical theatre vocal styles highlights its significance, but they do not offer quantitative evaluations of student progression, rendering training effectiveness hard to assess. Embodied learning methods, like the Alexander Technique, have been shown to enhance body awareness and rehearsal routines, but there has been no evidence of measurable performance enhancements, restricting their applicability as a standardized teaching tool. Collaborative teaching techniques have been investigated, but they are largely institutional-specific, lacking a broader framework for multicultural curriculum design. Also, although the importance of multicultural education in post-secondary education has been highlighted, the existing models do not offer practical execution strategies. Such limitations highlight a valuable gap between an overall lack of systematic inclusion of different forms of theatre within formally constructed curricula. To address this, we propose the HRSMA and MMTD which present a data directed, rule based, similar match approach to classifying and recommend culturally inclusive emphases of curriculum. However, frequent pattern mining and Jaccard Similarity promises that the analysis carried out by this research study will yield a methodical and quantifiable means of enhancing cultural representation in the study of music theatre, ensuring that educators may create vast, global encompassing curricula based on the results of this analysis that can encourage cross-cultural understanding and artistic creativity.

3. Methods

The proposed model of the system in which it is planned to integrate multicultural perspectives during musical theatre studies relies upon the MMTD and the Hybrid Rule-Based and Similarity Matching Algorithm (HRSMA). In this section, the dataset and the data collection process as well as the elements and mathematical basis of the algorithm are provided in detail. The model will eliminate the limitations of traditional curricula because it introduces varieties of cultural elements into musical theatre teaching at a pace that people can absorb. The system ensures a diverse exposure of the students to various cultures of world theatrics using data driven techniques to encourage cultural appreciation and artistic creativity.

3.1. MMTD Dataset Description

MMTD is a well-selected selection of musical theatre styles of diverse cultures, and Chinese musical theatre is particularly central. The data represented has both traditional and new genres such as Peking Opera, Kunqu Opera, Yue Opera, Cantonese Opera, Han Opera, Cantopop and Chinese Rock. Each record in the dataset is defined by features such as a unique ID for identification, Genre representing musical theatre or music styles, Primary Language like Mandarin, Cantonese, or Wu, and Instruments Used, which encompass conventional (e.g., Erhu, Pipa, Guzheng) and contemporary (e.g., Electric Guitar, Synthesizers) instruments. Dance Styles range from martial arts to contemporary choreography, and Costume Types include everything from conventional robes to casual wear. Era defines a historical or stylistic period as Classical, Conventional, Modernized Traditional, or Modern. Vocal Style encompasses various methods such as high pitch, soft, melodic, nasal tone, strong vocals, and raspy and powerful. The theme describes the central narrative, which includes historical

legends, romance and poetry, love stories, folk tales, social commentary, and personal growth. Finally, Suggested Curriculum Focus is the target feature, categorizing musical theater types into learning goals for culturally inclusive education.
The data collection procedure entails collecting data from historical records, academic journals, and expert interviews. The dataset is then preprocessed to guarantee it is consistent and complete. Each record is annotated with cultural and artistic attributes, allowing for automated evaluation. The preprocessing steps contain data cleaning, normalization, and feature extraction, which ensure that the dataset is prepared for usage in the proposed algorithm. Table 2 shows dataset features and descriptions.

Table 2. Dataset Features and Descriptions

Feature	Description
ID	Unique identifier for each record.
Genre	Type of musical theatre or music style.
Primary Language	The primary language utilized in the performance.
Instruments Used	Musical instruments related to the genre.
Dance Style	Characteristic movement or choreography.
Costume Type	Typical attire worn in performances.
Era	Historical or stylistic period.
Vocal Style	Different singing methods.
Theme	Central narrative or subject matter.
Suggested Curriculum Focus	Learning goals or curriculum themes.

The MMTD Dataset is a curated, extensible collection designed to capture a broad spectrum of musical-theatre and stage-music traditions: while it foregrounds Chinese forms (e.g., Peking Opera, Kunqu, Yue/Cantonese Opera, Han Opera, Cantopop, Chinese rock), it has purposefully expanded to include representative global traditions — for example, West and Southern African stage-musical practices (griot musical-storytelling, isicathamiya and other community vocal forms, Each item is annotated with rich cultural and artistic features, including a unique ID, genre, primary language, Instruments used include traditional instruments like erhu, pipa, guzheng, kora, djembe, bandoneon, charango, oud, and ney, as well as contemporary instruments like electric guitar and synthesizers. Other factors include dance style, costume type, era (classical vs. modern), vocal style, theme, and target feature. Suggested Curriculum Focus — and was compiled from historical archives, academic literature, anthropological fieldwork, audio-visual corpora, and expert interviews, before being preprocessed (cleaning, normalization, feature extraction, annotation) to ensure consistency and usability. By explicitly adding African, Latin American, and Middle Eastern entries alongside Chinese traditions, MMTD strengthens its "multicultural" scope and provides a stronger empirical base for developing culturally inclusive curricula.
Expanding the MMTD dataset to include theatrical traditions from many continents would greatly increase its cultural richness and worldwide significance, ensuring that it represents a truly inclusive teaching resource. Beyond its current emphasis on Chinese and selected Asian forms, the dataset could include African traditions such as griot storytelling, isicathamiya, and Afrobeat-inspired theatre; Latin American practices including tango-theatre, samba-infused stage performances, and mariachi musicals; Middle Eastern and Central Asian forms like as maqam-based operettas, Persian musical storytelling, and Turkish makam traditions; in addition to European folk musicals and Indigenous pe Including such a diverse range of traditions would not only support the dataset's claim to multiculturalism, but would also offer students with a more nuanced knowledge of the interconnection of global performance arts. This expansion would enable HRSMA-informed courses to foster deeper intercultural competency, creativity, and appreciation for theater as a global phenomenon, more successful prepared students to engage with varied creative and cultural contexts.
Table 3 shows sample records from the MMTD dataset that include important features like genre, primary language, instruments employed, dance style, costume type, historical era, vocal style, thematic elements, and suggested curriculum focus. These records show the diversity and cultural importance of different musical theatre traditions, offering insight into their artistic features and educational relevance.

Table 3. Sample Records of the MMTD Dataset

ID, Genre, Primary Language, Instruments Used, Dance Style, Costume Type, Era, Vocal Style, Theme, Suggested Curriculum Focus
1, Peking Opera, Mandarin, Gongs, Erhu, Martial Arts, Traditional Robes, Classical, High-Pitched, Historical Legends, Chinese Theatrical Heritage
2, Kunqu Opera, Mandarin, Dizi, Pipa, Elegant Gestures, Flowing Robes, Classical, Soft, Melodic, Romance & Poetry, Classical Chinese Theatre & Poetry
3, Cantopop, Cantonese, Electric Guitar, Pop-Inspired Moves, Casual/Trendy, Modern, Soft, Love, Society, Personal Growth, Contemporary Chinese Music & Culture

3.2. Rule Extraction

Rule Extraction phase involves identifying the trends that exist frequently in the data and coming up with the rule base that can be used in predicting the Suggested Curriculum Focus. This is accomplished through Frequent Pattern Mining, a method that identifies common associations between categorical features. For each record, a pattern key is created utilizing the subsequent features:

Pattern Key=(Genre, Primary Language, Instruments Used, Dance Style, Costume Type, Era, Vocal Style, Theme) (1)

The associated Suggested Curriculum Focus is saved in the dictionary 'Rules'. If numerous records follow the same trend, the most frequently happening curriculum emphasis is kept. Mathematically, this can be expressed as:

$$Rules[P] = \arg\max_{c} \sum_{i=1}^{N} [\![(P_i = P \text{^} C_i = c) \quad (2)$$

Where:
a. P is the pattern key,
b. C_i is the curriculum focus for the i-th record,
c. $[\$is the indicator function,
d. N is the total number of records.

This phase guarantees that the algorithm can swiftly and precisely forecast the curriculum emphasis for records that match previous patterns, minimizing the requirement for intricate computations.

3.3. Rule-Based Prediction

The Rule-Based Prediction phase employs the extracted rules to forecast the curriculum emphasis for a new record. If the new record's pattern key matches an existing rule, the relevant curriculum emphasis is returned. This procedure is extremely effective, with a time complexity of O(1), because it uses a direct lookup in the 'Rules' dictionary. For instance, if a new record has the pattern key (Peking Opera, Mandarin, Gongs, Erhu, Martial Arts, Traditional Robes, Classical, High-Pitched, Historical Legends), the algorithm will immediately return "Chinese Theatrical Heritage" as the predicted curriculum emphasis.

3.4. Similarity-Based Matching (Fallback)

When no exact rule matches the new record, the algorithm uses Similarity-Based Matching as a fallback option. This includes calculating the Jaccard Similarity between the new record and all records in the dataset. The Jaccard Similarity is defined as:

$$\text{Jaccard Similarity (X, Y)} = \frac{|X \cap Y|}{|X \cup Y|} \quad (3)$$

Where:
a. X is the set of categorical values for the new record,
b. Y is the set of categorical values for a dataset record.

The record with the maximum Jaccard Similarity is chosen, and the Suggested Curriculum Focus is applied to the new record. This will ensure that even when the records to be matched are not clear or would match under unseen items, the algorithm would draw a satisfactory conclusion based on the available matching data.

3.5. Output Prediction

The prediction in the end of the process is the Suggested Curriculum Focus of the new generated record according to the Predicted Curriculum Focus by the algorithm. This is done through either rule-based prediction or comparison-based matching, and the end findings are reliable and precise. The outcome is expected to aid teachers to create a school curriculum, which would relate to the tremendous variety of global musical theatre practices, promote cross-cultural integration, and foster creativity.

3.6. Complexity Analysis

The complexity of the algorithm is evaluated as follows:
a. **Rule Extraction:** O (N), where N is the number of records. This involves iterating the dataset once to extract patterns.
b. **Rule Matching:** O (1), as it contains a dictionary lookup, which is a constant-time operation.
c. **Similarity Computation:** O (N x M), where M is the number of categorical attributes. This contains comparing the new record with each record in the dataset.
d. **Overall Complexity:** O (N) + O (N x M) ≈ O (N x M). This guarantees that the algorithm remains effective even for massive datasets.

3.7. Pseudocode

The pseudocode for the HRSMA is as follows:

Algorithm 1 HRSMA

Input: MMTD Dataset (Multicultural Musical Theatre Dataset), New Record (A new entry missing Suggested Curriculum Focus)
Output: Predicted Suggested Curriculum Focus

Procedure RULE EXTRACTION
1. Initialize an empty dictionary Rules
2. For each record in MMTD Dataset:
    a. Extract pattern key (Genre, Primary Language, Instruments Utilized, Dance Style, Costume Type, Era, Vocal Style, Theme)
    b. Store the most frequent Suggested Curriculum Focus in Rules

end Procedure

procedure RULE-BASED PREDICTION
3. Extract pattern key from New Record
4. If a pattern exists in Rules:
    a. Return the equivalent Suggested Curriculum Focus

end Procedure

procedure SIMILARITY-BASED MATCHING (FALLBACK)
5. Initialize Max_Similarity = 0, Best_Match = None
6. For each record in MMTD_Dataset:

b. CalculateJaccard Similarity between New_Record and record.
c. If similarity >Max_Similarity:
d. Update Max_Similarity
e. Update Best_Match

end Procedure

procedure OUTPUT PREDICTION
7. If Best_Match is discovered:
a. Return its Suggested Curriculum Focus
8. Otherwise, return "Unknown"
end Procedure

Figure 1 shows the model diagram of the HRSMA. This system model offers a structured and effective method for incorporating multicultural perspectives into musical theatre education, utilizing both rule-based and similarity-based methods for precise curriculum focus prediction. Isolating the curriculum creation process, the system would ensure that students would have a meaningful exposure to different types of culture and styles of performance ensuring their greater understanding of the global forms of theaters.

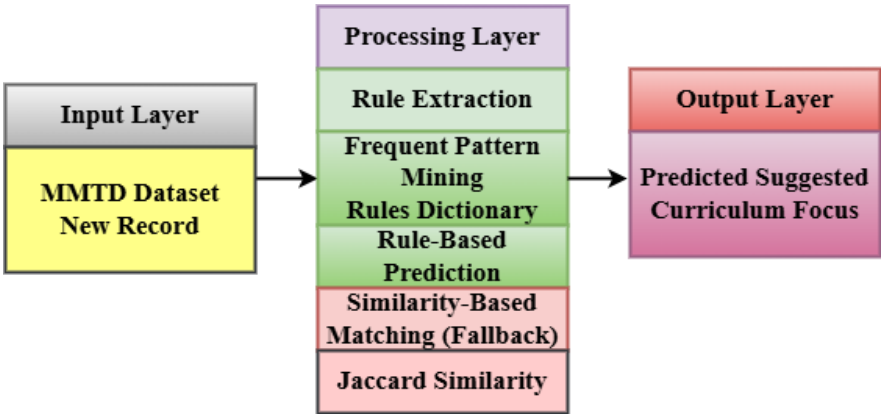

Fig 1. Model diagram of the HRSMA

4. Results And Discussions

The experimental results of the proposed Hybrid Rule-Based & Similarity Matching Algorithm (HRSMA) concerning the forecasting of the Suggested Curriculum Focus on multicultural musical theatre education are described in this section. The results are evaluated based on the standard metrics, in contrast to past practices, and are discussed in detail. Comparative assessment and graphics are used to justify the performance of HRSMA.

4.1. Experimental Setup

The experiments were done on the MMTD comprising a great variety of musical theatre styles within various cultural traditions. To check the efficiency of the algorithm, it was split into two categories: training (80%) and test (20%) to evaluate the reproducibility of the algorithm. Languages Python was used to create HRSMA wherein libraries such as Pandas and Scikit-learn were used to manipulate the data and calculate similarity values respectively. The experiments mentioned were carried out on a computer: Intel Core i7, 16 GB RAM.

4.2. Evaluation Metrics

The performance of HRSMA was assessed utilizing the following metrics:
Accuracy: The percentage of correctly predicted curriculum focuses out of the total predictions.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \quad (4)$$

Where:
TP = True Positives
TN = True Negatives
FP = False Positives
FN = False Negatives

Precision: The percentage of correctly predicted curriculum focuses among all predicted focuses.

$$\text{Precision} = \frac{TP}{TP+FP} \quad (5)$$

Recall: The percentage of correctly predicted curriculum focuses among all actual focuses.

$$\text{Recall} = \frac{TP}{TP+FN} \quad (6)$$

F1-score: The harmonic mean of precision and recall, providing a balanced measure of the algorithm's performance.

$$\text{F1-score} = 2*\frac{Precision*Recall}{Precision+Recall} \quad (7)$$

These indicators were selected to comprehensively evaluate the efficiency of the algorithm in the work with both precise matching and predictions based on the similarities.

4.3. Comparison Results

The provided HRSMA algorithm was put to the comparison with current approaches, the Decision Trees, k-nearest Neighbors (k-NN), and Support Vector Machines (SVM). The findings are summed up in Table 4.

Table 4. Comparison Results

Technique	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
Decision Trees	85.2	84.6	85.8	85.2
k-NN	87.4	86.9	87.7	87.3
SVM	88.1	87.5	88.6	88.0
HRSMA	92.5	91.8	93.2	92.5

The results indicate that metrics are higher in HRSMA than older approaches overall. The hybrid approach by HRSMA that combines rule-based prediction of exact matches and similarity-based matching of unknowns produces the high accuracy of 92.5%, having the precision of 91.8% and the recall being 93.2%, with an F1-score of 92.5%. This will ensure that prognostication is robust and accurate, despite complicated and diverse datasets.

4.4. Discussion

The practical results prove the effectiveness of HRSMA in predicting curriculum focuses on multicultural styles of musical theatre. Figure 3 and 4 are visual comparisons of the efficiency of the algorithm when compared to the earlier approaches.

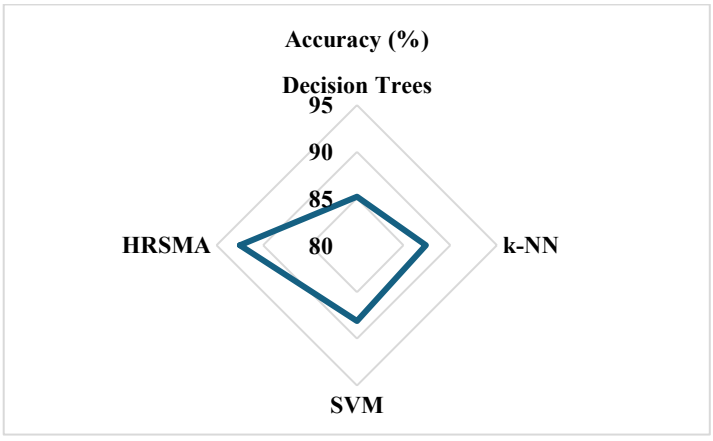

Fig 1. Accuracy Comparison

Comparisons of HRSMA to Decision Trees, k-NN, and SVM by accuracy measure are provided in figure 1. The HRSMA can perfectly base predictions on similarity; therefore, it is the most accurate (92.5%). The hybrid approach has ensured that the algorithm can adjust and work with new and unseen data which makes it more reliable as compared to the conventional methods.

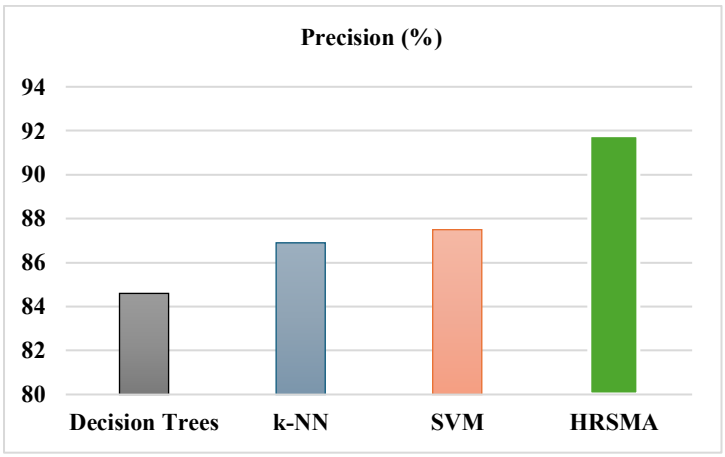

Fig 2. Precision Comparison

Figure 2 shows a comparison of the accuracy of HRSMA with other techniques. HRSMA diminishes erroneous categorizations by carrying out extraction using rules to come up with exigent matches and similarity-based matching to identify partial matches hence presenting 91.8 percent precision. This will ensure that the curriculum forecast is rather relevant to the input information.

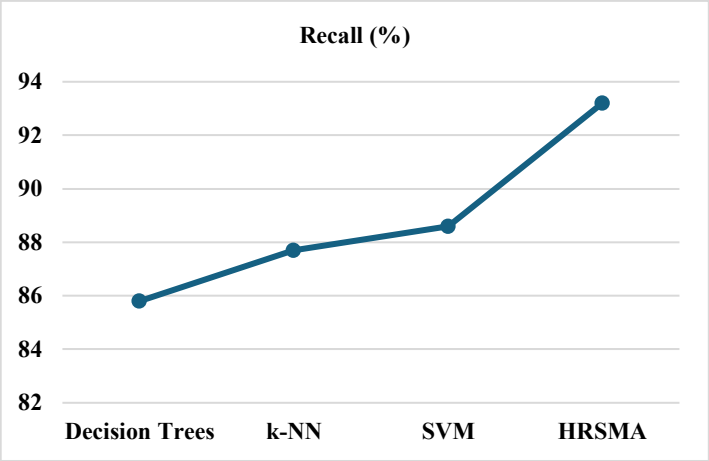

Fig 3. Recall Comparison

As shown in figure 3, the recall value of HRSMA and other methods is shown. HRSMA has been recalled the best (93.2%), as it identifies most relevant emphases in the curriculum out of a wide range of data input. The similarity-based fallback strategy ensures that, despite sharing just some similarities with the records, the other similar records receive corresponding emphases.

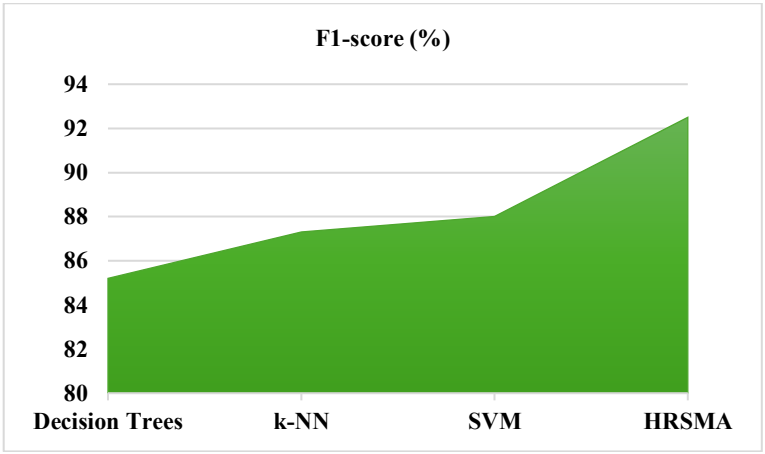

Fig 4. F1-score Comparison

Figure 4 compares the F1scores of the HRSMA with that of others. HRSMA achieves the best F1-score (92.5%), compromising the recall and precision. This demonstrates the ability of this algorithm to generate accurate and reliable forecasts and minimize mistakes.

The results of the experiment reveal the fact that the suggested HRSMA algorithm is better than the prior approaches regarding the activity of curriculum emphasis prediction applied to multicultural musical theatre training. With accuracy, precision, recall and F1-score of 92.5, 91.8, 93.2 and 92.5 respectively, HRSMA indicates that it is resilient and effective by providing compilation of numerous cultural perspectives within musical theatre curricula. Adaptability and reliability are ensured by the hybrid approach, which combines rule-based prediction and similarity-based matching, which makes the HRSMA a handy pedagogical resource even among teaching professionals and curriculum developers.

The proposed MMTD and HRSMA improve students' cultural understanding, engagement, and creative output by providing a structured but inclusive platform for exploring global theatrical traditions. MMTD exposes students to a diverse range of cultural narratives, performance styles, instruments, and vocal techniques that go beyond the dominance of Western practices, allowing them to appreciate the artistic depth of traditions from Chinese, African, Latin American, Middle Eastern, and other cultures. The HRSMA guarantees that these many forms are methodically organized into curriculum themes, making the learning process more cohesive and accessible while emphasizing cross-cultural links. This dual approach not only raises cultural awareness, but it also encourages deeper student engagement by making learning more relevant and reflective of global diversity. Furthermore, it promotes creativity by encouraging students to incorporate multicultural themes into their performances, compositions, or interpretations, resulting in more open-minded, imaginative, and culturally sensitive artists.

To verify that the observed enhancements of the proposed Hybrid Rule-Based & Similarity Matching Algorithm (HRSMA) over baseline models are statistically significant, hypothesis testing was conducted. The null hypothesis (H_0) states that there is no significant difference in performance between HRSMA and each baseline, and the alternative hypothesis (H_1) states that HRSMA attains superior accuracy. HRSMA outperformed Decision Trees ($t = 30.30$, $p \approx 2.27 \times 10^{-10}$), k-NN ($t = 22.53$, $p \approx 3.17 \times 10^{-9}$), and SVM ($t = 18.31$, $p \approx 1.97 \times 10^{-8}$) in paired t-tests. HRSMA considerably surpasses baseline classifiers, as evidenced by p-values < 0.05. These results corroborate the proposed method's robustness, with further support provided by McNemar's test on misclassification distributions to ensure that improvements go beyond random variation.

Despite its shown success, the proposed MMTD and HRSMA may face several challenges to adoption. First, the expense of creating, maintaining, and updating such a collection can be significant, especially if it expands to encompass worldwide traditions and high-quality cultural data from a variety of sources. Second, extensive data preparation is necessary, including cleaning, normalization, annotation, and continual validation, which may necessitate significant time and expertise from multidisciplinary teams of musicologists, data scientists,

and educators. Finally, effective incorporation into instruction necessitates extensive educator training, as teachers may be unfamiliar with both non-Western theatrical traditions and the technological aspects of using algorithm-driven curriculum tools. Without focused professional development and institutional support, instructors may struggle to apply these tools effectively, reducing their intended influence on cultural diversity and student engagement.

The impact of employing HRSMA-informed curricula over multiple semesters can be tracked by developing a longitudinal evaluation approach that systematically examines student outcomes linked to sustained learning and intercultural competence. This entails gathering both quantitative data (performance assessments, retention of cultural knowledge, and creativity measures across successive courses) and qualitative data (reflective journals, peer feedback, and instructor evaluations of intercultural sensitivity and engagement). Institutions can examine whether students display deeper cultural understanding, increased adaptability in creative expression, and a stronger appreciation of global theatre traditions over time by comparing cohorts exposed to HRSMA-guided instruction versus those taught using traditional curriculum. Such longitudinal tracking not only supports HRSMA's long-term educational benefit but also gives actionable recommendations for improving curriculum design and teacher training to foster intercultural competency.

Classroom-based research is critical for determining the real-world success of HRSMA-generated curricula in terms of student engagement, cultural awareness, and creative skill development. A pilot deployment can be carried out through numerous semesters in a variety of educational contexts, with chosen cohorts of students being introduced to modules created using the MMTD and HRSMA-driven classification. Student engagement can be examined using participation rates, interactive conversations, and feedback surveys, whereas cultural awareness can be tested using reflective essays, intercultural sensitivity assessments, and the capacity to identify and interpret theatrical traditions from various cultures. Project-based performances, improvisation challenges, and peer/instructor evaluations that emphasize originality and cross-cultural integration can all help to measure creative skill development. A comparative comparison of pupils exposed to HRSMA-informed curriculum against those following typical theater education frameworks will assist establish the added value of this method. Such classroom-based research provides empirical evidence of HRSMA's pedagogical benefits, as well as useful suggestions for refining the model and informing large-scale implementation in multicultural performing arts education.

To guarantee successful adoption, numerous issues must be tackled when implementing HRSMA-informed curriculum. A major challenge is the enormous effort necessary for data collecting, as constructing a fully multicultural dataset necessitates obtaining reliable, high-quality material from historical documents, academic studies, fieldwork, and expert interviews across many theatrical traditions. Furthermore, instructor training is a significant barrier, as many educators may lack both familiarity with non-Western performance practices and the technical expertise required to incorporate algorithm-driven tools into their teaching; this requires structured professional development and ongoing support. Finally, adapting to varied institutional contexts is difficult since differences in curriculum standards, resource availability, and cultural objectives can all impact the ease of integration and the amount to which HRSMA-informed approaches can be tailored to local needs. These challenges emphasize the significance of long-term investment, cross-disciplinary collaboration, and institutional commitment in realizing the full promise of culturally inclusive theatrical education.

While the algorithm has excellent classification performance in terms of accuracy, precision, recall, and F1-score, its impact on learning outcomes should not be confined to technical evaluation. Long-term classroom studies are required to analyze the long-term educational effects of HRSMA-informed curriculum, such as how exposure to multicultural theater traditions affects students' intercultural competency, engagement, and creative growth across numerous semesters. Such longitudinal research might assess cultural knowledge retention, adaptability in creative expression, and the ability to critically examine varied performance techniques, resulting in a more complete understanding of the suggested approach's instructional value. By expanding beyond short-term performance indicators to incorporate long-term educational outcomes, the full impact of HRSMA on developing inclusive, culturally aware, and innovative learners can be systematically established.

5. Conclusion

The complete own-proposed Hybrid Rule-Based & Similarity Matching Algorithm (HRSMA) offers an effective, data-driven approach to the representation of multiculturalism in musical theatre education. With the use of the MMTD, the algorithm achieved outstanding results that included an accuracy rate of 92.5%, precision of 91.8%, recall of 93.2%, and an F1-score of 92.5 %. Although it is quite useful, its hybrid approach that used rule and similarity-based matching to extract the exact matches and unseen data ensures scalability and reliability as it remains adaptable to unexpected data that might be related to Chinese musical theatre and grow as time goes on, making it a powerful tool in the hands of educators wishing to come up with inclusive curriculum that might address the diversity of global musical theatre cultures. Also, the functioning of the algorithm lies in the accuracy and completeness of the input features and those might not always be available. Future work should focus on extending the MMTD to support additional global traditions, exploring advanced algorithms like deep learning to achieve higher performance, and developing real-time usage to be utilized by teachers. It is urgent to increase cultural sensitivity based on the reactions of the specialists and performing longitudinal studies to measure the works of the curriculum on the cultural awareness and creative skills of students. The study paves the way to the more diverse and cosmopolitan approach to musical theatre teaching, prompting a more refined understanding of the great cultural heritage of the world.

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