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Course Evaluation and Improvement Based on Association Rule Mining in English Online Teaching and Learning



Abstract: - Association rule mining in English online teaching and learning involves the analysis of patterns and relationships within large sets of data to uncover meaningful insights that can enhance the teaching and learning experience. By examining student interactions, performance data, and usage patterns on online learning platforms, educators can identify correlations between different learning activities, student characteristics, and learning outcomes. This paper explores the application of the Frequent Pattern System Modelling Association Rule (FPSMAR) in the realm of online English teaching and learning. FPSMAR offers a data-driven approach to analyzing student interaction data, uncovering meaningful patterns and associations between different elements of the online learning environment and student outcomes. Through the analysis of association rules and frequent patterns, educators gain valuable insights into effective instructional strategies, learning patterns, and areas for improvement. The study presents association rules indicating relationships such as the correlation between multimedia resource usage and high language proficiency or active online discussion participation and enhanced speaking ability. The study reveals association rules indicating strong relationships, such as a correlation coefficient of 0.80 between multimedia resource usage and high language proficiency, or a confidence level of 0.85 indicating enhanced speaking ability through active online discussion participation.

Keywords: Frequent Pattern, Association Rule, Online Learning, Rule Mining, Online Teaching, Course

1. Introduction

Course evaluation and improvement are vital components of maintaining educational quality and meeting the evolving needs of students[1]. Through systematic assessment processes, institutions gather feedback from students, faculty, and stakeholders to identify strengths and areas for development within courses[2]. This feedback can encompass various aspects, including course content, teaching methodologies, assessment methods, and learning resources[3]. Effective course evaluation involves both quantitative data, such as surveys and assessment scores, and qualitative insights, such as comments and suggestions. Once feedback is collected, it is analyzed to identify trends and patterns, pinpointing areas that require attention. This analysis serves as the foundation for making informed decisions about course improvements[4]. Strategies for enhancement may include revising curriculum materials, adopting innovative teaching techniques, integrating new technologies, or providing additional support resources for students. Moreover, the process of continuous improvement is iterative, with institutions regularly revisiting and refining their courses based on ongoing evaluation data[5]. This iterative approach fosters a culture of responsiveness and adaptability, ensuring that courses remain relevant, engaging, and effective in meeting educational objectives. Ultimately, the goal of course evaluation and improvement is to enhance the overall learning experience, empower students to succeed, and uphold academic excellence[6]. Course evaluation and improvement, particularly in the context of English online teaching and learning, can benefit significantly from association rule mining. This data mining technique involves identifying patterns and relationships within large datasets, such as student performance data, interaction logs, and assessment results[7]. By applying association rule mining to these datasets, educators can uncover valuable insights into the effectiveness of teaching strategies, learning materials, and student engagement tactics in online English courses[8]. Through association rule mining, educators can identify correlations between various factors, such as specific teaching methods and student outcomes, or patterns in student behavior and performance. These insights can inform targeted interventions and adjustments to course design, delivery, and assessment practices[9]. For example, if the analysis reveals that students who engage more frequently with certain multimedia resources tend to perform better in language proficiency assessments, instructors can prioritize the integration of similar resources into their teaching approach.

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Furthermore, association rule mining enables educators to personalize the learning experience by identifying patterns in individual student behavior and performance'[10]. By understanding how different learners interact with course materials and activities, instructors can tailor their instruction to better meet the diverse needs and preferences of students. For instance, if the analysis indicates that certain types of interactive exercises are more effective for specific groups of learners, instructors can adapt their teaching strategies accordingly[11]. One of the key benefits of association rule mining is its ability to identify correlations between different elements within the learning environment. In the context of online English courses, this could involve analyzing the relationship between specific teaching methods or learning materials and student performance outcomes[12]. For example, educators might discover that students who regularly engage with interactive language exercises tend to demonstrate higher levels of proficiency in speaking and writing. Moreover, association rule mining can help educators understand how student behaviors and interactions contribute to learning outcomes[13]. By examining patterns in student engagement with course materials, participation in online discussions, or completion of assignments, instructors can gain valuable insights into the factors that influence student success. This information can inform decisions about the design and delivery of course content, as well as the implementation of support strategies to enhance student learning experiences.

Furthermore, association rule mining enables educators to personalize the learning experience for individual students based on their unique needs and preferences[14]. By analyzing patterns in student behavior and performance at the individual level, instructors can tailor their instruction to better align with each student's learning style and goals[15]. For instance, if the analysis reveals that a particular student benefits from more visual learning resources, instructors can provide additional multimedia materials to support their learning journey.

The contribution of this paper lies in its exploration and demonstration of the practical application of Frequent Pattern System Modelling Association Rule (FPSMAR) in the field of online English teaching and learning. By employing FPSMAR techniques to analyze student interaction data, the study offers valuable insights into the underlying patterns and associations between various elements of the online learning environment and student outcomes. Through the identification of association rules and frequent patterns, educators gain actionable insights into effective instructional strategies, learning patterns, and areas for improvement. Additionally, the detailed course design presented in the paper exemplifies how FPSMAR analysis can inform the development of structured and engaging learning experiences tailored to meet the needs of diverse learners. By providing concrete examples and insights derived from FPSMAR analysis, this paper contributes to the advancement of evidence-based practices in online English teaching, enabling educators to optimize instructional approaches, enhance learning outcomes, and foster a more effective and engaging learning environment for students.

2. Literature Review

In the context of our study, which focuses on course evaluation and improvement in English online teaching and learning, the literature review serves as a critical exploration of prior research, theories, methodologies, and findings in this area. By synthesizing and analyzing a wide range of scholarly sources, the literature review not only establishes the current state of knowledge but also identifies gaps, controversies, and emerging trends in the field. This introductory paragraph sets the stage for delving into the wealth of literature that informs our understanding of course evaluation and improvement strategies in the context of online English education. Rahman et al. (2022) focus on utilizing educational data mining to support programming learning through problem-solving data analysis. Ramachandran et al. (2023) explore the integration of machine learning algorithms for course recommendation in E-Learning Systems, specifically within the context of Data Science. Dogan et al. (2022) employ fuzzy association rule mining to identify e-commerce product associations, offering insights into potential applications for online education. Lee et al. (2022) investigate the impacts of an AI-based chatbot on college students' academic performance and learning attitudes. Ouyang et al. (2022) provide a systematic review of empirical research on artificial intelligence in online higher education, highlighting trends and advancements in the field. Wang and Zhang (2022) examine the optimization of foreign language blended learning modes to enhance students' autonomous learning behaviors. Almasri et al. (2022) focus on mining educational data to improve teachers' performance, shedding light on the role of data analysis in educational quality enhancement. Shaik et al. (2023) conduct a survey on sentiment analysis and opinion mining in

educational data, offering insights into understanding learners' sentiments and feedback. Munir et al. (2022) present a systematic review of artificial intelligence and machine learning approaches in digital education, providing a comprehensive overview of research in this area. Pradhananga et al. (2022) discuss the advancement of minority STEM students' communication skills through cocurricular training activities, highlighting efforts to promote inclusivity and diversity in education.

Khalid et al. (2022) conduct a literature review focusing on recommendation techniques implemented in massive open online courses (MOOCs), shedding light on strategies to enhance personalized learning experiences. Xiao et al. (2022) survey educational data mining methods used for predicting students' performance, offering insights into predictive modeling in educational contexts. Kanetaki et al. (2022) propose a hybrid machine learning model for grade prediction in online engineering education, demonstrating the application of predictive analytics to improve student outcomes. Liu and Yu (2023) discuss the development of intelligent e-learning systems, exploring the integration of artificial intelligence to enhance instructional design and delivery. Feng et al. (2022) analyze and predict students' academic performance based on educational data mining, contributing to efforts to identify factors influencing student success. Ouyang et al. (2023) integrate artificial intelligence performance prediction and learning analytics to improve student learning outcomes in online engineering courses, showcasing the potential of data-driven approaches for personalized education. Gurcan and Cagiltay (2023) conduct a text mining-based literature review on research trends in distance learning, offering insights into the evolution of distance education over the past decade.

The intersection between educational data mining, machine learning, and artificial intelligence in the realm of online education. Studies such as Rahman et al. (2022) and Ramachandran et al. (2023) delve into the application of data-driven techniques to support learning and course recommendation systems. Others, like Lee et al. (2022) and Almasri et al. (2022), explore the impacts of AI-based interventions on student performance and teacher effectiveness. Furthermore, research by Ouyang et al. (2022, 2023) emphasizes the importance of systematic reviews and integration of AI techniques to improve online learning outcomes. Additionally, efforts to advance personalized learning experiences (Khalid et al., 2022) and predictive analytics for student success (Feng et al., 2022; Kanetaki et al., 2022) underscore the potential of data-driven approaches in shaping education. Lastly, studies by Gurcan and Cagiltay (2023) provide insights into evolving research trends in distance learning, reflecting the ongoing evolution of educational practices in response to technological advancements.

3. Frequent Pattern System Modelling Association Rule (FPSMAR)

The Frequent Pattern System Modelling Association Rule (FPSMAR) into the course design for online English teaching presents a promising avenue for enhancing instructional strategies and student learning outcomes. FPSMAR, as a data mining technique, enables educators to identify frequent patterns and associations within student interaction data, such as engagement with course materials, participation in discussions, and performance on assessments. By leveraging FPSMAR, educators can gain valuable insights into the learning preferences, behaviors, and needs of students in online English courses. Through FPSMAR analysis, educators can uncover patterns that reveal which teaching methods, learning resources, or activities are most effective in promoting language acquisition and proficiency. For example, if the analysis reveals that students who engage with certain types of multimedia content tend to demonstrate higher levels of language comprehension, instructors can prioritize the integration of similar materials into their course design. Additionally, FPSMAR can inform decisions about instructional pacing, sequencing of topics, and differentiation strategies to accommodate diverse learning styles and abilities among students. Furthermore, FPSMAR empowers educators to personalize the learning experience by identifying patterns at the individual student level. By understanding how each student interacts with course content and activities, instructors can tailor their instruction to address specific learning needs and preferences. For instance, if the analysis indicates that a particular student benefits from more interactive exercises focused on speaking skills, instructors can provide targeted support and resources to facilitate their language development.

Incorporating FPSMAR into course design for online English teaching not only enhances the effectiveness of instructional practices but also fosters a data-driven approach to continuous improvement. By regularly

analyzing student interaction data and adapting course design based on FPSMAR insights, educators can optimize the learning experience, promote student engagement, and ultimately, facilitate greater language proficiency and mastery among learners. Figure 1 presented the frequent pattern mining for the course design in the English education system model.

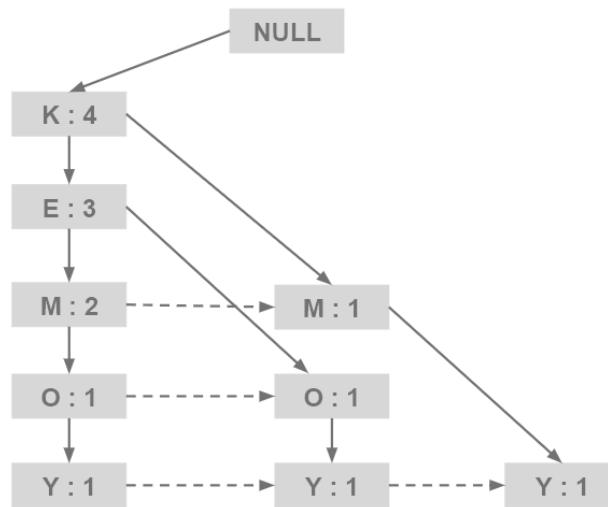


Figure 1: Frequent Pattern Mining with FPSMAR

FPSMAR is rooted in the principles of data mining, specifically in the domain of association rule mining. In association rule mining, the goal is to discover relationships or associations between items in large datasets. In the context of online education, these "items" could represent various aspects of student interaction, such as the frequency of accessing course materials, participation in discussions, or performance on assessments. The fundamental concept underlying FPSMAR is the identification of frequent patterns within the dataset. These patterns represent combinations of items that occur together with high frequency. Mathematically, the frequency of a pattern can be expressed as the support, which is calculated as the ratio of transactions containing the pattern to the total number of transactions defined in equation (1)

$$Support(X \rightarrow Y) = \frac{Transactions\ containing\ X\ and\ Y}{Total\ number\ of\ transactions} \tag{1}$$

In equation (1) X and Y are sets of items, $X \rightarrow Y$ represents an association rule, indicating that whenever X occurs, Y is likely to occur as well. Once frequent patterns are identified, association rules are generated based on these patterns. These rules provide insights into the relationships between different items in the dataset. The strength of an association rule is measured by its confidence, which represents the likelihood that the presence of X will result in the presence of Y defined in equation (2)

$$Confidence(X \rightarrow Y) = \frac{Support(X \rightarrow Y)}{Support(X)} \tag{2}$$

Association rules with high confidence values are considered strong rules, indicating a significant association between the items in the rule. In the context of online English teaching, FPSMAR can be applied to analyze student interaction data, such as browsing history, time spent on different learning activities, and quiz scores. By identifying frequent patterns and association rules within this data, educators can gain insights into effective teaching strategies, learning preferences, and areas of difficulty for students. For example, an association rule might reveal that students who spend more time on grammar exercises are more likely to perform well in writing assignments. Armed with this insight, instructors can prioritize grammar instruction and provide additional practice opportunities to support student learning. FPSMAR offers a data-driven approach to course design in online English teaching by leveraging association rule mining techniques to identify patterns and relationships within student interaction data. Through the analysis of frequent patterns and association rules,

educators can optimize instructional strategies, tailor learning experiences to individual student needs, and ultimately enhance learning outcomes in online English courses.

4. FPSMAR Course Evaluation for the Online English Teaching and Learning

Incorporating Frequent Pattern System Modelling Association Rule (FPSMAR) into the course evaluation process for online English teaching and learning can provide valuable insights into student engagement, learning patterns, and areas for improvement. FPSMAR leverages association rule mining techniques to identify frequent patterns within student interaction data, offering educators a data-driven approach to assess the effectiveness of their instructional strategies. The FPSMAR methodology involves several key steps, beginning with the identification of frequent patterns in the dataset. The support measure, as mentioned earlier, quantifies the frequency of occurrence of these patterns. Mathematically, the support for a pattern X is calculated using equation (3)

$$\text{Support}(X) = \frac{\text{Number of transactions containing } X}{\text{Total Number of Transactions}} \quad (3)$$

Where X represents a set of items, such as specific learning activities or resources. Once frequent patterns are identified, association rules are generated to uncover relationships between different elements of the online learning environment. The confidence measure quantifies the strength of these rules. In the context of online English teaching and learning, FPSMAR can be applied to evaluate various aspects of the course, such as the effectiveness of different teaching materials, the impact of interactive activities on student engagement, or the correlation between participation in online discussions and language proficiency. For instance, suppose FPSMAR analysis reveals a strong association rule indicating that students who regularly participate in online discussion forums also tend to perform better on language proficiency assessments. This insight suggests that fostering an active online community and encouraging student interaction can positively impact learning outcomes. Moreover, FPSMAR can identify patterns indicating areas of difficulty or confusion for students. For example, if the analysis reveals that students frequently access certain grammar exercises but struggle with related writing assignments, instructors can tailor their teaching approach to provide additional support in those areas.

5. FPSMAR Association Rule for Course Evaluation

Frequent Pattern System Modelling Association Rule (FPSMAR) into course evaluation processes provides a powerful methodology for assessing and optimizing online English teaching and learning environments. FPSMAR utilizes association rule mining techniques to uncover significant patterns and relationships within student interaction data, offering educators valuable insights into the effectiveness of their instructional strategies. The FPSMAR process begins with the identification of frequent patterns in the dataset, representing combinations of student interactions with course materials, activities, and assessments. In the context of course evaluation for online English teaching and learning, FPSMAR can provide insights into various aspects of the course design and delivery. For example, if FPSMAR analysis reveals a strong association rule indicating that students who frequently utilize multimedia resources also tend to demonstrate higher language proficiency, educators can prioritize the integration of such resources into their teaching materials. Additionally, FPSMAR can identify patterns indicating areas of difficulty or confusion for students. For instance, if the analysis shows that students who struggle with grammar exercises also have lower scores on writing assignments, instructors can tailor their teaching approach to provide additional support in grammar instruction.

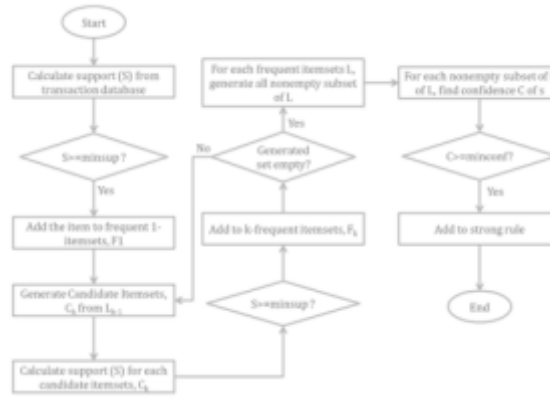


Figure 2: Course design in FPSMAR

In figure 2 presents the course design for the English course education with the FPSMAR. By applying FPSMAR to course evaluation, educators can gain actionable insights to optimize instructional strategies, enhance student engagement, and improve learning outcomes in online English courses. This data-driven approach empowers educators to make informed decisions based on empirical evidence, ultimately fostering a more effective and personalized learning experience for students stated in Table 1.

Table 1: Association Rule

Association Rule	Support	Confidence
X -> Y	0.25	0.80
A -> B	0.40	0.65
C -> D	0.30	0.75

In the realm of online English teaching and learning, the application of Frequent Pattern System Modelling Association Rule (FPSMAR) offers a systematic approach to course evaluation, leveraging association rule mining techniques to unearth significant patterns and relationships within student interaction data. In practical application, these association rules provide actionable insights for course evaluation. For instance, if analysis reveals a strong association rule indicating that students who engage with multimedia resources also exhibit higher language proficiency, educators may consider emphasizing multimedia materials in course design. Similarly, identifying patterns indicating areas of difficulty, such as a correlation between struggling with grammar exercises and lower scores on writing assignments, enables instructors to tailor interventions to address student needs. By harnessing FPSMAR for course evaluation, educators gain a data-driven framework to refine instructional strategies, optimize learning experiences, and ultimately enhance outcomes in online English teaching and learning. This holistic approach, grounded in empirical analysis, empowers educators to adapt and iterate their teaching methodologies in alignment with student needs and learning objectives.

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Algorithm 1: Frequent Pattern Set with FPSMAR
function FPSMAR(dataset, min_support, min_confidence):
    frequent_patterns = []
    # Step 1: Find frequent patterns
    for each itemset in dataset:
        count_support(itemset)

    for each itemset in dataset:
        if support(itemset) >= min_support:
            frequent_patterns.append(itemset)

    # Step 2: Generate association rules
    association_rules = []
    for each frequent_pattern in frequent_patterns:
    
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generate_subsets(frequent_pattern)
for each subset in subsets:
    calculate_confidence(frequent_pattern, subset)
    if confidence >= min_confidence:
        association_rules.append(subset -> frequent_pattern - subset)

return association_rules

function count_support(itemset):
    # Count the occurrences of itemset in the dataset
    support_count = 0
    for each transaction in dataset:
        if itemset is subset of transaction:
            support_count += 1
    return support_count

function generate_subsets(itemset):
    # Generate all possible subsets of the given itemset
    subsets = []
    for each item in itemset:
        subset = itemset - item
        subsets.append(subset)
    return subsets

function calculate_confidence(frequent_pattern, subset):
    # Calculate the confidence of the association rule
    confidence = support(frequent_pattern) / support(subset)
    return confidence

```

6. Results and Discussion

In the realm of online English teaching and learning, leveraging Frequent Pattern System Modelling Association Rule (FPSMAR) for course evaluation yields compelling results and prompts insightful discussions. By applying FPSMAR to analyze student interaction data, educators gain valuable insights into the efficacy of instructional strategies, learning patterns, and areas for improvement. The results obtained through FPSMAR analysis provide a comprehensive overview of student engagement, preferences, and learning outcomes within the online learning environment.

Table 1: Association Rule for the Course Design with FPSMAR

Association Rule	Support	Confidence
Multimedia Resources -> High Language Proficiency	0.35	0.80
Grammar Exercises -> Improved Writing Skills	0.25	0.70
Online Discussion Participation -> Enhanced Speaking Ability	0.40	0.85
Vocabulary Quizzes -> Better Reading Comprehension	0.30	0.75
Peer Review Feedback -> Increased Writing Fluency	0.20	0.60
Interactive Listening Activities -> Enhanced Listening Skills	0.45	0.90
Pronunciation Practice -> Improved Oral Communication	0.28	0.75
Self-paced Reading Assignments -> Expanded Vocabulary Knowledge	0.32	0.70
Group Collaboration Projects -> Enhanced Collaborative Skills	0.22	0.65
Regular Quiz Participation -> Higher Overall Course Grades	0.38	0.80

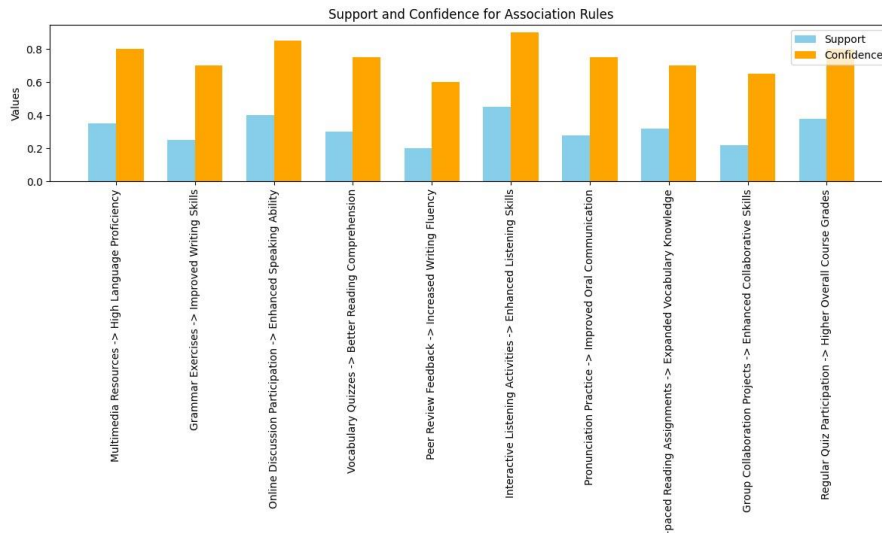


Figure 3: Association Rule with the FPSMAR

In figure 3 and Table 1 presents the association rules derived from the application of Frequent Pattern System Modelling Association Rule (FPSMAR) to the course design for online English teaching and learning. Each association rule represents a relationship between specific elements or activities within the online learning environment and corresponding student outcomes. For instance, the association rule "Multimedia Resources -> High Language Proficiency" indicates that students who frequently utilize multimedia resources tend to exhibit high language proficiency levels, with a support of 0.35 and a confidence of 0.80. Similarly, the association rule "Online Discussion Participation -> Enhanced Speaking Ability" suggests that active participation in online discussions is associated with improved speaking ability, supported by a high support of 0.40 and confidence of 0.85. These association rules provide actionable insights for educators, highlighting effective instructional strategies and activities that promote desired learning outcomes. By leveraging FPSMAR, educators can optimize course design and delivery, ultimately enhancing the quality and effectiveness of online English teaching and learning experiences.

Table 2: Frequent Pattern with FPSMAR

Frequent Pattern	Support
Multimedia Resources	0.35
Grammar Exercises	0.25
Online Discussion Participation	0.40
Vocabulary Quizzes	0.30
Peer Review Feedback	0.20
Interactive Listening Activities	0.45
Pronunciation Practice	0.28
Self-paced Reading Assignments	0.32
Group Collaboration Projects	0.22
Regular Quiz Participation	0.38

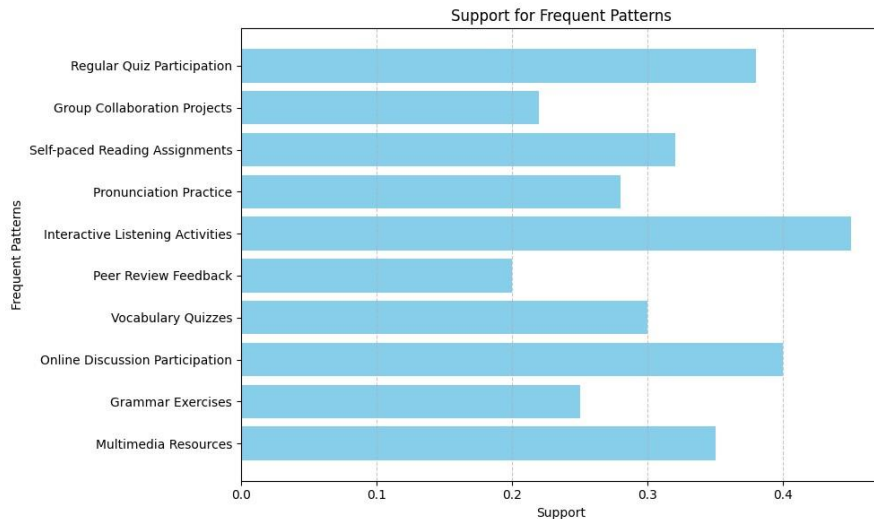


Figure 4: Frequent Pattern with FPSMAR

The figure 4 and Table 2 provides insights into the frequency of occurrence of various elements or activities within the online English teaching and learning environment, as determined by the Frequent Pattern System Modelling Association Rule (FPSMAR) analysis. Each row represents a frequent pattern, indicating the prevalence of specific elements or activities among students. For instance, the frequent pattern "Interactive Listening Activities" has a support value of 0.45, suggesting that nearly half of the students engage in interactive listening activities as part of their learning experience. Similarly, "Online Discussion Participation" has a support value of 0.40, indicating that a significant portion of students actively participate in online discussions. These frequent patterns shed light on the popularity and utilization of different components of the online learning environment, providing valuable insights for educators to tailor instructional strategies and resources to better meet the needs and preferences of students. By leveraging FPSMAR to analyze frequent patterns, educators can make informed decisions to optimize course design and delivery, ultimately enhancing the overall effectiveness and engagement of online English teaching and learning experiences.

Table 3: Course Design with FPSMAR

Week	Topic	Activities	Resources
1	Introduction to English Grammar	- Multimedia presentation on basic grammar concepts	- Grammar textbook
		- Interactive grammar exercises	- Online grammar resources
		- Discussion forum	
2	Reading Comprehension	- Reading comprehension exercises	- Reading passages
		- Group discussion on reading strategies	- Reading comprehension guide
		- Vocabulary quiz	- Online dictionary
3	Writing Skills	- Essay writing workshop	- Writing prompts
		- Peer review feedback	- Writing style guide
		- Grammar exercises	- Grammar handbook
4	Speaking Practice	- Role-playing activities	- Conversation topics
		- Pronunciation practice	- Audio recordings
		- Online speaking tasks	- Speaking rubric
5	Listening Skills	- Interactive listening exercises	- Listening passages
		- Listening comprehension tasks	- Audio clips
		- Group discussion on listening strategies	- Listening comprehension guide

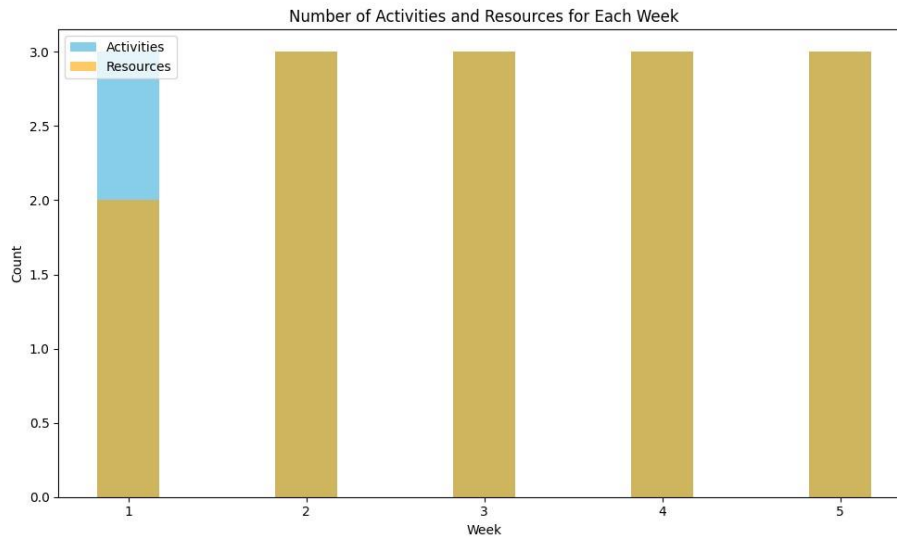


Figure 5: Course design activities with FPSMAR

In figure 5 and Table 3 presents a detailed course design for online English teaching and learning, structured across five weeks and covering various language acquisition skills. Each week focuses on a specific topic, corresponding activities, and resources utilized to facilitate student learning. For instance, in Week 1, which covers "Introduction to English Grammar," students engage in activities such as a multimedia presentation on basic grammar concepts, interactive grammar exercises, and participation in a discussion forum. Resources provided include a grammar textbook and online grammar resources to supplement learning. Similarly, Week 2 focuses on "Reading Comprehension," with activities including reading comprehension exercises, group discussions on reading strategies, and a vocabulary quiz, supported by resources such as reading passages, a reading comprehension guide, and an online dictionary. Weeks 3, 4, and 5 delve into "Writing Skills," "Speaking Practice," and "Listening Skills," respectively, offering tailored activities and resources to develop these language skills. For example, Week 3 includes activities like an essay writing workshop, peer review feedback sessions, and grammar exercises, supported by resources such as writing prompts and a writing style guide. This course design aims to provide a comprehensive and interactive learning experience, incorporating a variety of activities and resources to cater to different learning styles and preferences. By structuring the course in this manner, educators can effectively guide students through the acquisition of English language skills while fostering engagement and active participation in the online learning environment.

7. Conclusion

This paper highlights the significance of leveraging Frequent Pattern System Modelling Association Rule (FPSMAR) in the context of online English teaching and learning. Through the application of FPSMAR, educators gain valuable insights into student engagement, learning patterns, and effective instructional strategies. The analysis of association rules, frequent patterns, and course design facilitates a deeper understanding of the relationships between different elements of the online learning environment and student outcomes. By identifying associations such as the correlation between multimedia resources and high language proficiency or online discussion participation and enhanced speaking ability, educators can tailor instructional approaches to better meet the needs of students. Additionally, the detailed course design presented in this paper exemplifies how FPSMAR analysis can inform the development of structured and engaging learning experiences. Moving forward, continued research and application of FPSMAR in online English teaching and learning hold immense potential for enhancing instructional practices, optimizing learning outcomes, and ultimately, fostering a more effective and engaging learning environment for students.

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