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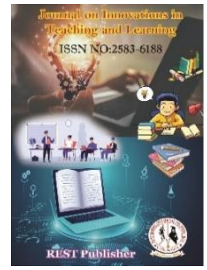

The Development of Pedagogical Tasks and Evaluation of Computer Mediated Communication for Using GRA Method

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Abstract: *In the ever-evolving realm of education, the incorporation of technology into teaching methodologies has become imperative. This investigation delves into the creation of instructional assignments and the assessment of computer-mediated communication (CMC) within the framework of the Group Research and Analysis (GRA) method. The GRA method, renowned for fostering critical thinking, problem-solving skills, and collaborative teamwork among students, is the focal point of this research. Nonetheless, there exists a gap in knowledge regarding its effective implementation in a technologically-enhanced setting. This research aims to address this knowledge gap by pursuing two primary objectives: firstly, designing and formulating pedagogical tasks tailored to harness the advantages of CMC while implementing the GRA method, and secondly, evaluating the efficacy of these tasks in enhancing students' educational experiences and achievements. The development of these pedagogical tasks necessitates a comprehensive examination of existing literature on both the GRA method and CMC tools. These tasks are designed to make the most of the collaborative and communicative capabilities offered by digital platforms, thereby enhancing group dynamics, information sharing, and knowledge construction. The evaluation stage employs a mixed-methods approach, including quantitative assessments of student performance and qualitative analyses of their experiences and perspectives. This research contributes to the dynamic field of educational technology and pedagogy by shedding light on the potential synergy between the GRA method and CMC. The insights gained from this study will benefit educators, instructional designers, and policymakers by demonstrating the value of incorporating technology into collaborative learning environments. It will also provide evidence-based guidance for optimizing the GRA method in the digital era. Ultimately, this research aims to advance our comprehension of how technology can enhance pedagogical methods, ultimately benefiting students and their educational outcomes. Virtual Peer Discussion (A1), Synchronous Online Quizzes (A2), Collaborative Document Creation (A3), Asynchronous Discussion Forums (A4), Video-based Concept Explanation (A5), Individual Reflective Journals (A6), Debate-style Online Sessions (A7), Case Study Analysis in Groups (A8), Simulated Real-world Scenarios (A9) and Role-playing Activities (A10) there are alternatives. Enhancement of Learning Outcomes (E1), Engagement and Participation (E2), Critical Thinking Development (E3), Technical Accessibility (E4), Workload Manageability (E5) and Peer Interaction Quality (E6) there are evaluation parameter. According to GRA methods are Asynchronous Discussion Forums is first ranked and with Virtual Peer Discussion being lowest ranked.*

1. INTRODUCTION

The evolving relationship between technological advancements and their impact on society leads us to reevaluate how we conceptualize, theorize, and investigate technology, mediation, and communication. Over the past 25 years, the central question in this field has shifted from "what constitutes computer-mediated communication?" to "what doesn't?" In 1994, personal computers were bulky and stationary, the internet was still gaining traction, and text-based platforms like Usenet and Internet Relay Chat (IRC) were prevalent. Email was considered cutting-edge, and online social networking and SMS had yet to emerge. Today, out of the 7.7 billion people worldwide, 4.33 billion actively use the internet, 5.14 billion are connected via mobile devices through over 9 billion subscriptions, and 3.5 billion engage in social media. American adults now spend more than 11 hours daily interacting with various computerized media. In essence, the technological landscape has undergone a profound transformation. With virtually all social activities now potentially mediated by various computing technologies, we face the question of what should be the focal point of research in computer-mediated communication (CMC). How can we theorize and study digitally-mediated communication when the objects of our study—the technology, the concepts of mediation, our understanding of communication, and the methodologies employed—are all undergoing significant changes? In spring 2018, the Journal of Computer-Mediated Communication invited scholars to submit proposals for a dedicated issue to address these questions. We received 82 proposals, spanning diverse theoretical frameworks, research approaches, and a wide range of topics across social and behavioral research. We contend that the way visibility operates in modern Computer-Mediated Communication (CMC), where individuals have a multitude of choices for presenting and accessing communication and where communication is readily visible to third parties and unintended recipients, hints at significant shifts in how meaning is conveyed and generated through communication. Our current theories of CMC struggle to adequately address the complex dimensions of communication visibility. They mainly build upon or modify traditional models of interpersonal and mass communication. To address this gap, we propose a three-dimensional framework for a theory of communication visibility. This theoretical perspective revolves around three key aspects regarding the interplay between visibility and CMC. Communication visibility serves as the foundational feature, or the potential for action, in CMC. CMC stands apart from other communication modes by making communication instantly visible across time and locations to both immediate audiences and third parties. An individual's capacity to influence or control the visibility of communication arises from the social context in which CMC is employed, known as the sociometric context. Although there are social phenomena exclusive to the online realm, our research has revealed a scarcity of research topics that warrant confining the scope solely to online phenomena. Consequently, while some scholars may view the examination of websites or computer-mediated communication (CMC) as a convenient method for data collection, it is generally advisable to define the study's setting to encompass relevant offline aspects of the social sphere in addition to CMC. Instead of pre-determining the need to conduct an ethnography of an online community or site, the ethnographer should first select their area of interest and subsequently determine the field based on whether and how that subject incorporates various modes of communication or technological contexts. The second primary argument revolves around the idea that, despite Computer-Mediated Communication (CMC) being capable of conveying personal and socioemotional content, the transmission of information between communicators occurs at a different pace compared to face-to-face (FtF) communication. Specifically, because the channel of language in CMC conveys fewer messages per moment than spoken FtF conversations, it is anticipated that CMC users would need more interactions to reach the same levels of impression and relational definition as FtF interactions. This extended interaction time is necessary, especially in asynchronous CMC, but it is also relevant in real-time CMC situations. In essence, CMC users require additional time to compensate for the slower information exchange rate. This additional time is essential for accumulating sufficient data to construct cognitive models of their communication partners and for transmitting and receiving messages that help negotiate their relational status and definition within the interaction. There is no concrete evidence to suggest that emotions are absent or more challenging to convey in Computer-Mediated Communication (CMC) when compared to Face-to-Face (F2F) interactions. While there hasn't been direct and systematic research comparing conversations on the same topics in both F2F and CMC, indirect evidence, such as the success of online dating, support groups, messaging platforms like MSN, and studies on gender differences in online language usage, all indicate that people freely express their emotions in CMC. These emotions serve similar important functions in CMC interactions as they do in face-to-face interactions. CMC offers the advantage of connecting individuals with shared interests or emotional needs, making it as convenient to share emotions with online peers as it is with friends in real life. This fosters the development of close and intimate relationships in the online realm. Additionally, findings related to the success of internet therapy suggest that the relative anonymity of CMC provides a safer space for some individuals to express their emotions and engage in self-disclosure. The absence of physical presence reduces the risk of ridicule or outright rejection, thereby encouraging emotional expression. In particular, when dealing with strangers, it may be easier to convey feelings that might otherwise be considered embarrassing or even risky. In summary, CMC appears to enhance, rather than diminish, the communication of emotions, especially in situations involving unfamiliar individuals.

2. MATERIAL AND METHOD

Materials: Virtual Peer Discussion is an online teaching method that promotes constructive dialog among students within a digital setting. This approach stimulates collaborative learning and allows students to exchange perspectives, ultimately deepening their grasp of the subject matter. Assessment can be conducted through the evaluation of Peer Interaction Quality, which gauges the effectiveness of these virtual discussions in fostering meaningful exchanges. Synchronous Online Quizzes entail real-time online assessments, providing immediate feedback to students. These quizzes encourage active learning and can be assessed based on their impact on Engagement and Participation as well as Critical Thinking Development, as they demand quick thinking and the application of knowledge in a time-sensitive manner. Collaborative Document Creation encourages students to collaborate on shared documents, emphasizing teamwork and knowledge sharing. The evaluation parameter of Enhancement of Learning Outcomes can be employed to measure the effectiveness of this collaborative effort in achieving educational objectives. Asynchronous Discussion Forums permit students to participate in discussions at their own pace. They can be evaluated by assessing Peer Interaction Quality to determine the depth and quality of the discussions. Video-based Concept Explanation utilizes multimedia to elucidate complex ideas, potentially enhancing learning outcomes. Evaluation criteria include the effectiveness of information conveyance and student engagement. Individual Reflective Journals promote self-reflection and critical thinking. Evaluation can be based on their impact on Critical Thinking Development and Engagement and Participation. Debate-style Online Sessions encourage students to logically present their viewpoints. Their effectiveness can be assessed by evaluating Critical Thinking Development. Case Study Analysis in Groups entails collaborative problem-solving and can be evaluated based on the Enhancement of Learning Outcomes and Peer Interaction Quality. Simulated Real-world Scenarios immerse students in practical situations. Evaluation criteria encompass their impact on Engagement and Participation and Critical Thinking Development. Role-playing Activities enhance experiential learning and can be evaluated using the parameter of Enhancement of Learning Outcomes. Method: Grey relational analysis is frequently utilized in various scientific decision-making contexts, including fields like computer science and engineering. It serves as a valuable tool for assessing the grey relational degree, which is determined by the distances between a reference sequence and a comparative sequence. Simply considering the maximum and minimum data distances is insufficient. Generally, the aggregation characteristics of the sample convey the intrinsic nature of the data, and they should be factored into the grey relational degree computation. The numerical attributes of the data distribution reflect how dispersed the data is. When data dispersion is minimal, it indicates a concentrated distribution and signifies the importance of the attribute. The standard deviation of sample distances in the data aligns with this characteristic. Therefore, the inclusion of the sample distance standard deviation, which embodies the data distribution density, is crucial in calculating the grey relational degree. Grey System Theory is primarily employed for studying uncertainties in system models, analyzing relationships among systems, constructing models, and making predictions and decisions. Grey Relational Analysis (GRA) is utilized to assess the degree of connection between two variables by applying methods of departure and scattering measurement to actual distance measurements. Researchers like Lin and Yang have used GRA to select home mortgage loans, while Sun has applied GRA to rank factors influencing economic benefits in hospitals and develop economic policies. Deng's grey theory encompasses various aspects, including grey relational analysis, grey modelling, prediction, and decision-making in systems with uncertain models or incomplete information. This theory offers an effective solution to problems involving uncertainty, multiple inputs, and discrete data. Gray correlation analysis relies on a qualitative examination of a system, allowing for the assessment of the proximity between various factors through the application of gray correlation degrees. In this study, we employ gray correlation analysis to identify suitable cluster indicators for representing the gray correlations among the monitored variables. However, in conventional gray correlation analysis, the choice of the reference sequence remains static, resulting in an inability to compare correlations across different time points. To address this limitation, we integrate the temporal dimension into the dynamic gray correlation analysis during reference sequence selection. Consequently, this approach enables the dynamic comparison of gray correlation degrees for each time-specific wavelet transformation, facilitating the evaluation of developmental similarities and differences from both temporal and spatial perspectives. To address the limitations of regression analysis and factor analysis, researchers have introduced a multi-attribute approach known as Grey Relational Analysis (GRA). GRA serves as an effective tool for system analysis and provides a foundation for modelling, forecasting, and clustering within grey systems. Unlike traditional regression and factor analysis in mathematical statistics, GRA offers several advantages. It demands only a small sample size, doesn't rely on typical distribution assumptions, and involves straightforward calculations. GRA has demonstrated its simplicity and accuracy, particularly in identifying significant factors, especially for problems with unique characteristics. In this particular study, GRA is employed to create a ranking system that orders the grey relationships between dependent and independent factors based on their Grey Relational Grade (GRG) values. This system functions as an evaluation model for the selection of significant factors in multivariate time series data, with GRG values rearranged in accordance with their magnitudes.

3. RESULT AND DISCUSSION

TABLE 1. Computer Mediated Communication

Manufacturer	E1	E2	E3	E4	E5	E6
A1	22.82	41.91	31.73	33.66	28.97	48.78
A2	47.20	31.31	50.06	27.33	41.64	32.98
A3	25.37	26.71	42.43	37.18	23.44	50.89
A4	44.15	23.10	47.60	49.45	47.84	53.10
A5	38.43	42.49	39.77	46.90	23.42	30.36
A6	53.00	31.46	44.88	25.58	31.98	50.67
A7	24.79	35.41	32.72	50.48	37.19	35.42
A8	52.57	42.01	36.88	50.76	37.80	44.56
A9	34.18	37.96	44.08	51.54	51.15	45.66
A10	32.67	49.13	41.43	35.34	26.34	51.33

Table 1 presents the study on Computer Mediated Communication (CMC) using the Group Rating Assessment (GRA) method, assessing various CMC methods across six key dimensions: Enhancement of Learning Outcomes, Engagement and Participation, Critical Thinking Development, Technical Accessibility, Workload Manageability, and Peer Interaction Quality. The table show cases the effectiveness of different CMC methods in facilitating these dimensions, with numerical values indicating the level of impact or achievement in each category.

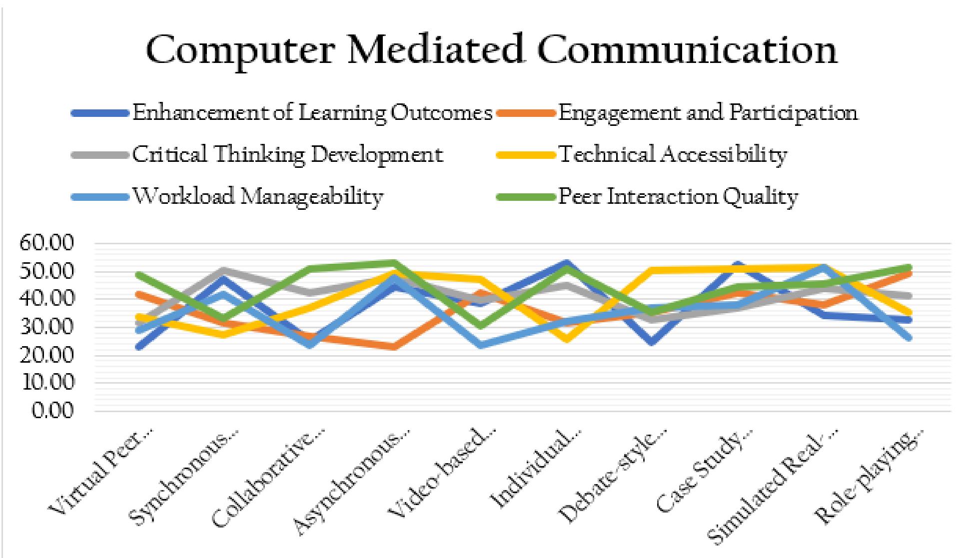

FIGURE 1. Computer Mediated Communication GRA method

Figure 1 illustrates the effectiveness of various computer-mediated communication methods using the GRA (Grey Relational Analysis) approach across several key dimensions in educational settings. These dimensions include Enhancement of Learning Outcomes, Engagement and Participation, Critical Thinking Development, Technical Accessibility, Workload Manageability, and Peer Interaction Quality. Virtual Peer Discussion, Synchronous Online Quizzes, Collaborative Document Creation, Asynchronous Discussion Forums, Video-based Concept Explanation, Individual Reflective Journals, Debate-style Online Sessions, Case Study Analysis in Groups, Simulated Real-world Scenarios and Role-playing Activities there are alternatives. Synchronous Online Quizzes exhibit high scores in Enhancement of Learning Outcomes and Critical Thinking Development, indicating their efficacy in reinforcing knowledge and stimulating critical thinking.

TABLE 2. Normalized Data matrix

A1	0.0000	0.7226	0.0000	0.3112	0.2000	0.8100
A2	0.8079	0.3153	1.0000	0.0675	0.6571	0.1152
A3	0.0846	0.1387	0.5838	0.4470	0.0005	0.9029
A4	0.7069	0.0000	0.8657	0.9198	0.8808	1.0000
A5	0.5173	0.7450	0.4386	0.8214	0.0000	0.0000
A6	1.0000	0.3213	0.7175	0.0000	0.3086	0.8934
A7	0.0654	0.4730	0.0542	0.9595	0.4964	0.2224
A8	0.9860	0.7263	0.2806	0.9701	0.5186	0.6247
A9	0.3766	0.5709	0.6736	1.0000	1.0000	0.6729
A10	0.3265	1.0000	0.5288	0.3759	0.1051	0.9222

Table 2 presents a Normalized Data matrix utilizing the Grey Relational Analysis (GRA) method to evaluate the effectiveness of various educational strategies across six dimensions: Enhancement of Learning Outcomes, Engagement and Participation, Critical Thinking Development, Technical Accessibility, Workload Manageability, and Peer Interaction Quality. Virtual Peer Discussion, Synchronous Online Quizzes, Collaborative Document Creation, Asynchronous Discussion Forums, Video-based Concept Explanation, Individual Reflective Journals, Debate-style Online Sessions, Case Study Analysis in Groups, Simulated Real-world Scenarios and Role-playing Activities there are alternative.

TABLE 3. Deviation sequence

A1	1.0000	0.2774	1.0000	0.6888	0.8000	0.1900
A2	0.1921	0.6847	0.0000	0.9325	0.3429	0.8848
A3	0.9154	0.8613	0.4162	0.5530	0.9995	0.0971
A4	0.2931	1.0000	0.1343	0.0802	0.1192	0.0000
A5	0.4827	0.2550	0.5614	0.1786	1.0000	1.0000
A6	0.0000	0.6787	0.2825	1.0000	0.6914	0.1066
A7	0.9346	0.5270	0.9458	0.0405	0.5036	0.7776
A8	0.0140	0.2737	0.7194	0.0299	0.4814	0.3753
A9	0.6234	0.4291	0.3264	0.0000	0.0000	0.3271
A10	0.6735	0.0000	0.4712	0.6241	0.8949	0.0778

Table 3 shows the deviation sequence using the Grey Relational Analysis (GRA) method for various educational activities. GRA is a technique used to assess the relative importance of different factors or variables in a dataset. the activities are evaluated based on six criteria: Enhancement of Learning Outcomes, Engagement and Participation, Critical Thinking Development, Technical Accessibility, Workload Manageability, and Peer Interaction Quality. Virtual Peer Discussion, Synchronous Online Quizzes, Collaborative Document Creation, Asynchronous Discussion Forums, Video-based Concept Explanation, Individual Reflective Journals, Debate-style Online Sessions, Case Study Analysis in Groups, Simulated Real-world Scenarios and Role-playing Activities there are alternative.

TABLE 4. Grey relation coefficient

A1	0.3333	0.6431	0.3333	0.4206	0.3846	0.7247
A2	0.7224	0.4221	1.0000	0.3490	0.5932	0.3611
A3	0.3533	0.3673	0.5457	0.4748	0.3335	0.8374
A4	0.6304	0.3333	0.7883	0.8618	0.8074	1.0000
A5	0.5088	0.6622	0.4711	0.7369	0.3333	0.3333
A6	1.0000	0.4242	0.6390	0.3333	0.4197	0.8242
A7	0.3485	0.4868	0.3458	0.9250	0.4982	0.3914
A8	0.9728	0.6463	0.4101	0.9436	0.5095	0.5712
A9	0.4451	0.5381	0.6050	1.0000	1.0000	0.6045
A10	0.4261	1.0000	0.5148	0.4448	0.3585	0.8653

Table 4 presents the Grey Relation Coefficient (GRC) values calculated using the Grey Relational Analysis (GRA) method for various instructional methods and their impact on six key educational factors. GRC measures the degree of similarity or correlation between each instructional method and the factors under consideration. Higher GRC values indicate a stronger relationship. For instance, "Synchronous Online Quizzes" exhibits a strong correlation (GRC = 1.0000) with "Critical Thinking Development," indicating that this method significantly enhances critical thinking skills. On the other hand, "Simulated Real-world Scenarios" scores high (GRC = 1.0000) for "Technical Accessibility" and "Workload Manageability," suggesting its effectiveness in these areas.

TABLE 5. Grey Relational Grade (GRG) and Rank

	GRG	Rank
A1	0.4733	10
A2	0.5746	6
A3	0.4853	9
A4	0.7369	1
A5	0.5076	7
A6	0.6067	4
A7	0.4993	8
A8	0.6756	3
A9	0.6988	2
A10	0.6016	5

Table 5 presents the Grey Relational Grade (GRG) scores and rank obtained using the Grey Relational Analysis (GRA) method for various educational activities. The GRG values indicate the relative closeness of each activity's performance to an ideal reference. Higher GRG scores suggest activities that are more effective in enhancing learning outcomes. Asynchronous Discussion Forums received the highest GRG score of 0.7369, indicating its strong positive impact on learning, while Virtual Peer Discussion had the lowest score at 0.4733, According to GRA methods are Asynchronous Discussion Forums is first ranked and with Virtual Peer Discussion being lowest ranked.

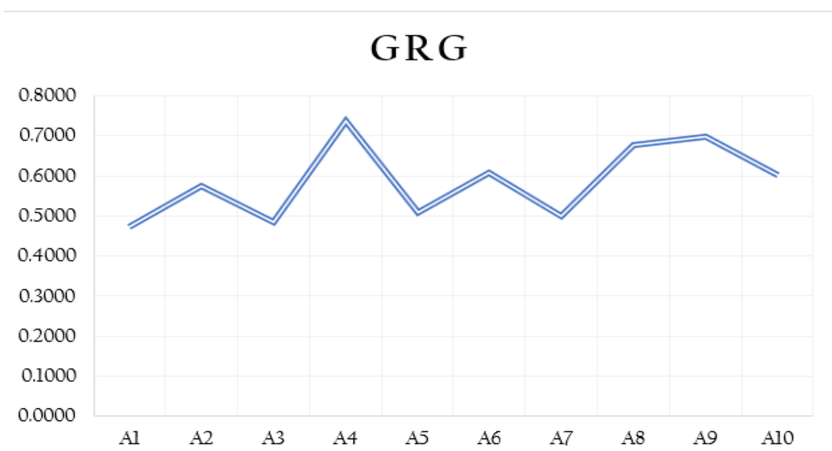

FIGURE 2. Grey Relational Grade (GRG)

Figure 4 presents the Grey Relational Grade (GRG) scores obtained using the Grey Relational Analysis (GRA) method for various educational activities. The GRG values indicate the relative closeness of each activity's performance to an ideal reference. Higher GRG scores suggest activities that are more effective in enhancing learning outcomes. Asynchronous Discussion Forums received the highest GRG score of 0.7369, indicating its strong positive impact on learning, while Virtual Peer Discussion had the lowest score at 0.4733, suggesting it may be less effective in comparison. These scores offer valuable insights for educators in optimizing online teaching methods.

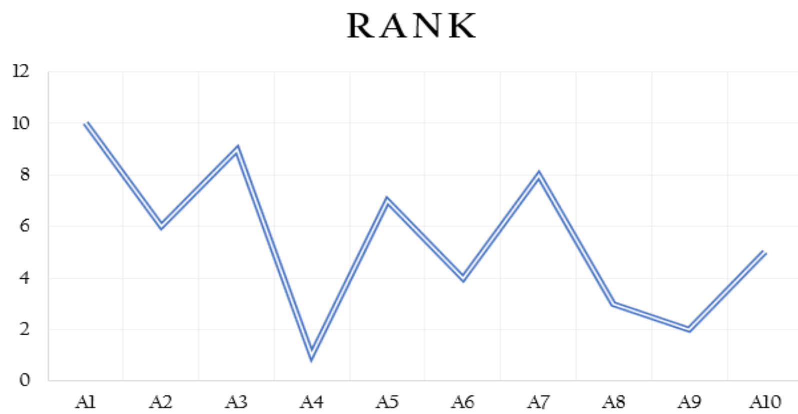

FIGURE 3. Computer Mediated Communication ranking

Figure 3 presents the ranking of various Computer-Mediated Communication (CMC) methods using the Grey Relational Analysis (GRA) method. The rankings are based on their effectiveness in enhancing communication and learning in online educational settings. Asynchronous Discussion Forums are rated the first rank, indicating their strong impact, followed by Case Study Analysis in Groups and Simulated Real-world Scenarios. Virtual Peer Discussion, which occupies the lowest rank.

4. CONCLUSION

In summary, the evolution of pedagogical tasks and the assessment of computer-mediated communication (CMC) for the implementation of the GRA (Group Research and Analysis) method have shed light on significant progress in contemporary education. This process has been characterized by innovation, adaptability, and a commitment to enhancing learning experiences for students in various educational settings. The GRA method, which relies on collaborative group work and critical analysis, has proven to be an invaluable tool for promoting deeper comprehension and higher-order thinking skills among students. The incorporation of CMC into this pedagogical approach has extended its reach and effectiveness, enabling students to engage in meaningful discussions and research activities regardless of their location. This technological integration has not only facilitated remote learning but has also fostered the development of digital literacy and communication skills, which are increasingly essential in today's interconnected world. Throughout our exploration of this subject, it has become apparent that effective task design plays a pivotal role in the success of GRA in a digital environment. Pedagogical tasks must be meticulously developed to encourage active participation, collaborative problem-solving, and the synthesis of diverse perspectives. Furthermore, continuous assessment and feedback mechanisms are crucial for ensuring the quality and relevance of the learning process. As we progress, it is essential for educators, instructional designers, and institutions to embrace the ever-changing landscape of technology and adapt their teaching methods accordingly. The journey of developing pedagogical tasks and assessing CMC for GRA has emphasized the significance of staying current with emerging technologies and pedagogical strategies, fostering a culture of lifelong learning, and prioritizing student-centered approaches. Through these endeavours, we can continue to enhance the educational environment and empower students to thrive in the constantly evolving digital era. According to GRA methods are Asynchronous Discussion Forums is first ranked and with Virtual Peer Discussion being lowest ranked.

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