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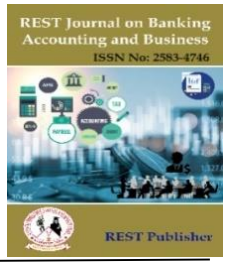

The Impact of Gamification Strategies on Motivation and Knowledge Retention in Learning Environments

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Abstract: *The abstract provides a comprehensive overview of the study's focus, methodology, and key findings, encapsulating the essence of the research. Gamification emerges as a pivotal strategy in revolutionizing traditional educational approaches to enhance learning outcomes. By infusing game elements like challenges, rewards, and progression systems into educational settings, gamification aims to make learning dynamic and interactive, fostering heightened engagement and motivation among learners. This research explores the impact of gamified learning on motivation, knowledge retention, and long-term learning outcomes, particularly in the context of Saudi Arabia where the concept is underexplored. The study employs the Gray Relational Analysis (GRA) method as a systematic approach to resolve multi-attribute decision-making problems, particularly in situations with incomplete weight information. By comparing various renewable and non-renewable energy sources, the study aims to ensure consistency in evidence assessment. Additionally, the study introduces a novel approach based on GRA, addressing the limitations and drawbacks identified in previous methodologies. The abstract further delves into the theoretical foundations of gamification and its application in educational settings. It highlights the potential of gamification to nurture intrinsic motivation among students, encouraging active engagement and persistence in overcoming challenges. Through game mechanics like scoring systems and achievement badges, educators aim to capture students' interest and fuel their curiosity to explore and master new concepts. Furthermore, the abstract discusses the significance of understanding motivation and knowledge retention in educational contexts. It emphasizes the role of feedback, reflection, and adaptability in fostering continuous improvement and customization of learning experiences. The study acknowledges the ongoing research to understand the theoretical and psychological underpinnings of gamification, aiming to contribute to the broader understanding of its role in education. The Gray Relational Analysis (GRA) method provides a systematic approach for resolving multi-attribute decision-making problems, particularly when faced with incomplete weight information. This method involves several computational steps to determine the relative performance of alternatives. Firstly, the gray relation sizes are calculated by comparing each alternative against both the positive-best and negative-best solutions. In the realm of educational pursuits, "Achievement Unlocked" stands out as the foremost symbol of academic achievement. Close behind is "Beyond the Scoreboard," highlighting the broader dimensions of learning beyond simple metrics. "Game-Changing Education" takes the third spot, embodying inventive methods for cultivating knowledge and development. "Game On for Learning" maintains its position at fourth, reflecting the enduring passion and involvement in educational activities. Lastly, "Quest for Knowledge" concludes the rankings, representing the continuous quest for enlightenment and comprehension. Quest for Knowledge, Achievement Unlocked, Beyond the Scoreboard, Game-Changing Education and Game On for Learning. Motivation Assessment, Knowledge Retention, Performance Improvement, Feedback and Reflection and Adaptability and Customization*

Keywords: *Quest for Knowledge, Achievement Unlocked, Beyond the Scoreboard, Game-Changing Education and Game On for Learning.*

1. INTRODUCTION

Gamification strategies have demonstrated a significant impact on motivation and knowledge retention within educational settings. By integrating elements of gaming such as challenges, rewards, competition, and progression systems, gamification transforms the learning experience into one that is dynamic and interactive, fostering heightened engagement and a drive for success among learners. Motivation is bolstered through gamification's ability to make learning enjoyable and captivating, tapping into intrinsic motivators like autonomy, mastery, and

purpose. This cultivates a sense of ownership and control over the learning journey, leading to increased engagement and persistence. Furthermore, the competitive element inherent in gamified environments spurs motivation as learners strive to achieve goals and outdo their peers [1]. The interactive nature of gamified learning environments facilitates active participation and experiential learning. Immersed in simulated scenarios, learners can apply theoretical knowledge in practical contexts, receiving immediate feedback and tracking progress to foster a sense of accomplishment and encourage continual improvement. Knowledge retention is enhanced through gamification's reinforcement of concepts via repetition, application, and reward. Mechanics like spaced repetition, quests, and challenges solidify learning by prompting learners to revisit and practice material over time. Additionally, the storytelling and narrative elements in gamified content aid in memory consolidation and retrieval. While extrinsic rewards like points and badges may initially motivate learners, intrinsic motivation stemming from genuine interest in the subject matter and a sense of mastery is ultimately more sustainable. Balancing extrinsic rewards with intrinsic motivators ensures long-term engagement and nurtures a love for learning beyond the gamified environment [2]. the utilization of gamified learning, despite being recognized as part of this educational revolution, largely remains unexplored. The Jordan Ministry of Education (2020) acknowledges the potential for gamified learning to enhance student participation and foster greater interest in education. Yet, what is lacking in the current discourse is a comprehensive understanding of how gamified learning impacts long-term knowledge retention and knowledge transfer. This necessitates a deeper exploration of the unique dynamics inherent in gamified learning, particularly in contexts like Saudi Arabia, where the concept is widely researched and implemented worldwide but remains relatively under-understood. Due to its specific implications and the need for tailored adaptations for students, there has been limited exploration of gamified learning in Saudi Arabia [3]. Gamification, primarily explored by researchers within technology centers, has faced criticism for prioritizing digital technology over substantive content (Burn, 2016). Bogost (2011) views gamification as the extraction of game elements, such as points and rewards, from games, resulting in less engaging components. He contends that these elements become mere symbols of motivation, lacking intrinsic value. Bogost's argument aligns with the idea that in video games, points and rewards are less compelling due to players' focus on the gameplay experience rather than the rewards themselves. Hughes and Lacy (2016), among others, suggest that gamification's rarity in successful implementations is due to design flaws stemming from a lack of understanding of player motivation, persistence, and psychology, particularly in fostering learning. They highlight the failure to grasp how players engage with gamified systems as a significant hurdle. The debate surrounding gamification's effectiveness in education remains unresolved, as critiques persist without a comprehensive evaluation of its impact. This research paper aims to address these criticisms and potentially contribute to the understanding of gamification's role in education [4]. The term "gamification," initially coined in 2008, gained widespread acceptance in education around 2010 and is now commonly used across various industries. Its definition revolves around the application of game design elements to non-gaming contexts. These elements include popular game mechanics such as points, badges, leaderboards, competition, instant feedback, and time constraints. However, the concept of gamification differs significantly from traditional education and extreme sports. In gamification, the emphasis is on integrating game elements into an environment, whereas extreme sports involve physical challenges and adrenaline-driven experiences. Gamification typically utilizes game elements either within games themselves or through Gameful Design, which extends beyond gaming into non-entertainment purposes, describing full-fledged games tailored for specific objectives outside of pure entertainment [5]. Gamification, a widely researched technique, focuses on enhancing user engagement and increasing positive usage patterns, particularly in service-related contexts. It involves incorporating game elements such as points, badges, and leaderboards into non-game environments. Recent articles, essays, and research studies have delved into this trending topic, reflecting its growing popularity. The integration of gamification into various domains, including college courses, massive open online courses (MOOCs), conferences, and workshops, is on the rise. This trend is particularly notable in education, where gamification elements are increasingly utilized in teaching practices. Emerging evidence suggests that gamification holds promise as a future trend in education, offering engaging, enjoyable learning experiences that foster critical thinking skills and encourage active learner participation [6]. Knowledge-based organizations vary in their interpretation of knowledge management, evoking diverse scenarios such as customer service representatives accessing FAQs, consultants collaborating on salary studies, or marketers learning from trial and error (Fontaine et al., 2002). The United Kingdom's development agency, IDeA, prioritizes knowledge management in local government by fostering organizational intelligence and capturing insights into how people work, thus enhancing feedback mechanisms and improving performance through shared experiences and expertise [7]. Online education, an extension of information and communication technology (ICT), fosters adaptable learning environments that accommodate various learning styles and the autonomy of self-driven learners. It diverges from traditional face-to-face learning by integrating online lessons, teaching methods, and elements of play into the educational process. This approach to universal education is pivotal in leveraging educational technology for development. With the proliferation of technological learning tools, learners now have the opportunity to directly engage in acquiring knowledge beyond the confines of physical classrooms, thereby gaining deeper insights into

their own learning preferences and capabilities [8]. Gamification has been widely studied for its effectiveness in enhancing learning outcomes. Previous research has examined its application in motivating personnel during trials or engaging students in educational settings. Various incentives have been utilized to some degree, typically aimed at improving performance and knowledge retention. Studies often report a positive impact on student engagement and achievement. One notable study conducted on final year students taking the National Assessment of Educational Progress (NAEP) exam examined the use of cash incentives as an external motivator. The study compared the impact of gamification, which offered rewards for exploration, to a control group. The analysis revealed a relatively weak impact compared to the control group, indicating that the use of gamification did not significantly enhance performance [9]. The preceding section underscores the significance of addressing challenges faced by educators and schools today, particularly concerning the lack of student interest and motivation in learning. Kiriakova, Angelova, and Yordanova identified various contributing factors to this issue, including outdated traditions and ineffective teaching methods that fail to actively engage students in the learning process. In response, innovative instructional approaches and pedagogies are deemed essential to overcome these challenges and cultivate a more conducive learning environment. By adopting such approaches, educators can effectively layer learning materials and activities to actively engage students, thereby fostering increased motivation and ultimately enhancing student outcomes [10]. Gamification, which involves integrating game-design elements such as points and challenges into non-game contexts, has gained significant attention for its potential to achieve various outcomes, such as enhancing student learning. Many educators have adopted gamification in the classroom, and researchers have studied its impact on education extensively. Despite its widespread use, there is still ongoing research to understand the theoretical and psychological underpinnings of gamification, as well as how individual differences affect its effectiveness. To address this, Landers (2014) introduced the theory of Learning through Gamification, providing a theoretical foundation for gamified learning efforts. This theory emphasizes the potential of gamification to facilitate implicit learning and optimize instructional content. By leveraging gamification strategies, instructors can create more engaging and effective learning experiences that benefit students' understanding and retention of material [11]. Gamification tools, which introduce gaming elements into non-game environments, have been instrumental in increasing students' interest in learning. By incorporating components such as badges and leaderboards, educators create a game-like atmosphere in educational settings, as highlighted by Attali and Attali (2015). This approach has proven effective in addressing the boredom often associated with traditional learning methods, thereby enhancing student engagement and participation. Many schools have embraced gamification to motivate students, leveraging its ability to provide immediate feedback and rewards, as noted by Duran, Avinc, Kara, and Kokdas (2016). These gamification components, such as stimulus effects and reward feedback, effectively incentivize desired behaviors among students, fostering a more dynamic and interactive learning environment [12].

2. MATERIALS AND METHOD

Quest for Knowledge: Educators are increasingly turning to gamification as a means to revolutionize traditional educational approaches and improve learning outcomes. By integrating elements of game design into conventional teaching methods, gamification aims to make learning more captivating and immersive. A key goal of gamification in education is to nurture intrinsic motivation among students, encouraging them to actively engage in their learning journey and persist in overcoming challenges. Employing game mechanics like scoring systems, progress levels, achievement badges, and competitive leader boards, educators strive to capture students' interest and fuel their curiosity to explore and master new concepts.

Achievement Unlocked: In various fields, whether academics, sports, or personal endeavors, hitting milestones is often viewed as a significant indicator of success. Yet, true accomplishment surpasses mere acknowledgment; it embodies growth, resilience, and the culmination of persistent effort. Each attained milestone symbolizes a victorious moment, a testament to perseverance, and a progression toward loftier objectives. Whether it involves mastering a new skill, surmounting obstacles, or positively impacting others, every achievement carries its distinct importance. Commemorating these landmarks not only recognizes individual feats but also inspires others to pursue their dreams. With each milestone surpassed, we edge closer to realizing our utmost potential and tasting the satisfaction that arises from striving for greatness.

Beyond the Scoreboard: In the world of sports, success is often gauged by the points displayed on the scoreboard. However, true achievement extends well beyond numerical victories. It encompasses personal growth, the development of character, and the impact on the community. Beyond the confines of the scoreboard lies a realm where athletes cultivate qualities like resilience, teamwork, and perseverance—traits that extend beyond the game and shape individuals throughout their lives. Whether it's overcoming obstacles, mentoring teammates, or inspiring fans, genuine achievement is found in the intangible moments that forge connections and establish a

lasting legacy. By acknowledging and celebrating these accomplishments, we pay homage to the essence of sportsmanship and the essence of competition.

Game-Changing Education: Education is experiencing a profound transformation, spurred by innovation and technological advancements. Revolutionary methods of learning are challenging traditional norms, rendering education more engaging, accessible, and efficient. From interactive simulations to tailored learning platforms, educators are employing principles of gamification to capture students' interest and augment their comprehension. Through gamified education, students actively participate in their learning journey, driven by challenges, incentives, and the excitement of progress. This groundbreaking approach not only nurtures critical thinking and problem-solving abilities but also instills a lifelong passion for learning. As we embrace novel educational horizons, we unlock the potential for every student to thrive in the digital era.

Game On for Learning: Learning in today's world extends far beyond the confines of the classroom—it's a dynamic, immersive adventure that transcends traditional boundaries. "Game On for Learning" embodies this spirit, harnessing gamification's power to render learning engaging, interactive, and enjoyable. By integrating gaming elements such as challenges, quests, and rewards into educational content, educators can captivate students' attention and foster a deeper understanding of intricate concepts. Whether it involves exploring ancient civilizations in a virtual realm or solving math puzzles to unlock hidden treasures, gamified learning transforms passive learners into active participants, fueling motivation and retention. As we embrace the gamification revolution, we embark on an exhilarating journey where every lesson evolves into an adventure waiting to be embraced.

Motivation Assessment: Understanding motivation entails grasping individuals' drive, objectives, and enthusiasm toward tasks. By analyzing factors like intrinsic and extrinsic motivation, goal clarity, and alignment with personal values, organizations can craft strategies to effectively inspire and engage employees. Employing tools such as surveys, interviews, and performance evaluations offers insights into employees' motivation levels, facilitating targeted interventions and support where necessary.

Knowledge Retention: Knowledge retention denotes the capacity of individuals or organizations to effectively preserve and recall information over time. Techniques to bolster knowledge retention encompass active learning methods, spaced repetition, reinforcing knowledge through practical application, and fostering a culture of continuous learning. Evaluating knowledge retention entails measuring information recall, its application in real-life situations, and pinpointing areas necessitating improvement or reinforcement.

Performance Improvement: Enhancing performance involves identifying strengths and weaknesses, establishing clear objectives, delivering feedback, and implementing tailored interventions to boost skills and productivity. Strategies for performance enhancement may encompass training initiatives, mentorship programs, performance assessments, and acknowledgment of accomplishments. Monitoring performance improvement involves tracking progress against predetermined goals, eliciting feedback from stakeholders, and adapting strategies as required to maximize outcomes.

Feedback and Reflection: Feedback and reflection serve as integral components of the learning and development journey, offering individuals insights into their performance, areas for enhancement, and avenues for growth. Effective feedback entails precise, actionable, and timely communication, fostering a culture of transparency and continual improvement. Encouraging reflection enables individuals to analyze experiences, identify key takeaways, and devise strategies for future success. Evaluating feedback and reflection entails seeking input from peers, supervisors, and self-assessment to gauge the efficacy of feedback mechanisms and the depth of reflection.

Adaptability and Customization: Adaptability and customization involve tailoring approaches, processes, and solutions to meet the distinct needs and preferences of individuals or organizations. Embracing adaptability fosters flexibility in response to evolving circumstances, nurturing innovation and resilience. Customization entails personalizing experiences, products, or services to heighten relevance and effectiveness. Assessing adaptability and customization involves evaluating responsiveness to change, the ability to accommodate diverse needs, and the effectiveness of personalized solutions in attaining desired outcomes.

Method: The Gray Relational Analysis (GRA) method provides a systematic approach for resolving multi-attribute decision-making problems, particularly when faced with incomplete weight information. This method involves several computational steps to determine the relative performance of alternatives. Firstly, the gray relation sizes are calculated by comparing each alternative against both the positive-best and negative-best solutions. Subsequently, the Positive-Ideal Solution (BIS) and Negative-Ideal Solution (NIS) are identified

concurrently with the gray relation sizes to establish the ranking order of all alternatives [13]. Gray Correlation Analysis (GRA) was initially introduced by Deng as a Multi-Criteria Decision-Making (MCDM) tool aimed at assisting in problem-solving tasks. Over time, GRA has been effectively utilized in addressing various MCDM challenges. It serves as an impact assessment model capable of quantifying correlations between different series, falling within the realm of communication and data analysis methods, either analytical or geometric. Typically, researchers define objective and reference series based on the investigated problem [14]. The primary objective of gray relational analysis is to gauge the correlation between reference and comparison series. In this paper, we propose an extended Fuzzy GRA method to tackle MCDM problems. This method incorporates scale values expressed linguistically in triangular fuzzy numbers format for variables and handles information regarding scale weights that may not be readily available. To ascertain criterion weights, we build upon the basic idea of traditional GRA and establish optimization samples [15]. The GRA methods are outlined, detailing a general process of constructing a regression model involving two main steps. Firstly, computer simulations are employed, utilizing an experimental design to model and represent data. Secondly, the model is fitted with sample data to approximate its performance. In this study, an optimal Latin hypercube design and orthogonal array technique are selected for testing weights and criteria, respectively. The average ranking scores of GRA methods are then calculated to generate a dataset. Test data are approximated using Response Surface Methodology (RSM). The developed model serves as a guide for decision-makers, aiding in rendering fair judgments. Compared to other MCDM methods, the proposed approach offers three key benefits. Firstly, a weight allocation test is conducted using design techniques, enabling a comparison of each criterion's statistical significance. In classical MCDM methods, experts' input in the decision-making process plays a pivotal role, making rankings subjective and imprecise [16]. In the context of employee selection, precise decision-making can be challenging due to the inherent uncertainty surrounding the available information. Atanassov (1986) introduced intuitive fuzzy sets as a means to address this uncertainty effectively. These sets offer an appropriate framework for dealing with imprecise data in employee selection scenarios. Furthermore, in practical settings, where numerous decisions are made amidst uncertainty, Xu (2007) proposed the use of the Propositional Intuition Fuzzy Weighted Average (IFWA) operator. This operator integrates the opinions of individual decision-makers to form a collective group opinion, leveraging intuition to determine fuzzy entropy and scale weights. The Gray Relational Analysis (GRA) method emerges as a popular choice for decision-making [17]. Gray Relational Analysis (GRA), when employing gray numbers, addresses the challenges posed by incomplete information and instability in assessments. Gray numbers encapsulate the subjective preferences and uncertainty inherent in decision-making processes, allowing for the representation of interval sizes and personal options in numerical form. In this study, we compare and evaluate various renewable and non-renewable energy sources, aiming to ensure consistency in evidence assessment. We introduce a novel approach based on GRA that accounts for diverse criteria. Despite the development of numerous GRA-based methodologies, certain limitations and drawbacks have been identified [18]. Gray Correlation Analysis (GRA), originally proposed by Deng, serves as a valuable tool in addressing Multiple Criteria Decision Making (MCDM) problems and has demonstrated success in resolving various challenges. GRA is categorized as an evaluation model and data analysis method, falling under the umbrella of communication-measurable impact or geometric approaches. Typically, researchers designate target series as reference points within the scope of the problem under study. The primary objective of GRA is to gauge correlation between series, particularly when dealing with ambiguous information in the MADM process. In instances where attribute values and weights are uncertain due to time constraints, knowledge gaps, or lack of data, traditional GRA methods may fall short in effectively handling incomplete weight information in MADM problems. Consequently, the determination of attribute weights remains a significant research focus within the realm of GRA [19]. The GRA Model with Hierarchy Relationship Analysis (SRA) method, introduced by Guo in 2007, is utilized to determine weights for indicators. In summary, the GRA-SRA method combines the simplicity of the GRA model with the hierarchical relationship analysis of the SRA method. The GRA model calculates the degree matrix for different indicators, representing their relational importance. Subsequently, the SRA method assigns weights based on the relative significance of each indicator in comparison to others. This method ensures the consistency and objectivity of weight analysis. Moreover, the GRA-SRA approach facilitates the examination of interdependence and reflection among indicators [20]. Initially developed by Deng to address Multiple Attribute Decision Making (MADM) problems, Gray Correlation Analysis (GRA) has become a popular and effective tool for analyzing multivariate relationships and aiding decision-making processes across various contexts. Its simplicity and straightforwardness in the calculation process contribute to its widespread use. GRA offers several key benefits, including its reliance on original data, making the results dependable [21]. GRA has been applied in diverse business environments as an optimal decision-making method. For instance, Tan, Chen, and Wu utilized GRA in conjunction with Analytic Hierarchy Process (AHP) to evaluate green design alternatives for venture capital firms. Additionally, GRA has been extended and hybridized with other methods, such as the hybrid GRA method proposed by Alptekin, Alptekin, and Charak, which optimizes criteria for green resilient supply problems in MADM scenarios [22].

3. RESULTS AND DISCUSSION

TABLE 1. Impact of Gamification Strategies on Motivation and Knowledge Retention in Learning Environments

	Motivation Assessment	**Knowledge Retention**	**Performance Improvement**	**Feedback and Reflection**	**Adaptability and Customization**
Quest for Knowledge	51.36	65.96	89.68	77.60	90.63
Achievement Unlocked	75.89	89.96	85.74	85.64	70.78
Beyond the Scoreboard	63.52	75.63	99.69	65.87	80.69
Game-Changing Education	75.63	69.56	68.65	75.89	85.63
Game On for Learning	65.56	79.65	63.74	80.96	75.96

Table 1 the Impact of Gamification Strategies on Motivation and Knowledge Retention in Learning Environments for Grey relational analysis Motivation Assessment: in Beyond the Scoreboard (99.69) is showing the Highest Value and Game On for Learning (63.74) is showing the lowest value. Knowledge Retention in Achievement Unlocked (89.96) is showing the Highest Value and Game-Changing Education (69.56) is showing the lowest value. Performance Improvement in Quest for Knowledge (89.68) is showing the Highest Value and Game On for Learning (63.74) is showing the lowest value. Feedback and Reflection in Quest for Knowledge (77.60) is showing the Highest Value and Beyond the Scoreboard (65.87) is showing the lowest value. Adaptability and Customization in Quest for Knowledge (90.63) is showing the Highest Value and Achievement Unlocked (70.78) is showing the lowest value.

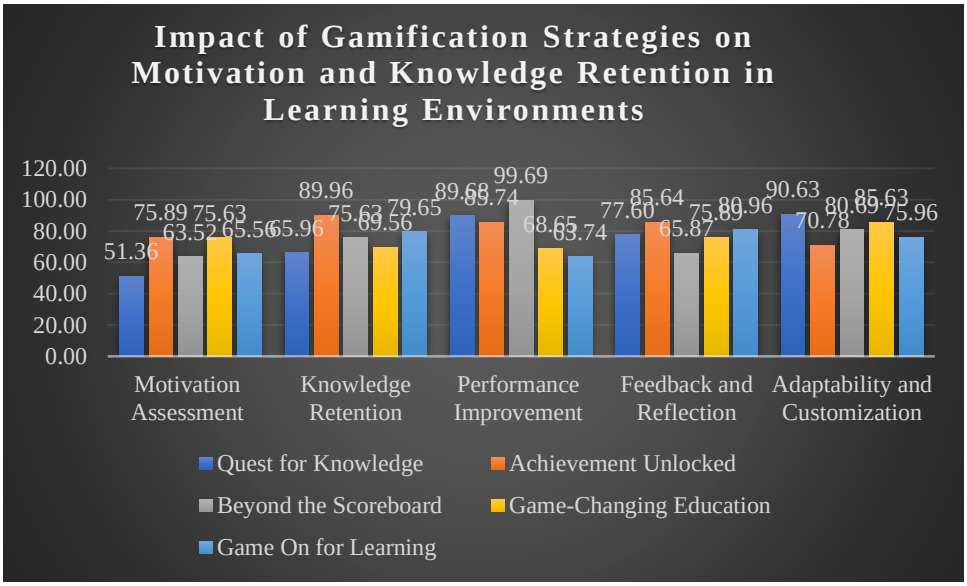

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TABLE 2. Normalized Data

	Motivation Assessment	Knowledge Retention	Performance Improvement	Feedback and Reflection	Adaptability and Customization
Quest for Knowledge	0.0000	0.0000	0.7216	0.4067	0.0000
Achievement Unlocked	1.0000	1.0000	0.6120	0.0000	1.0000
Beyond the Scoreboard	0.4957	0.4029	1.0000	1.0000	0.5008
Game-Changing Education	0.9894	0.1500	0.1366	0.4932	0.2519
Game On for Learning	0.5789	0.5704	0.0000	0.2367	0.7390

Table 2 The normalized data showcases the varying degrees of effectiveness across different educational methodologies in key areas. "Quest for Knowledge" stands out with high performance improvement (0.7216) and moderate feedback and reflection (0.4067), but lacks motivation assessment and adaptability (both at 0.0000). "Achievement Unlocked" excels in motivation assessment, knowledge retention, and adaptability, all at perfect scores (1.0000), but lacks feedback and reflection (0.0000). "Beyond the Scoreboard" demonstrates balanced performance across all categories, particularly strong in performance improvement, feedback and reflection, and adaptability. "Game-Changing Education" exhibits high motivation assessment and decent feedback and reflection, but struggles with knowledge retention and performance improvement. "Game On for Learning" showcases solid knowledge retention and adaptability, but lacks in performance improvement and feedback and reflection.

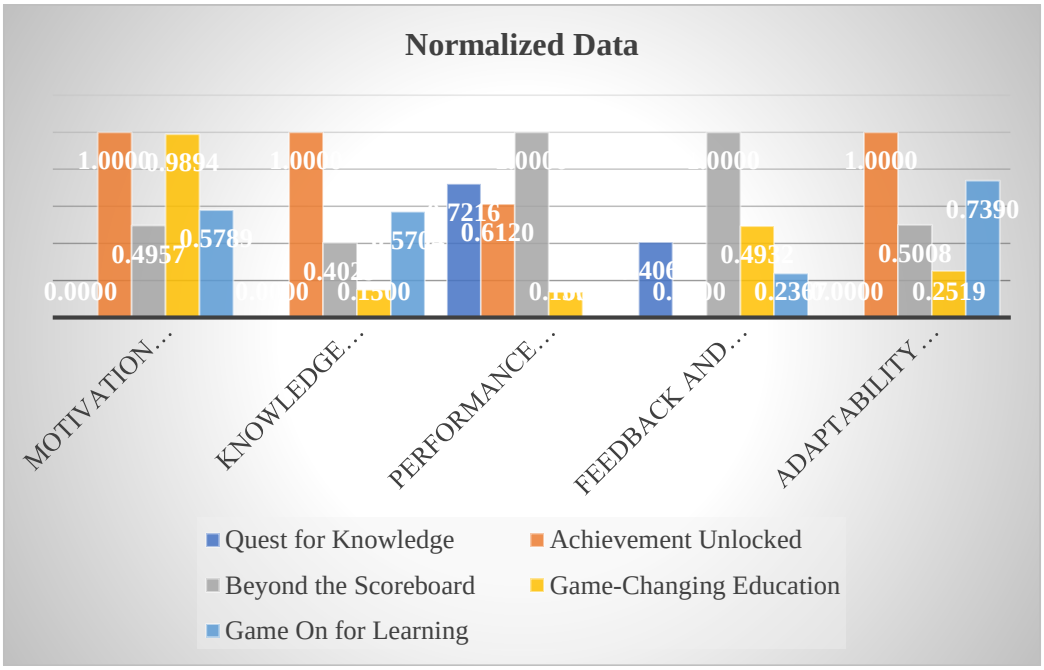

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TABLE 3. Deviation sequence

	Motivation Assessment	Knowledge Retention	Performance Improvement	Feedback and Reflection	Adaptability and Customization
Quest for Knowledge	1.0000	1.0000	0.2784	0.5933	1.0000
Achievement Unlocked	0.0000	0.0000	0.3880	1.0000	0.0000
Beyond the Scoreboard	0.5043	0.5971	0.0000	0.0000	0.4992
Game-Changing Education	0.0106	0.8500	0.8634	0.5068	0.7481
Game On for Learning	0.4211	0.4296	1.0000	0.7633	0.2610

Table 3 The deviation sequence illustrates the divergence in performance across various aspects of education among different methodologies: "Quest for Knowledge" demonstrates uniformity in motivation assessment, knowledge retention, and adaptability, but shows a lower deviation in performance improvement and a moderate one in feedback and reflection. "Achievement Unlocked" displays a complete deviation in motivation assessment, knowledge retention, and adaptability, while showing a moderate deviation in performance improvement and none in feedback and reflection. "Beyond the Scoreboard" exhibits slight deviations in motivation assessment and knowledge retention, but significant ones in performance improvement and feedback and reflection, and a moderate one in adaptability.

"Game-Changing Education" presents minimal deviations in motivation assessment and significant ones in knowledge retention and performance improvement, while moderate ones in feedback and reflection and adaptability. "Game On for Learning" showcases moderate deviations in all categories except performance improvement, where it shows none, indicating a consistent performance in this aspect.

TABLE 4. Grey Relation Coefficient

	Motivation Assessment	Knowledge Retention	Performance Improvement	Feedback and Reflection	Adaptability and Customization
Quest for Knowledge	0.3333	0.3333	0.6423	0.4573	0.3333
Achievement Unlocked	1.0000	1.0000	0.5630	0.3333	1.0000
Beyond the Scoreboard	0.4979	0.4558	1.0000	1.0000	0.5004
Game-Changing Education	0.9792	0.3704	0.3667	0.4966	0.4006
Game On for Learning	0.5428	0.5379	0.3333	0.3958	0.6571

Table 4 The Grey Relation Coefficient (GRC) is a method used to analyze the relationship between multiple factors or variables. In this case, the GRC is applied to assess the relationship between motivation assessment, knowledge retention, performance improvement, feedback and reflection, and adaptability and customization. The values in the provided matrix represent the degree of correlation or similarity between each pair of factors. A higher coefficient indicates a stronger relationship between the factors. By calculating the GRC for these factors, one can gain insights into their interdependencies and prioritize areas for improvement or focus.

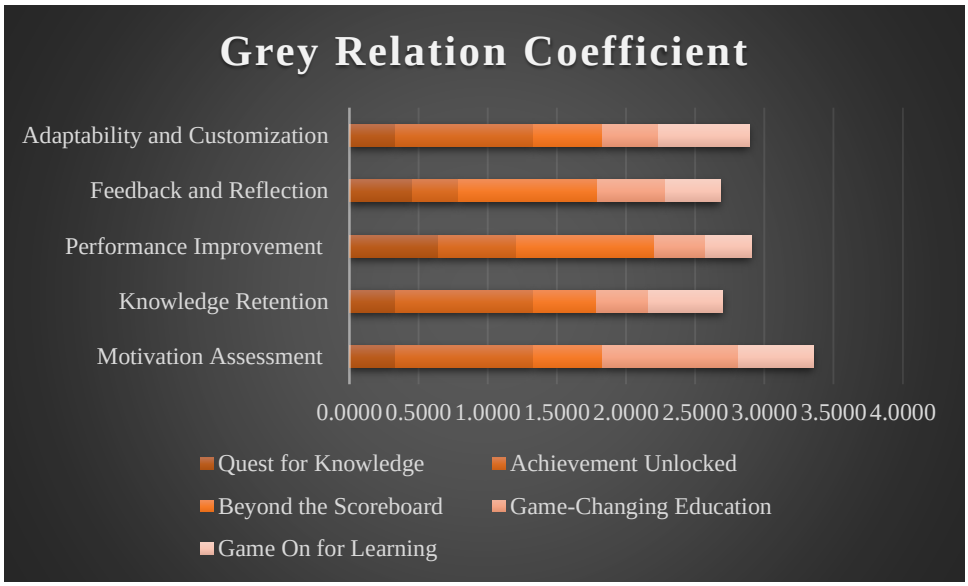

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TABLE 5. Result of final GRG Rank

	GRG	Rank
Quest for Knowledge	0.4199	5
Achievement Unlocked	0.7793	1
Beyond the Scoreboard	0.6908	2
Game-Changing Education	0.5227	3
Game On for Learning	0.4934	4

Table 5 The final Grey Relation Grade (GRG) ranks the effectiveness or impact of various educational programs or initiatives based on their Grey Relation Coefficients (GRC). The GRG values indicate the degree of correlation or similarity between each program and the desired outcomes, such as motivation assessment, knowledge retention, performance improvement, feedback and reflection, and adaptability and customization. A higher GRG value signifies a stronger correlation and thus a more favorable rank. In this ranking, "Achievement Unlocked" has the highest GRG of 0.7793, securing the top rank, followed by "Beyond the Scoreboard" with a GRG of 0.6908 in the second position. "Game-Changing Education" and "Game On for Learning" hold the third and fourth positions, respectively, with GRG values of 0.5227 and 0.4934. Lastly, "Quest for Knowledge" ranks fifth with a GRG of 0.4199. This ranking provides valuable insights into the relative effectiveness of each program in achieving educational objectives, aiding decision-making and resource allocation in educational planning and policy.

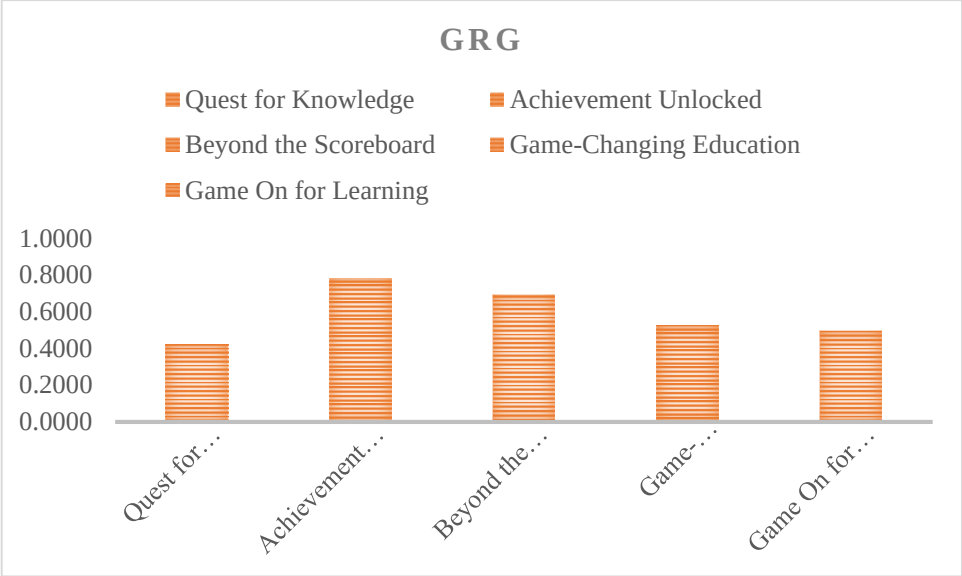

FIGURE 4. GRG

Figure 4 The final Grey Relation Grade (GRG) ranks the effectiveness or impact of various educational programs or initiatives based on their Grey Relation Coefficients (GRC). The GRG values indicate the degree of correlation or similarity between each program and the desired outcomes, such as motivation assessment, knowledge retention, performance improvement, feedback and reflection, and adaptability and customization. A higher GRG value signifies a stronger correlation and thus a more favourable rank. In this ranking, "Achievement Unlocked" has the highest GRG of 0.7793, securing the top rank, followed by "Beyond the Scoreboard" with a GRG of 0.6908 in the second position. "Game-Changing Education" and "Game On for Learning" hold the third and fourth positions, respectively, with GRG values of 0.5227 and 0.4934. Lastly, "Quest for Knowledge" ranks fifth with a GRG of 0.4199. This ranking provides valuable insights into the relative effectiveness of each program in achieving educational objectives, aiding decision-making and resource allocation in educational planning and policy.

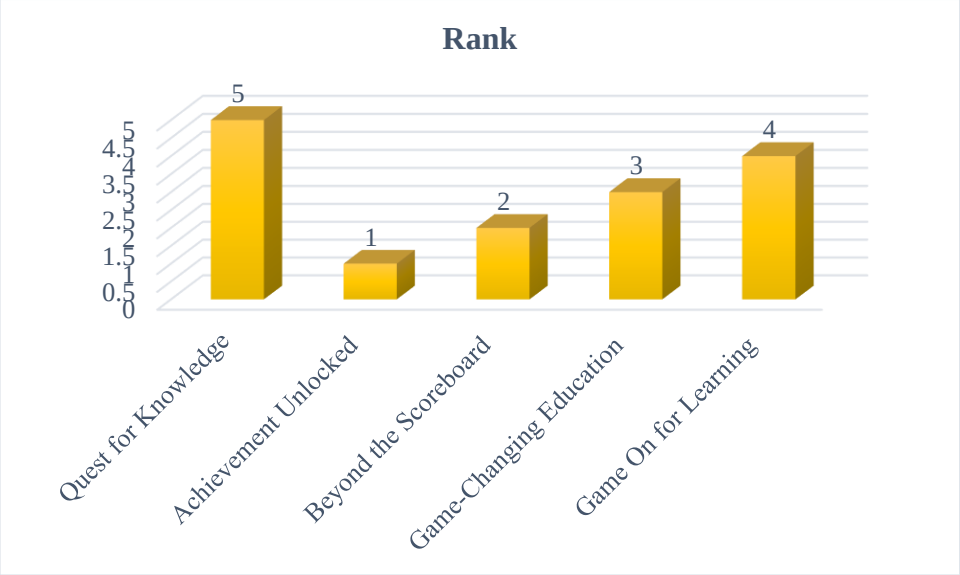

FIGURE 5. Shown the Rank

Figure 5 In the realm of educational pursuits, "Achievement Unlocked" stands out as the foremost symbol of academic achievement. Close behind is "Beyond the Scoreboard," highlighting the broader dimensions of learning beyond simple metrics. "Game-Changing Education" takes the third spot, embodying inventive methods for cultivating knowledge and development. "Game On for Learning" maintains its position at fourth, reflecting the enduring passion and involvement in educational activities. Lastly, "Quest for Knowledge" concludes the rankings, representing the continuous quest for enlightenment and comprehension.

4. CONCLUSION

This study demonstrates the transformative potential of gamification in education, particularly within the context of Saudi Arabia, where the application of gamified learning is still emerging. By integrating game mechanics such as challenges, rewards, and progression systems, gamification has proven to significantly enhance student motivation, knowledge retention, and long-term learning outcomes. The study highlights the importance of intrinsic motivation, actively engaging students in their learning process and encouraging perseverance in the face of challenges. Utilizing the Gray Relational Analysis (GRA) method, the research offers a structured approach to evaluate the effectiveness of gamified learning strategies, even when dealing with incomplete weight information. The findings suggest that gamification not only increases academic achievement but also fosters deeper engagement through symbols like "Achievement Unlocked" and "Beyond the Scoreboard," which reflect the broader dimensions of learning beyond mere academic metrics. The study further underscores the importance of feedback, reflection, and adaptability in refining educational experiences. These elements are key to personalizing learning paths and ensuring continuous improvement. By examining the interplay of motivation, knowledge retention, and performance improvement, this research contributes valuable insights into the theoretical and psychological foundations of gamification, establishing its relevance as a powerful tool for educational enhancement. Gamification holds significant promise for reshaping educational landscapes, promoting active participation, and enhancing student outcomes in a dynamic, interactive learning environment. Through this approach, educators can inspire a lifelong quest for knowledge and foster a deeper connection to learning.

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