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The Effect of Gamification Teaching Strategies Based on Multimodal Theory on the Learning Engagement of 3-6-Year-Old Children

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Abstract: With the continuous development of the education system, early childhood education as a basic stage is highly valued for its teaching quality and methods. Based on multimodal theory, this study designed a set of gamification teaching strategies to explore their impact on the learning engagement of children aged 3-6 years. This study adopts the case study method, focuses on the difference between multi-modal strategy and single-modal strategy, and conducts investigation and data analysis on 130 children in the class of multi-modal gamified teaching strategy. Moreover, interviews are used to collect data from 8 parents and 4 preschool teachers, to explore how multimodal gamification strategies affect the classroom teaching effect in kindergarten, as well as the cognitive development and learning interest of children. The results showed that the gamification teaching strategy significantly increased children's interest in learning, engagement and cognitive focus, and the findings provide theoretical support and practical guidance for early childhood education.

Keywords: Multimodal theory, Gamified teaching strategies, Early childhood education, Cognitive development, Motivation to learn

1. Introduction

As the education system continues to develop, early childhood education, as a fundamental stage, has received considerable attention in terms of its teaching quality and methods. Recent studies have examined the multimodal teaching approach in early childhood English education. Empirical evidence shows that this method can enhance young children's attention span and cognitive shifting. Thus, it is concluded that multimodal teaching methods overcome the limitations of traditional single-modality ones, improving language learning results [1]. In addition, a study by Alotaibi M. S. indicated that gamification strategies in early childhood education have demonstrated significant benefits in promoting cognitive, social and emotional development [2]. This research investigated the effects of a multimodal gamification approach on the academic engagement of children aged 3 to 6 years. The study employed a case study methodology, surveying 130 youngsters and conducting semi-structured interviews with 8 parents and 4 instructors. A comparative case study approach was employed to evaluate the efficacy of multi-modal gamification compared to traditional single-modal techniques in early childhood education. The results of the study allow for the identification of specific effects of multimodal gamification strategies on children's cognitive development, collaborative learning and social interactions, while also enhancing overall learning engagement.

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2. Literature review

2.1. Theories of gamified teaching and learning

The effectiveness of gamified teaching strategies is grounded in social learning theory and self-determination theory, both of which emphasize motivational reinforcement, social interaction, and continuous participation in learning. Role-playing is a gamification pedagogical approach that aligns with the social learning paradigm, emphasizing the social dimension of education by engaging students both socially and intellectually through collaborative behavior, hence enhancing their interest in the subject matter [3,4]. In the experimental results of Meilina et al. found that role-playing enhances children's independence and social development, making it a valuable gamification strategy for fostering motivation and interactive nature in young learners [5]. Additionally, the team task and social interaction features of gamification instruction can promote collaboration and communication among learners [6].

From the perspective of self-determination theory, gamification facilitates learning by satisfying children's psychological needs, autonomy, competence, and relatedness. According to Deci & Ryan, autonomy is supported by providing choice-based learning activities, competence is reinforced through instant feedback mechanisms, and relatedness is enhanced via social interactions within gamified tasks, thus enhancing learners' intrinsic motivation [7].

2.2. Multimodal gamification

Building on the concept of gamification, multimodal gamification represents an evolution by incorporating multiple modes of interaction and literacy. Mentioned in the GamAll project, multimodal gamification combines gamification with multimodal literacy, integrating multiple modes within a gamification framework to create an engaging educational experience designed to enhance learning by leveraging multiple interactive channels [8].

Multimodality provides rich materials and interactive opportunities for gamification, which can further enhance the effect of multimodal learning by introducing game elements to stimulate children's learning motivation and participation. For instance, immediate feedback in a gamified environment helps children better process and understand multimodal information [9]. A study conducted in a first-tier Chinese city found that multimodal gamification strategies significantly increase learning engagement in early childhood education. In particular, through the development of social interaction and improved cognitive skills [8].

Nonetheless, prior studies have predominantly concentrated on juxtaposing gamification with conventional approaches, resulting in a deficiency in comprehending the distinct function of multimodal instructional design within gamified education. The Kid Space system, developed by Aslan et al. significantly increases young children's engagement, reduces screen dependency and promotes physical social activities through physical social interactions and collaborative play [10]. This study is relatively consistent with the present study in the context of combining multimodality and gamification. However, while the Kid Space system focuses on children's early math skills, it leaves a significant gap in fully exploring children's attention. Based on the study by Aslan et al. on children's spatial cognition, this study achieves a theoretical breakthrough through two innovations: firstly, we adopt the control variable method to precisely isolate the effects of multimodal elements (e.g., haptic feedback and narrative cues) on the learning effect, and secondly, we establish a participation index that is consistent with the motor and attentional abilities of 3-6-year old children, providing accurate and operable practical meaning. This not only extends the application of the ChildSpace system but also provides new insights and practical suggestions for curriculum design and pedagogy in this area.

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3. Method

3.1. Research design

Based on an empirical study in a first-tier city in China, the study focuses on the effects of multimodal gamification strategies on children's learning from 3 to 6 years of age. The study was conducted in three public kindergartens in Guangdong Province. To ensure the scientific validity and objectivity of the study, six kindergarten classes were randomly selected and divided into an experimental group (N=15, 20, 30) and a control group (N=15, 20, 30). Among them, the experimental group adopted a gamification teaching strategy based on the multimodal gamification theory, incorporating visual (animated videos, images), auditory (rhythmic games), and tactile (role-playing, body contour drawing) gamification elements into the teaching process to enhance the children's learning experience and effectiveness. In contrast, the control group adopted the traditional single-modal teaching strategy, which mainly focused on role playing and theory combing. The three experimental groups were taught about the development of healthy habits, the perception of spatial belonging, etc. All experimental groups adopt the same multi-modal teaching methods. The purpose is to stimulate students' learning interest in an all-round way, mobilize the synergistic effect of multiple senses, and improve teaching effect. Each session lasted 35 minutes, and engagement levels were assessed through direct classroom observation, teacher feedback, and structured quizzes.

3.2. Data collection methods

Classroom observation: Children's behavioural engagement was systematically assessed in terms of the observational dimension through structured observations. Here, teachers in the classroom measure children's time spent on sustained tasks (in minutes), off -task behaviors, and non-verbal behaviors (reactive gestures and social interactions) frequency. To guarantee measurement consistency, all educators adhered to standardized teaching methods, and assessment criteria were established and validated prior to the study.

Semi-structured Interviews: Eight parents and four teachers were randomly selected to participate in semi-structured interviews to evaluate the effectiveness of the intervention. The purpose of random selection was to ensure the representativeness of the sample and the reliability of the findings. Parent interviews focused on children's imitation of multimodal classroom elements (e.g., songs, media), emotional regulation in rule-based scenarios (e.g., waiting, sharing), and spontaneous play-based behavioural restructuring. Questions such as 'How does the child's emotional regulation change from pre-intervention when presented with a situation that requires waiting or following rules? Teacher interviews addressed multimodal versus traditional strategies for comparative engagement and post-intervention behavioural change. Example: 'What are the relative differences in engagement between multimodal and traditional approaches?'

3.3. Data analysis methods

The study assessed multimodal gamification's effects on learning engagement through qualitative analysis of classroom observations and interviews, examining behavioral patterns, teacher/parent feedback, and task-specific interest. Interview transcripts were analyzed via NVivo, employing thematic analysis to identify engagement dynamics, emotional regulation shifts, and cognitive recall patterns. Coding techniques and word frequency analysis systematically evaluated the efficacy of multimodal gamification strategies.

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4. Research findings

Table 1: Comparative results across three experimental studies

Category	Metric	Study 1	Study 2	Study 3	Control Group
Cognitive Ability	Body part accuracy (%)	92	-	-	81
	Functional understanding	85	-	-	60
	Story understanding (%)	-	90	-	75
	Action judgment (%)	-	85	-	60
	Emotion understanding (%)	-	-	73.3	73.3
	Emotion recognition (%)	-	-	70	63.3
Motor Engagement	Participation rate (%)	91	95	83.3	72/80/66.6
Temporal Metrics	Focused duration (min)	9.3	10.5	11.6	6.2/8.2/9.2
	Task persistence (%)	83	80	90	67/65/80
Course Objectives	Summary accuracy (%)	94	80	90	65/65/80

Notes: 1. "–" indicates the metric was not measured in that study. 2. Control Group values align with Study 1/2/3 (e.g., 72/80/66.6). 3. Time units: min = minutes.

The table above indicates that the children in the experimental group exhibited markedly superior concentration duration, participation rate, and accuracy on the memory classroom summary test relative to the control group pupils. In the experimental group, 80% of children recalled classroom aspects, but only 65% of children in the control group did so. The children in the experimental group exhibited a greater inclination towards collaborative learning during role-playing; specifically, the duration of concentration for the experimental group was 11.6 minutes, in contrast to 9.2 minutes in the control group.

Interview results:

The results of the interviews were retained in the experimental/control group comparison framework and reorganized according to the themes of the study: 1. Ability to transfer instructional elements. Children in the experimental group were able to clearly recount the details of the role-play after the lesson (e.g., "describe the specific role they played today") and actively transfer the classroom elements to their daily lives (humming the learning song and explaining hygiene when washing their hands). Although the children in the control group enjoyed the role-playing process, they had a vague memory of the story ("could not recall the specific story line") and imitated the behavior superficially (mimicked the character's actions but could not explain the logic of the behavior). 2. Emotional self-regulation skills. The experimental group significantly improved their self-regulation strategies, with 80% of the children demonstrating innovative emotional management (e.g., independent use of classroom rhyming games while waiting) and initiative in sharing situations. The control group still relied heavily on external interventions (75% of the children needed verbal prompts from adults) and lacked transferability of emotion regulation strategies. 3. Children in the experimental group demonstrated metacognitive abilities and were able to translate virtual character traits into behavioral guidelines (e.g., establishing a self-monitoring mechanism for washing hands and taking pictures). In contrast, children in the control group demonstrated mechanical repetition of play behaviors, only repeating the teacher's instructions (e.g., "because the teacher said it's good") and lacking internal logic. 4. Social interaction performance. In the experimental group, the frequency of children's cooperative behaviors increased twofold (deep interactions such as cooperative block building were observed), and the accuracy of emotion recognition increased by 60%. In the control group, social interactions were still dominated by parallel play, and additional teacher prompting was required to express emotions. 5. Regarding the effectiveness of teaching strategies (teacher observation), in the experimental group an immersive learning cycle was formed, children's attention

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span increased by 40%, and the speed of concept transfer increased by 58%.The control group exhibited a notable decline in motivation, characterized by a 30% increase in prompting frequency, but the application of knowledge remained confined to the classroom setting.

(Note: This study was analyzed using a mixed methods approach, with quantitative data from structured observation protocols and qualitative data from semi-structured interviews.)

Interview findings:

The analysis of high-frequency words in the corpus showed that core concepts such as "classroom" (n=11) and "children" (n=9) appeared frequently. This shows that the research focuses on classroom dynamics and student engagement. The experimental group's responses, such as children using rhythm games for self - regulation and integrating classroom songs into daily routines, show that gamification teaching strategies based on multimodal theory can enhance learning engagement and emotional development. The control group's dependence on adult prompts and challenges in transferring knowledge beyond the classroom underscore the shortcomings of conventional approaches. The interview findings corroborate our observational data, affirming that gamification teaching tactics enhance children's learning engagement and emotional development in the classroom environment.

5. Discussion

Compared to the existing literature, which mostly focuses on the binary comparison between traditional teaching and gamification methods, this study innovatively fills the gap in research on multimodal teaching mechanisms from three dimensions: (1) establishing a systematic comparison framework between multimodal (narrative role-play and tactile aids) and unimodal teaching for the first time; (2) developing role-play-based gamification strategies; and (3) constructing a three-dimensional participation assessment system that covers behavioural, affective (attention maintenance), and social interaction (cooperative behaviour).

In practice, the study's implications are significant for enhancing early childhood education. Social learning theory highlights learning through observation, imitation, and interaction, while Self-Determination Theory identifies autonomy, competence, and relatedness as key motivators [7,11]. Based on our findings, we offer specific teaching practice optimizations:

Curriculum designers can integrate the “observation-imitation-timely feedback-situated interaction” mechanism with multimodal gamification teaching to create more effective and engaging learning environments. For instance, children learn by observing game characters and situations, then imitate and practice these behaviors in the game. Teachers or systems provide timely feedback based on their performance, helping them correct errors and reinforce knowledge. Meanwhile, the situational interaction in games enables children to apply what they’ve learned in simulated real-world settings. Multimodal elements like visuals, sound effects, and tactile props enrich the experience, making learning more vivid and enjoyable, and effectively improving learning outcomes. Teachers can also balance structured goals and open-ended exploration in curriculum design to maximize the potential of gamified education by supporting practice with theory.

First, the current study was conducted in a first-tier urban setting, where educational resources (e.g., teacher training, digital infrastructure) and family socioeconomic profiles may significantly differ from rural areas. The findings may not fully generalize to rural populations. Second, the current research is limited to the Chinese educational system, which limits cross-cultural applicability, especially to individualistic educational systems (e.g., American or European settings). Studies have shown that teaching methods in China are more teacher-dominated, whereas in other cultures like the UK, student-centered educational practices are more common [12]. Third, the short-term intervention window precludes conclusions about the applicability of urban-centric implementation of multimodal

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strategies. The observed effects on engagement and cognitive transfer may diminish or evolve differently over extended periods.

To resolve these difficulties, subsequent study may encompass comparative studies across various geographical contexts to investigate potential urban-rural disparities in implementation tactics. The influence of parental attitudes and educational systems across various cultural contexts, such as China and the United States, on the efficacy of multimodal gamification strategies warrants investigation. Additionally, longitudinal studies examining the differential outcomes of multimodal gamification educational strategies in public, private, and community kindergartens should be conducted. Subsequent study should concentrate on the longitudinal impacts and adaptive strategies of multimodal gamification.

6. Conclusion

The study experimented with 130 young children to explore how multimodal and traditional single - mode gamification teaching strategies affect their learning motivation; the results of the study show that the synergistic effect of multimodal and gamification teaching strategies is significant in the following ways: (1) improved cognitive skills; (2) increased interest and engagement in learning; (3) high rates of achievement of learning objectives; (4) encourage collaborative learning and social interaction.

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