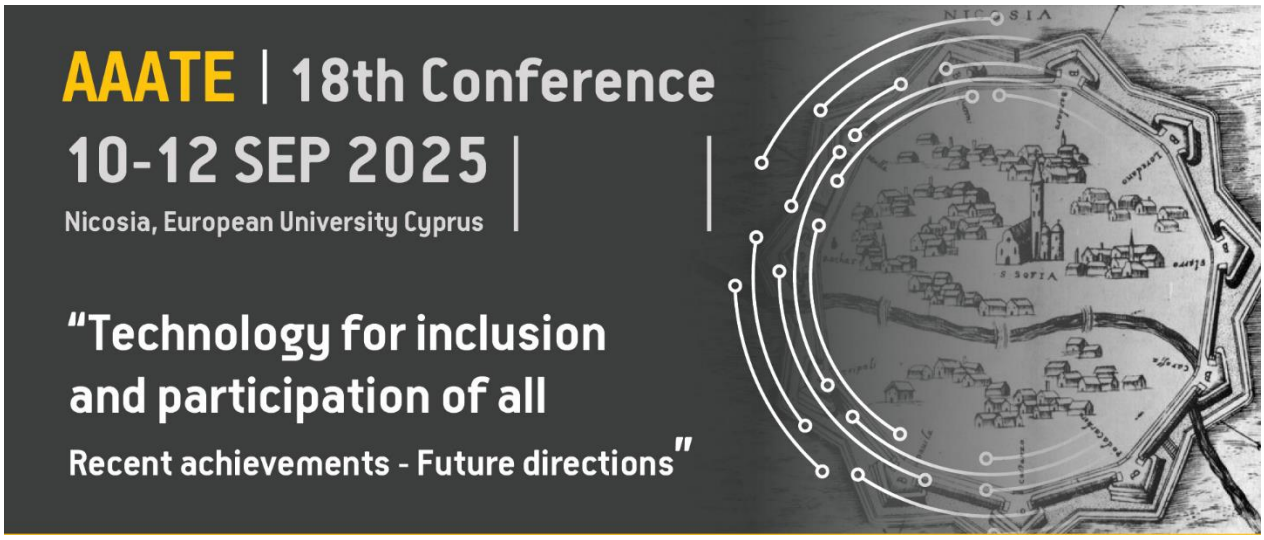

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Adaptive Learning and Gamification: Physical Assessment Tool for Students with Learning Disabilities

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Abstract: The integration of adaptive learning and AI gamification has opened new possibilities for personalized education, particularly for students with severe learning difficulties (SLD) and profound and multiple learning disabilities (PMLD). Despite these advancements, there is a significant lack of tools capable of dynamically measuring and adaptively challenging students' physical response times, which are critical for motor skill development and engagement. This study investigates the impact of rule based adaptive difficulty in a "Whac-a-Mole" game on physical response metrics, specifically reaction time and hit consistency. By utilizing AI algorithms, the system dynamically adjusts task difficulty based on individual performance, ensuring an optimal balance of challenge and ability. Additionally, the research aims to establish baseline physical response data for each student with SLD and PMLD to better identify milestones, track progress, and support individualized learning goals. Preliminary findings suggest that the adaptive approach enhances engagement, improves response time consistency, and provides valuable data for educators and therapists to monitor physical and cognitive development. This study contributes to the development of dynamic, data-driven tools that foster measurable progress in physical response skills within adaptive educational settings.

Keywords: Adaptive Learning, Rule based Gamification, Assistive Technology, EdTech

1 Introduction/Background

Adaptive gaming and Gamification have emerged as a powerful educational approach for engagement, skill development, and mental health improvement, particularly for individuals with disabilities. Adaptive gaming technologies have played a critical role in ensuring inclusivity, enabling individuals with diverse abilities to participate in meaningful and enjoyable activities. Despite its promise, the specific impacts of gaming on mental health, emotional resilience, and cognitive growth require further investigation. Research has highlighted the potential of gamification to address anxiety, stress, and depression through features like mood tracking, immersive environments, and tailored game mechanics. These elements not only engage users but also promote emotional regulation and mental health treatment [4][5].

Recent studies have also demonstrated the utility of gamification in detecting and addressing cognitive dysfunction and mental illnesses. For instance, it was explored that gamified psychological tests can be used as tools for early detection of cognitive decline, highlighting their potential for young adults [2]. Similarly, games have been developed for cognitive rehabilitation, illustrating how gaming can support patients recovering from brain injuries [7]. These interventions leverage engaging game elements like avatars, rewards, and narrative storytelling to encourage participation and improve cognitive outcomes. Moreover, it has also been emphasized how gamification can reduce stigma surrounding mental health by creating a safe, interactive space for users to manage stress, anxiety, and mood disorders [3]. Together, these studies highlight the effectiveness of gamification as both a diagnostic and therapeutic tool for diverse mental health needs.

This research builds on the growing body of evidence supporting the integration of gamification into education and therapy for individuals with disabilities. Conducted in collaboration with Filisia Interfaces Ltd. The company has successfully developed an award-winning assistive hardware (COSMO), which is being used in schools, therapy, and homes to aid in learning for users with SEND. Filisia Interfaces Ltd. has also carried out their own research on how assistive technologies assisted by a data driven approach can be helpful in generating insights for progress tracking of SEND individuals [1]. Drawing on frameworks like the Basic Needs in Games Model, this paper examines how gaming satisfies psychological needs for autonomy, competence, and relatedness [6].

2 Methods

2.1 AI Gamification Design

Game Adaptation for Response Assessment:

- The "Whac-a-Mole" game is presented as a digital interface using the COSMO Training App and COSMO switches to ensure accessibility for students with physical limitations.
- Visual and auditory cues (e.g., lit or sound-producing cosmoids) are used to engage participants. A cosmoid (digital “mole”) lights up randomly, prompting students to respond to it by tapping.
- Two modes are introduced:
    - Normal Mode (Baseline Activity): Allows for the game to be played normally without any implementation of the assessment features. o
    - Assessment Mode (Adaptive Difficulty): This mode measures the participant's baseline physical response in a controlled environment

User Interaction and Feedback:

- Each session lasts a predetermined duration of time, ensuring the game is not overwhelming while capturing sufficient data for analysis.
- Visual and auditory feedback is provided immediately after successful hits or missed hits.

2.2 Adaptive Mechanism

To ensure that the game remains engaging and appropriately challenging, Rule based logic algorithms dynamically adjust the difficulty based on the participant’s ongoing performance.

Rule-based Difficulty Adjustment:

A rule-based model is employed to analyze user input in real-time. The system evaluates two core physical response metrics:

- Reaction Time: The duration (in milliseconds) between the cosmoid lighting up and the participant’s response (e.g., tap or interaction).

- Hit Consistency: The percentage of successful hits versus total opportunities, including missed attempts.

Parameters for Difficulty Adjustment:

The difficulty level is adjusted based on thresholds derived from user performance metrics, ensuring the task is neither too easy nor too difficult:

- **Increasing Difficulty:**

If the participant achieves consistent reaction times below a pre-determined threshold (e.g., <2 seconds) and maintains a hit consistency above 80

- **Decreasing Difficulty:**

If reaction times exceed a pre-determined threshold (e.g., >4 seconds) or hit consistency drops below 50%

Data Collection and Logging:

- The system records all performance metrics during gameplay, including:
- Response Time Logs: Individual reaction times for each cosmoid interaction.
- Success Rates: Total hits vs. misses and hit consistency percentages.
- Adaptation Triggers: The points at which the model adjusts difficulty based on performance data.
- These logs are stored in a secure database for post-session analysis and progress tracking.

Participants and Tools

- Participants: A sample group of students with SLD and PMLD will be selected, ensuring diversity in age, abilities, and motor skills.
- Tools: The COSMO Training App (iPad application) and COSMO switched which are Bluetooth enabled accessibility switches will be used to ensure inclusivity and effective data collection. Ethical Considerations
- Parental/guardian consent will be obtained for all participants.
- The game design prioritizes inclusivity, comfort, and engagement while avoiding stress or frustration.

3 Results

3.1 Baseline and Progress Measurement

The methodology includes establishing a physical response baseline for each participant to identify milestones and track progress over multiple sessions:

Initial Baseline Measurement:

- Participants' reaction times and hit consistency are recorded over three sessions. The averages from these sessions establish their baseline physical response metrics.

Progress Monitoring:

- In subsequent sessions (assessment mode), performance metrics are compared to the baseline to track improvements in:
    - Reduction in average reaction time.
    - Increase in hit consistency (percentage of successful hits).
- The model's adaptive difficulty ensures that progress is measured in alignment with each participant's abilities, allowing for gradual and measurable improvement.

Milestone Identification:

- Performance thresholds (e.g., improved reaction times by 20% or increased hit consistency above 70%) are identified as milestones to evaluate progress.

4 Discussion

This study proposes to investigate how adaptive difficulty impacts response times and consistency in individuals with SLD and PMLD through a gamified Rule Based Logic-driven system. The research aims to explore whether increasing the difficulty of tasks—by reducing response windows will initially challenge participants but ultimately lead to improvements in motor response and hit consistency over time. Additionally, the study seeks to identify patterns in performance that may indicate fatigue or peak engagement periods, such as increased response times or reduced accuracy after prolonged activity. By analyzing these trends, the research will provide insights into how adaptive systems can balance challenge and rest to optimize performance and engagement. The findings are expected to have significant implications for personalized physical education, as the proposed framework could dynamically tailor tasks to each individual's abilities, ensuring appropriate levels of challenge that promote progress without causing frustration or fatigue. This work aims to lay the foundation for scalable, AI-driven tools that enhance motor skill development and physical engagement in educational and therapeutic settings.

5 Conclusion/Implications for the AT field

This study demonstrates the application Dynamic Difficulty Adjustment algorithms for an adaptive assessment tool in evaluating and improving physical response metrics, such as reaction time and consistency, through a gamified "Whac-a-Mole" system. The findings highlight the effectiveness of dynamically adjusting difficulty levels to match individual abilities, fostering engagement and measurable progress among students with SLD and PMLD. Based on this, it is seen that the chosen method of gamification is valid for this concept, as it changes the complexity of the game to garner more engagement and achieve results in the form of a physical baseline for students. Furthermore, the implications of assistive technology are significant, as such tools can enhance accessibility, promote inclusivity, and empower students with diverse physical and cognitive needs. By bridging the gap between technology and individualized learning, this research contributes to advancing AI-driven tools that support both educators and students, with further potential applications in education and health contexts.

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