AKtiveWorld: A Gamified Mobile Application for Social Skills Development in Children with Autism Spectrum Disorder

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ABSTRACT

This study presents AKtiveWorld, an offline gamified mobile application designed to support social skills development among children with autism spectrum disorder (ASD) aged 6 to 12. The system integrates a rule-based dialogue mechanism, a threshold-based reinforcement algorithm, and a personalized progress tracking feature to provide a structured and adaptive learning environment. Through virtual character interactions and scenario-based dialogues, the application simulates real-life social situations that allow users to practice appropriate social responses in a safe and controlled setting. The study evaluated three core system components. First, the rule-based dialogue system achieved a functional suitability score of 3.6, indicating effective dialogue flow, scoring accuracy, and task completion. Second, the threshold-based reinforcement mechanism utilized the Independent Positive Count (IPC) to assess user performance, where a score of 11 out of 15 (73.33%) met the required 70% passing threshold, confirming the system's capability to identify weaker social skills and reinforce them through repeated dialogue exposure. Third, the personalized progress tracking feature demonstrated its effectiveness in monitoring and recording user responses, contributing to continuous skill improvement and obtaining a usability mean score of 3.8. In addition, the system achieved a performance efficiency mean score of 4.8, reflecting responsive interaction, smooth scene transitions, and stable offline operation. The findings indicate that AKtiveWorld is a functional, usable, and effective platform for supporting adaptive social skills learning among children with ASD.

Keywords: Autism Spectrum Disorder (ASD), Gamified Learning, Rule-Based Dialogue System, Threshold-Based Reinforcement, Social Skills Development, Mobile Application

INTRODUCTION

Autism Spectrum Disorder (ASD) is a developmental condition that affects social communication, behavioral interaction, and the interpretation of social cues. Children with ASD commonly experience difficulties in recognizing emotions, maintaining conversations, and responding appropriately in everyday social situations, which may limit their ability to build relationships and participate effectively in social environments. Conventional interventions such as therapy sessions and social skills training provide structured support; however, these approaches may offer limited opportunities for continuous, interactive, and repeatable social practice in realistic scenarios.

Recent advancements in mobile and gamified learning technologies have introduced alternative approaches for supporting social development among children with ASD. Interactive systems that utilize structured scenarios, adaptive feedback, and virtual character interactions have shown potential in improving engagement, motivation, and communication skills within controlled digital environments.

AKtiveWorld is a gamified offline mobile application developed to support social skills development among children with mild to moderate ASD aged 6 to 12. The application utilizes pre-authored dialogue scenarios and non-player character (NPC) interactions to simulate real-world social situations in a safe and structured

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environment. Users interact with virtual characters by selecting dialogue responses, allowing them to practice appropriate social behavior and observe corresponding outcomes.

The system integrates a rule-based dialogue mechanism and a threshold-based reinforcement algorithm to evaluate user performance through categorized responses identified as positive, neutral, or negative. Using the Independent Positive Count (IPC), the system identifies weaker social skill areas and reinforces them through repeated exposure to relevant dialogue scenarios. In addition, AKtiveWorld includes a personalized progress tracking feature that records user responses and monitors performance throughout gameplay.

The application operates entirely offline to improve accessibility and usability without requiring internet connectivity. Gamification elements such as points, guided progression, and adaptive dialogue reinforcement are incorporated to maintain engagement while supporting structured learning. This study evaluates the functionality, usability, and performance efficiency of AKtiveWorld as a gamified and adaptive platform for supporting social skills development among children with ASD.

Significance of the Study

The following individuals and groups may benefit from this study, as it introduces a gamified and adaptive mobile application designed to support social skills development among children with autism spectrum disorder (ASD) through structured dialogue interaction and personalized learning mechanisms:

1. Children with Autism. Children with autism will benefit from an engaging, gamified learning environment that helps them practice important social skills in a structured and safe space. The scenario system personalizes their learning experience, reinforcing skills like greeting, sharing, and emotional expression through interactive dialogues with virtual characters.
2. Parents and Guardians. Parents and guardians will gain a supportive tool that with built-in feedback and progress tracking, they can monitor their child's development and identify areas that need further practice.
3. Special Education Teachers and Therapists. Special education professionals can use the system as a repeatable and measurable tool to support social skills instruction. The game's rule-based logic ensures consistency while allowing them to track how a child responds to different social situations across multiple sessions.
4. Educational Institutions and SPED Programs. Schools and special education programs may integrate the platform as part of inclusive education strategies. The structured design and performance-based progression make it scalable and adaptable for diverse student needs.
5. IT and Game Development Students. Student developers will gain hands-on experience in implementing logic-based algorithms, structured dialogue systems, and scenario selection techniques in educational game design. The project serves as a model for purposeful and adaptive systems.
6. Future Researchers and Developers. This study can serve as a foundation for future research into non-AI adaptive learning systems. The algorithmic approach to scenario selection and performance tracking provides an alternative to data-heavy, AI dependent methods.

Scope and Delimitation

This study focuses on the design, development, and evaluation of AKtiveWorld, an offline gamified mobile application intended to support social skills development among children with mild to moderate autism spectrum disorder (ASD) aged 6 to 12. The application utilizes structured dialogue scenarios and virtual character interactions to simulate real-world social situations in a safe, controlled, and engaging digital environment. Through scenario-based interactions, users are provided opportunities to practice recognizing and responding to social cues related to common social behaviors such as greeting, sharing, and apologizing.

The system integrates a rule-based dialogue mechanism and a threshold-based reinforcement algorithm that adapts future interactions according to user performance. The dialogue component consists of 15 structured scenarios distributed across five targeted social skill categories, with three dialogue interactions assigned to

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each category. User responses are categorized as positive, neutral, or negative to support adaptive scenario selection and personalized progress tracking. The study covers the implementation and testing of the system's primary features, including dialogue interaction, adaptive reinforcement, virtual character engagement, and local progress monitoring. Evaluation is limited to the assessment of functionality, usability, engagement, and performance efficiency within an offline mobile environment.

The study is limited to children with mild to moderate ASD and may not fully address the needs of users with severe cognitive, behavioral, or developmental conditions. Since the system relies on predefined dialogue structures and multiple-choice interactions, it may not completely represent the complexity and unpredictability of real-world social communication. Although the threshold-based reinforcement mechanism provides adaptive learning support, interaction remains constrained within pre-authored scenarios and structured response pathways. Future research and development will prioritize the integration of advanced interactive modalities such as voice input, emotion recognition, and branching dialogue to transition from structured interactions toward more authentic social environments.

In addition, the application operates entirely offline, which improves accessibility but limits cloud-based synchronization, remote monitoring, and real-time content updates. User progress is stored locally on the device, making data vulnerable to loss if the application is uninstalled or the device is reset without backup. System performance may also vary depending on device specifications, particularly on lower-end mobile hardware where minor responsiveness issues may occur. Furthermore, user engagement and learning outcomes may be influenced by individual differences such as attention span, behavioral preferences, and familiarity with gamified learning environments.

METHODOLOGY

This study employed a developmental research design guided by the Agile methodology and Scrum framework. This allowed for continuous refinement of the AKtiveWorld application through iterative sprints and feedback from SPED professionals. The system was developed as an offline mobile application featuring a rule-based dialogue system, a threshold-based scenario selection algorithm, and a personalized progress tracking mechanism. The developmental process involved systematic collaboration with special education stakeholders, specifically including one (1) SPED consultant who participated in end-of-sprint reviews across four (4) two-week sprints to validate pedagogical alignment.

System Architecture and Overview

The AKtiveWorld system was designed as an interactive educational platform that operates entirely offline. The client side includes the mobile application where the user can select specific maps and interact with non-Player Characters (NPCs) to engage in social scenarios.

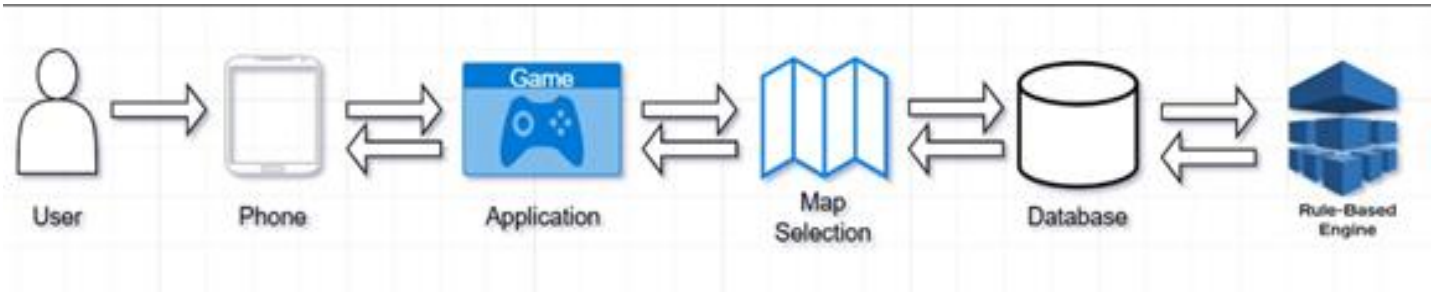

Figure 1. System Architecture

The system starts with the user, a child with autism spectrum disorder (ASD), interacting with the application on a mobile phone. The application manages the flow, allowing the user to select maps and virtual characters (NPCs) to engage in social scenarios. User interactions, including choices and responses, are recorded and stored locally using Unity PlayerPrefs or JSON storage to track progress and ensure consistency. The system's

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rule-based engine applies predefined logic and thresholds to determine scenario progression and tailor feedback based on the user's performance. This architecture provides a structured and adaptive learning environment that supports the development of social skills through interactive gameplay.

Evaluation Metrics and Instruments

The evaluation of AKtiveWorld utilized selected characteristics from the ISO/IEC 25010 Software Quality Model, specifically focusing on Functional Suitability, Usability, and Performance Efficiency. Data was gathered through direct observation during live testing sessions using a 5-point Likert scale.

The mean score for each observed behavior was computed using the formula:

$\bar{x} = \Sigma x / N$

(Where: $\bar{x}$ = Mean score, Σx = Sum of scores, N = Total number of participants/observations)

Table 1. Interpretation of Mean Scores

Mean Score	Interpretation
1.00 - 1.80	Not Observed
1.81 - 2.60	Rarely Observed
2.61 - 3.40	Sometimes Observed
3.41 - 4.20	Often Observed
4.21 - 5.00	Always Observed

Threshold-Based Scoring Mechanism

To evaluate the learner's performance and reinforce targeted social skills, the system uses a threshold-based scoring mechanism. The user interacts with NPCs across up to four attempts (A1-A4). Responses are categorized as Positive (P), Neutral (Ne), or Negative (N).

Table 2 Dialogue Attempts and Choices

Attempt	User Choices	Description
A1	P, N, Ne	First attempt. Dialogue ends immediately if P is chosen.
A2	P, N, Ne	Second attempt. Dialogue ends if P is chosen.
A3	P, Ne	Third attempt. (Negative option removed).
A4	Positive only	Corrective feedback. The system shows the correct response (No points awarded).

The system measures overall performance using the Independent Positive Count (IPC). A score of 1 is awarded if the user selects a Positive response within A1-A3. A score of 0 is given if the correct answer is only revealed at A4. The application requires a 70% passing threshold (11 out of 15 dialogues) to determine if a skill requires reinforcement or if the user can proceed.

Table 3 Independent Positive Count (IPC) Thresholds

IPC Score (out of 15)	Status	Interpretation
0 - 10	Fail (<70%)	Needs practice; scenarios will be repeated for reinforcement.
11 - 12	Pass (≥70%)	Sufficient positive responses; user may proceed to the next scenarios.
13 - 15	Mastery (≥85%)	High performance; user consistently selects appropriate responses

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RESULTS AND DISCUSSIONS

This chapter presents the results of the system evaluation based on the metrics and threshold mechanisms defined in the methodology.

Results

System Evaluation Results (ISO/IEC 25010)

The system was evaluated during an actual testing session to assess its overall software quality. The results demonstrate that AKtiveWorld successfully meets its intended objectives.

ISO/IEC 25010 Characteristic	Mean Score	Interpretation
Functional Suitability	3.6	Often Observed
Usability	3.8	Often Observed
Performance Efficiency	4.8	Always Observed

- **Functional Suitability (3.6):** The core features, including dialogue interaction, scoring accuracy, and attempt-based feedback, operated correctly and effectively guided the user.
- **Usability (3.8):** The interface was clear and easy to navigate. The user was able to understand dialogue prompts and complete tasks with minimal assistance, demonstrating high engagement.
- **Performance Efficiency (4.8):** The system consistently exhibited fast response times, smooth transitions, and stable performance without noticeable lag during gameplay.

Figure 2. Actual user interaction with AKtiveWorld in a controlled therapy environment, supervised by a SPED professional

Threshold-Based Mechanism Results

The effectiveness of the threshold-based learning mechanism was validated using the Independent Positive Count (IPC) across 15 dialogue scenarios.

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Table 4 Actual IPC Results of the User

Metric	Result
Total Dialogues Answered	15
Independent Positive Count (IPC	11
Percentage	73.33%
Final Status	Pass (Met the ≥70% Threshold)

The results indicate that the user achieved an IPC score of 11 out of 15 (73.33%), successfully meeting the required 70% passing threshold. In instances where the user selected incorrect or neutral responses (triggering A4 feedback), the system successfully marked those specific social skills for repeated exposure. This confirms that the threshold-based algorithm effectively identifies weaker areas and reinforces learning through guided repetition and personalized progress tracking.

Table 5 Threshold-Based Mechanism Results of AktiveWorld

Dialogue	Score (1 = Correct within A1–A3)	Cumulative IPC
1	1	1
2	1	2
3	0	2
4	1	3
5	0	3
6	1	4
7	1	5
8	1	6
9	0	6
10	1	7
11	1	8
12	0	8
13	1	9
14	1	10
15	1	11

The granular tracking of the 15 dialogue scenarios reveals that the algorithm effectively identifies areas of difficulty; specifically, dialogues marked with a score of 0 (Dialogues 3, 5, 9, and 12) automatically triggered the reinforcement mechanism for repeated exposure.

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions drawn from the system evaluation and the recommendations proposed for future development. The findings directly address how AKtiveWorld supports social skills training through its core mechanisms.

Conclusions

Problem 1: Problem 1: How can a rule-based dialogue system in AKtiveWorld provide children with autism, a safe and structured environment to practice essential social skills through skill-tagged, contextually appropriate NPC interactions?

The findings show that the AKtiveWorld system was able to provide a safe and structured learning environment through its rule-based dialogue mechanism. The system utilized an attempt-based guidance structure (A1-A4) alongside 15 skill-tagged scenarios to ensure consistent dialogue flow. The ISO/IEC 25010 evaluation confirmed its effectiveness, achieving a mean score of 3.6 for functional suitability and 4.8 for

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performance efficiency. These results confirm that the rule-based dialogue system was able to support skill-based learning and guided response selection effectively.

Problem 2: How can dialogue reinforcement, guided by a threshold-based algorithm, ensure that virtual character conversations repeatedly target and strengthen the child's weakest social skills while maintaining engagement within structured scenarios?

The findings show that the AKtiveWorld system was able to respond to the user's performance through its threshold-based reinforcement mechanism. The system monitored the Independent Positive Count (IPC) across 15 dialogue scenarios and compared it to the 70 percent passing threshold. When the user failed to select a positive response within the first three attempts, the system correctly marked the specific social skills for repeated exposure. These results confirm that the threshold-based algorithm was able to successfully identify areas that need improvement and support learning through guided repetition.

Problem 3: How can personalized feedback and progress tracking, based on categorized response scoring and performance thresholds, support continuous improvement in specific social interaction behaviors for children with autism?

The findings show that the AKtiveWorld system was able to support continuous improvement through its personalized progress tracking system. The system monitored user responses across the 15 dialogue scenarios and grouped them into specific targeted social skill categories. By translating the accumulated threshold data into clear qualitative remarks, the system provided data-driven feedback. These results confirm that the progress tracking feature was able to offer a clear measure of the user's development, allowing guardians and therapists to identify specific social interaction behaviors that require further reinforcement.

In conclusion, the results show that the AKtiveWorld system was able to meet the main objectives of the study. The system successfully combined structured dialogues, adaptive learning algorithms, and performance tracking into one functional and usable offline mobile application.

Recommendations

Based on the results of the study, the following recommendations are presented:

- It is recommended to enhance the User Interface (UI) and User Experience (UX) of the system to further improve visual clarity, navigation flow, and overall usability, thereby reducing the need for guardian assistance during initial interactions.
- It is recommended to expand the dialogue content and scenarios by adding more diverse social situations to provide broader exposure and support a wider range of social skill development.
- It is recommended to conduct multi-user testing with a larger and more diverse group of children with autism to obtain comprehensive data and validate the effectiveness of the system across users.
- It is recommended to integrate optional data backup or cloud synchronization features in future versions to preserve user progress securely and support long-term monitoring across different devices.
- It is recommended to explore and incorporate more advanced adaptive techniques, such as basic machine learning algorithms or artificial intelligence, to further personalize the learning paths beyond fixed threshold rules.
- It is recommended to optimize system performance further to ensure consistent, lag-free operation across a wider range of mobile devices, including lower-end hardware.
- It is recommended to maintain continuous collaboration with Special Education (SPED) professionals and therapists to ensure that any added dialogue content remains pedagogically sound and aligned with real-world therapy practices.
- It is recommended to strengthen clinical conclusions, it is recommended to conduct multi-user longitudinal testing across varying ASD severity levels, enabling a comparative analysis of learning gains over time through pre- and post-test instruments.

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