Nazarbayev University

CSCI 409 Senior Project II – Final Project Report Spring 2025

April Speaks – Final Report
Project Title: April Speaks
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1. Executive Summary

The April Speaks project aims to transform the traditional Picture Exchange Communication System (PECS) into a user-friendly digital application, empowering non-verbal children—particularly those on the autism spectrum—to express needs, emotions, and basic ideas more independently. By providing a customizable pictogram library and virtual sentence board, the app streamlines sentence construction and replicates core PECS practices in an intuitive touchscreen interface. Distinct user roles (Child, Parent, Specialist, Organization, Manager) tailor the experience for various stakeholders, ensuring that caregivers and therapists can manage content and view usage analytics. The solution uses text-to-speech to vocalize constructed sentences thus allowing other stakeholders to communicate with children in a more convenient way. Under Anara Sandygulova's supervision, an external development team built the frontend and backend, while I performed Quality Assurance and Testing—implementing automated TestNG/Selenium suites and conducting manual UI/UX evaluations. Initial evaluations demonstrate over 80% pass rates in automated tests and have identified targeted UX refinements; full end-user testing is planned upon deployment of remaining features.

2. Introduction

PECS is a method for communication used by non-verbal children, mostly those on the autism spectrum, that helps them to socialize, study, and receive support. It can greatly improve the quality of life of these children and their families.

Although the traditional, analogue PECS—using physical books, boards, and picture cards—has been significantly helpful, it has numerous drawbacks in its physical form. Carrying multiple boards and loose cards is cumbersome, cards can be lost, and finding the right pictures to form a sentence takes time and effort. Consequently, a digital PECS app should eliminate these inconveniences and make communication for non-verbal children faster and more intuitive.

My role in this Senior Project was Quality Assurance and Testing, as well as participating in requirements design. Because the app was under active development by an external team, continuous testing was essential to ensure product quality before user testing and potential deployment. Gathering defects, improving the UX, and preparing user-testing procedures were critical tasks throughout the project.

Outline of the report:

Background and Related Work: Reviews prior PECS and AAC solutions and positions *April Speaks* among them.
Project Approach: Describes system architecture, core workflows, third-party components, and team collaboration.
Project Execution: Chronicles development activities across Fall 2023, Spring 2024, and Spring 2025.
Evaluation: Details automated and manual testing results, along with plans for full user testing.
Conclusion and Possible Future Work: Reflects on achievements and outlines next steps.
References: Lists all sources cited throughout the report.

3. Background and Related Work

Early evaluations of tablet-based PECS applications have demonstrated promising results in improving communication for children with ASD. For instance, a study of a tablet-computer–based PECS Phase III app reported significant gains in spontaneous requesting and social language use among preschoolers with autism (Ganz et al., 2012);. Likewise, Soomro and Soomro (2018) developed an Android-based PECS app that yielded positive impacts on communicative competence and daily living skills, effectively translating the six-phase PECS methodology into a touchscreen format. Today, commercial solutions such as Proloquo2Go—known for enhancing classroom performance with versatile voice-output options—and PECSTalk™, which offers full access to the Pics for PECS library and multiple language support, extend these core PECS functionalities, though often rely on cloud services or carry higher license costs compared to fully offline apps.

Within the broader AAC domain, mobile core-vocabulary apps like Proloquo2Go and TouchChat HD have been shown to improve functional communication and overall quality of life for individuals with complex communication needs. Comparative research between PECS-style apps and dedicated speech-generating devices indicates that customization flexibility and an intuitive interface are key determinants of both effectiveness and user preference (Aguis and Vance, 2015). Moreover, systematic reviews of AAC interventions reveal consistent gains in language initiation, social interaction, and independence across educational and community settings, underscoring the broad applicability and impact of both PECS-inspired and SGD-based tools

April Speaks goal is providing, extensive customizable library (vocabulary), role-based customization, and an autism-friendly UX. Additionally, making it more accessible for Kazakhstan and neighbouring countries by providing proper localization eliminating inaccessible prices (PECSTalk app) or providing quality solution that can be used by professionals to take care of non-verbal children.

4. Project Approach

- **Key features:**
  🟢 - Marker is put near fully deployed features.
  🟠 - Marker is put near half deployed features.
  🔴 - Marker is put near fully deployed features.
    - Role-Based Account Management:
      - Create and manage accounts for Parents, Specialists, and Organizations.🟠
      - Login/logout with username and password.🟢
      - Password recovery via “Forgot Password” flow.🔴
      - Edit personal profile (name, surname, password).🟠
    - User Coordination & Permissions:
      - Parents/Specialists: Add, remove, edit assigned Children.🔴
      - Organizations: Manage Specialists and Children assignments.🔴
    - Categorized Picture Library:
      - Browse library by categories (e.g., Food, Activities, Emotions).🟢
      - CRUD operations on cards and categories (add, edit, remove).🟠
      - Mark certain categories as publicly available.🟢
    - Customizable Sentence Boards:
      - Configure board appearance (color, number of columns).🟢
      - Populate boards from the personal library.🔴
    - Sentence Construction & Playback:
      - Select and arrange picture cards on a sentence strip.🟢
      - Reorder or clear selected cards.🟠
      - Convert assembled sentences to speech via text-to-speech.🟠
    - Intuitive Navigation:
      - Visual cues and consistent UI elements for page navigation.🟠

- Progress Analytics:
  - View word-use analytics for selected Children.🟠
  - Filter analytics by custom date ranges.🟢
  - Download analytics reports (e.g., CSV/PDF).🟢
  - **Use-Case Diagrams** (Provided by back-end development team)**:**

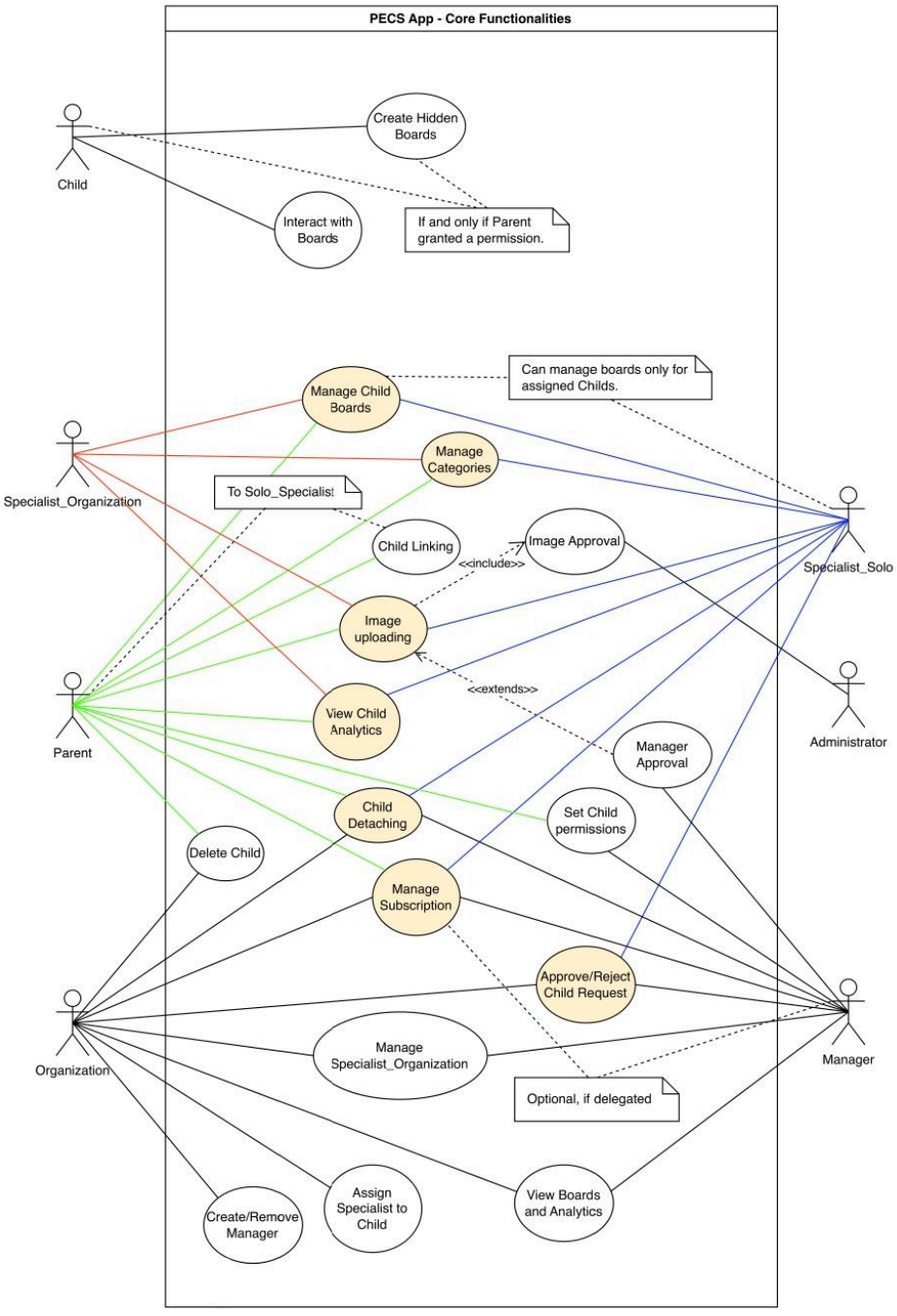

Image 1.1 Use-Case diagram of core features.

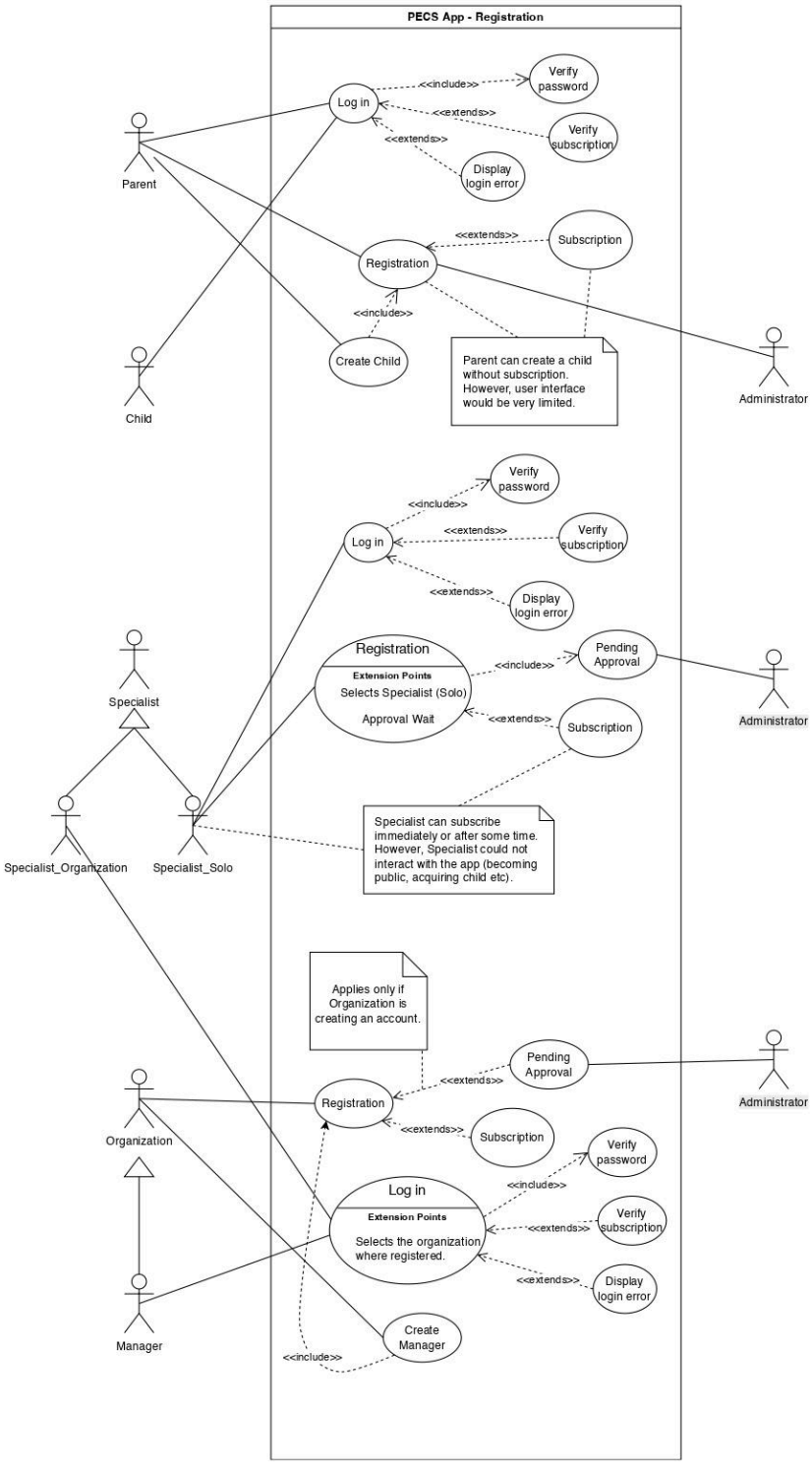
PECS App - Registration
Parent
Child
Log in
Verify password
Verify subscription
Display login error
Registration
Subscription
Create Child
Parent can create a child without subscription. However, user interface would be very limited.
Administrator
<<include>>
<<extends>>
Specialist
Specialist_Organization
Specialist_Solo
Registration
Extension Points
Selects Specialist (Solo)
Approval Wait
Pending Approval
Specialist can subscribe immediately or after some time. However, Specialist could not interact with the app (becoming public, acquiring child etc).
Applies only if Organization is creating an account.
Organization
Manager
Log in
Extension Points
Selects the organization where registered.
Create Manager

Image 1.2

- **Collaboration:** GitHub Project for version control and issue tracking; Trello for project management; weekly meeting sessions.

- **Testing:**
    - **Manual:** UI/UX walkthroughs; feature verification; child caregiver pilot sessions.
    - **Automated:** 120 TestNG/Selenium tests (Java/Maven) covering unit, integration, and UI flows; compatibility checks across OS versions and devices.

5. Project Execution

Fall 2023: Conducted PECS methodology research, identified challenges, and drafted preliminary requirements. Designed key features and created low-fidelity prototypes for stakeholder feedback. It required understanding the issue considering that it targets a narrow group of people. Therefore, identifying requirements and features was a significant part of our work during this semester.

Spring 2024: Tasks for this semester consisted of updating requirements; building the core architecture; populating the pictogram library; implementing basic card management, sentence construction, and offline TTS.

Spring 2025: Quality Assurance and UI/UX evaluation. I performed manual heuristic reviews and user-testing pilot sessions. Developed and ran automated TestNG/Selenium suites. Defined the full user-testing procedure and carried out compatibility testing. Late start for this project made me spend less time at testing, therefore the automated testing code is only covering registration and authorization features of the application. Meanwhile, the reactive nature development process, and waiting for certain testable functions to be deployed was a challenging aspect, because it decreased the understanding of project architecture thus making it harder to identify what steps and tasks should be performed first. However, collaboration with external team members allowed me to navigate through the system. Additionally, updates of the app made it more difficult to create automated testing since it required constant adjustments.

6. Evaluation

To assess system quality and alignment with requirements, we conducted:

Automated Unit Testing (Done for registration and authorization)**.**

- Total cases: 68
- Passded: 54
- Failed: 14
- Coverage: 79%

Testing results listed in detail below:

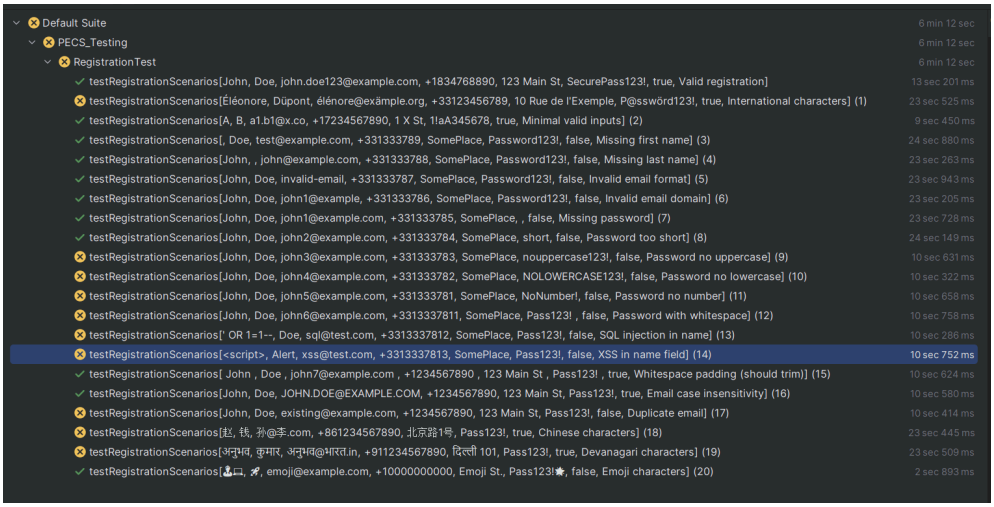

Image 2.1

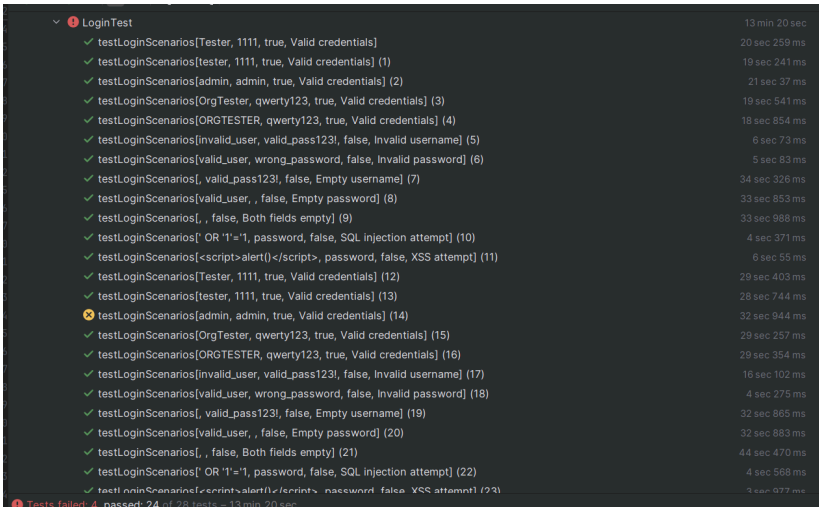

Image 2.2

Test result evaluation:

- Registration process doesn't allow use of non-latin or special characters.
- Password control is limited to only length detection, thus better security control is required.
- SQL injections and XSS are allowed, thus decreasing the security of the system itself.

Manual Testing

- Heuristic evaluation revealed navigation inconsistencies in Library and Boards pages.
- Performance inconsistencies in Analytics.
- Functional walkthroughs uncovered:
    - Board visibility in the drop-down menu varies by OS and role (e.g., missing for Parents on Windows/Mac but present on Android, reversed for Organizations).
    - Board scaling differs between vertical and horizontal modes on Android tablets.

- Error messages always appear in Russian regardless of selected language.
- Changing the UI language clears all text inputs in login/registration forms.
- The “number of lines” setting in tabs updates the layout but does not display the numeric value.
- While loading, system allows to click buttons numerous times resulting in numerous requests.

User Testing (Pending)

Core features—analytics dashboard and full role menus—are awaiting deployment; formal child-centered usability sessions and caregiver interviews will follow. Basic app functionality such as creating an account, authorization, adding a child (for “Parent” role), and customizing libraries will be used for user testing. For this testing users aged from 30 to 55 years old will be chosen to represent a parent. After completing specific tasks they will be asked to fill the questionnaire to record their feedback. For testing Board usability verbal children aged from 5 to 12 will be chosen, they will be asked to perform tasks involving boards such as, creating board tab, choosing colours, configuring board to include some words, creating a sentence. This type of testing will be in offline interview and observation form to allow testers to communicate with children and observe their actions and provide help if needed. After performing tasks users will be asked various questions to gather their feedback, either emotional or constructive.

7. Conclusion and Possible Future Work

Conclusion:

April Speaks successfully digitalizes PECS, offering an intuitive library, sentence board, and offline speech synthesis. Automated and manual testing confirm 80% functional reliability, and UX evaluations have identified targeted refinements. Some of those requirements were already met. Full user testing remains pending deployment of remaining features, but initial results indicate the app meets its goals of streamlining communication for non-verbal children and supporting their caregivers and specialists.

Future Work:

1. **Board feature & User Testing:** Conduct child usability and caregiver satisfaction studies based on their reviews. This will enhance accessibility and properly evaluate usability of the app. With each update and user tests the quality of the product will greatly increase making it ready for more targeted user tests.
2. **Automated testing improvements:** Creating more test cases, updating requirements on system functionalities based on security and performance standards. Creating

requirements not only for user-end features, but also defining requirements for coding, such as creating testable code, especially for a web based app. This requirement is a key for properly locating buttons and fields without constant adjustments.

3. **Integration testing:** also as part of automated testing integration testing is the next step in testing functionality of different features in combination with each other, more complex testing that should align with Use-Case diagrams and architecture of the program. Since the project focuses on creating system that might be integrated to specialized organizations and role based access to database integration testing will be necessary to make more effective and less-costly testing.

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8. References

1. Agius, M., & Vance, M. (2015). A comparison of PECS and iPad to teach requesting to pre-schoolers with autistic spectrum disorders. *Augmentative and Alternative Communication*, *32*(1), 1–11. https://doi.org/10.3109/07434618.2015.1108363
2. Ganz, J. B., Earles-Vollrath, T. L., Heath, A. K., Parker, R. I., Rispoli, M. J., Duran, J. B., & Furr, A. E. (2012). A meta-analysis of PECS: Effects on communication outcomes for individuals with ASD. *Journal of Developmental and Physical Disabilities*, 24(2), 187–203.
3. Soomro, S., & Soomro, N. (2018). Design and evaluation of an Android-based PECS application. *International Journal of Speech Technology*, 21(3), 555–565.