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Development and Design of a Skill Tracking Application to Aid Executive Function in Students with Autism Spectrum Disorder

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Author Note: Aut 1, is a team made up of Evan Chen, Ashley Cheung, Catherine Tai, and Ian Wendler. All are current seniors enrolled in the Industrial and Systems Engineering program at Binghamton University. The team's mentor is Dr. Romanczyk of the Institute for Child Development (ICD). To clarify, the ICD is the team's client, while the users are Binghamton University students with Autism Spectrum Disorder (ASD). The final deliverable of the project is a high-fidelity working prototype where backend security and data will be implemented by the ICD in the future.

Abstract: This paper outlines the development of Morph, a skill-tracking application designed to support students with Autism Spectrum Disorder (ASD) in managing executive function skills. Morph integrates gamification elements and user-friendly design to incentivize task completion and habit formation. Through iterative design processes and stakeholder collaboration, the application prioritizes simplicity, usability, and accessibility. This paper discusses the project's objectives, engineering methods, and identified risks, highlighting the potential impact on students with ASD and the university's community. Overall, Morph represents a promising tool that highlights the team's work of streamlined product development and design for enhancing executive function skills among individuals with ASD.

Keywords: Product Development, Application Design, Autism Spectrum Disorder

1. Introduction

1.1 Background

The term Autism Spectrum Disorder (ASD) refers to a wide range of characteristics with different intensities that can be observed. Some people with ASD may have strong executive functions, while others face significant difficulties in this area. Executive functions are a set of "cognitive processes that dictate behavior regulation and influence the ability to attain proximal goals" (Wallace, 2023). The three main areas of executive functions are memory, cognitive flexibility, and inhibitory control. These functions help us process information for goal creation and execution. Challenges in working memory can hinder multitasking and complex problem-solving, while cognitive flexibility is essential for adapting to new situations or changing plans, which typically represents a hurdle for those with ASD accustomed to routines. Inhibitory control focuses on maintaining motivation and ignoring distractions, which is critical for organization, time management, and self-regulation. Those struggling with executive functions may find aspects of daily life, including academic and personal management, particularly challenging due to difficulties in these areas.

1.2 Literature Review

Young adults with ASD struggle with the transition to college due to changes such as shifting schedules and new responsibilities like laundry and checking emails. However, studies have shown data linking technological assistance to improved focus and increased ability to complete tasks. The study focused on self-monitoring intervention for those with ASD and targeted different primary dependent variables, such as on-task behaviors, skill acquisition, and addressing problem behaviors. These self-monitoring variables are all under the umbrella of executive functioning. In the study, 33 participants aged 10 to 30 received various technological aids to assist with task completion: a mobile app that provided visual and auditory reminders, camera equipment that enabled self-monitoring through video playback, and an electronic checklist that allowed task tracking. (Li et al., 2022). The study findings suggest that technological interventions offer potential benefits to individuals experiencing difficulties in task recall and completion. The use of technology in interventions and instruction for learners with

Autism Spectrum Disorder has been recorded in previous studies as well. In a report study of 472 adolescents in high school with ASD, students reported the benefits and barriers of technology use within the educational setting. The study found that using technology both at school and at home helped in various ways, such as making them more independent, reducing their anxiety, and increasing their chances to socialize. This suggests that teachers could learn how to use technology to help students with ASD do better in school. (Hedges et al., 2017). It can be seen that using technology is a viable and feasible solution to tackling independence and executive functioning in those with ASD.

In addition, based on past literature, it is evident that students with ASD may need extra assistance when transitioning to college as a whole. As seen in an online survey completed by parents of students with ASD, there was an emphasis on the importance of wanting social interaction and independent living skills training. They acknowledged their child's potential challenges in relation to self-advocacy, emotional regulation, and adaptive skills. It is a need within this demographic for a personalized transition and customized support systems to assist in the navigation of college. (Elias, et al, 2017).

2. Methodology

In our journey to develop a skill tracking application tailored to college students with ASD, we adopted a multifaceted, methodical approach encompassing stakeholder collaboration, comprehensive research, iterative design processes, agile development methodologies, and engineering analysis. Collaboration with the Institute for Child Development (ICD), individuals with ASD, educators, and parents provided invaluable insights into the specific challenges faced by this population. Dr. Romanczyk, our mentor, facilitated these initial discussions, helping to shape our understanding of user needs and preferences.

Adopting agile development methodologies using Jira enabled flexible development cycles, accommodating rapid adjustments based on stakeholder input. Jira Software facilitates technical teams in planning, tracking, releasing, and managing software products, enabling project timeline creation, status updates, and issue reporting. Using this, we provided incremental updates and ensured that feature additions were implemented to address evolving user needs and preferences. Regular sprint reviews and retrospectives facilitated continuous improvement, ensuring alignment with project objectives and user requirements. Engineering analysis optimized UI design and functionality for individuals with ASD, focusing on color schemes, fonts, and navigation. Extensive testing, including focus groups and usability studies helped refine the application to better support executive function skills in college students with ASD. As a whole, these methods were helpful in building Morph into a minimum viable product with over eight core features and over 10 individual pages. By the end of this project, the team hopes to have met with over 25 individuals for feedback.

2.1 Requirements and Scope

During the initial research phase, our team engaged with a diverse array of subject matter experts (SMEs), each offering invaluable perspectives and insights. Dr. Romanczyk played a pivotal role by providing access to the original project details and guiding the development of a comprehensive problem statement. His mentorship facilitated connections with other experts, including Dr. Gillis, a specialist in behavioral assessment measures for individuals with ASD. In addition, we had consultations with the Service for Students with Disabilities office (SSD), led by Dr. Szymanski and Jennifer Roach, which provided firsthand accounts of support needs, reaffirming the project's significance. Insights from SSD and background literature informed our decision to prioritize executive function support within the application. This allowed us to align both the pressing needs identified and our project's feasibility constraints.

In parallel to engaging with SMEs, the team conducted a survey to gather qualitative data on challenges faced by college students, without specifically targeting ASD. This survey, consisting of five questions, garnered 22 responses from peers. The responses were analyzed to identify common challenges, with time management and self-discipline emerging as predominant issues. Additionally, the survey highlighted the various tools and techniques students utilized to overcome these challenges, ranging from social interaction to digital reminders and productivity techniques like the Pomodoro method. Figure 1 shows that 10 respondents struggled the most with managing their time and staying disciplined. In Figure 2, it is visible that 10 respondents found social interaction most helpful, although this technique did not directly help with time management. Out of the tools mentioned, five people used reminder apps. However, these apps did not help with tracking progress, giving encouragement or breaking down larger tasks. Overall, by synthesizing insights from SME consultations and survey responses, the team gained a comprehensive understanding of the project's context and requirements. This informed the refinement of the project scope to address the most pressing needs identified by both experts and potential users.

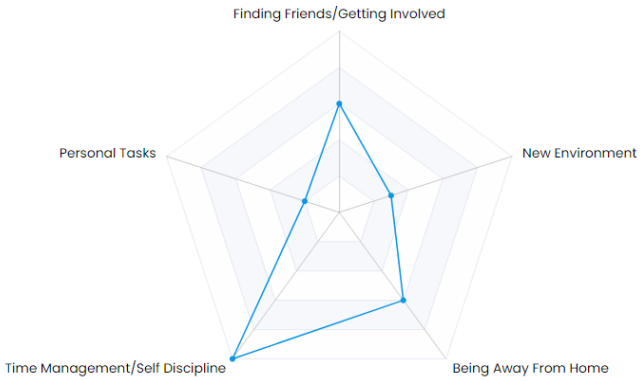

Figure 1: Challenges Faced By College Students

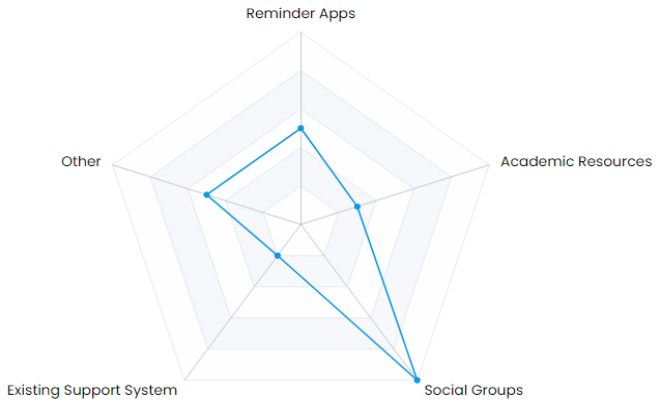

Figure 2: Tools or Techniques Used to Overcome Challenges

2.2 Design Process

Following stakeholder engagement, we conducted comprehensive research to deepen our understanding of the unique needs and challenges encountered by individuals with ASD. This research guided our design decisions, focusing on sensory sensitivities, cognitive styles, and organizational preferences. The iterative design process was central to our methodology, allowing for continuous refinement based on stakeholder feedback. We began by creating hand-drawn storyboards and prototypes, which were subsequently translated into digital mockups using Figma. Figma is a platform that enables collaborative UI/UX design for websites, mobile apps, and digital products, helping teams create, share, and test designs efficiently to speed up decision-making and feedback loops. Our prototypes underwent rigorous evaluation, including feedback from stakeholders and focus groups, leading to continuous improvements in usability and engagement. There was also an informative focus group which is touched on in Section 2.3. In the end, Morph's design iterations focused on incorporating visual schedules, customizable alerts, and intuitive navigation to enhance user experience.

In the development of Morph, significant thought was dedicated to establishing its identity both as a brand and as an application. The frontend development of Morph focuses on designing an intuitive and accessible UI for individuals with ASD. The team avoided non-intuitive abbreviations and used short, bullet-point sentences for clarity. Visual elements were prioritized due to ASD individuals' preference for colorful and animated content, facilitating communication and learning. Lastly, color choice was crucial, as it influences emotions. For instance, yellow "might be reflected as a hyper-sensitivity color to individuals with ASD and generally becomes the most fatiguing color" (Ismail et al., 2021). This is why for our application we decided to go with the color blue as "softer tones of blues banish the feeling of chaos and often soothe people" (Jones, 2021). We deliberately selected a blue-centric color palette that holds importance to the 'Light It Up Blue' campaign by Autism Speaks. In addition, the choice of the name "Morph" was inspired by the symbolism of the butterfly, which is a symbol often associated with ASD. The butterfly represents transformation, growth, and the potential for change, mirroring the diverse developmental

journeys of individuals with ASD. In addition the term "morph" itself is meant to convey the idea of transformation and adaptability, which aligns with the concept of habit formation and personal growth.

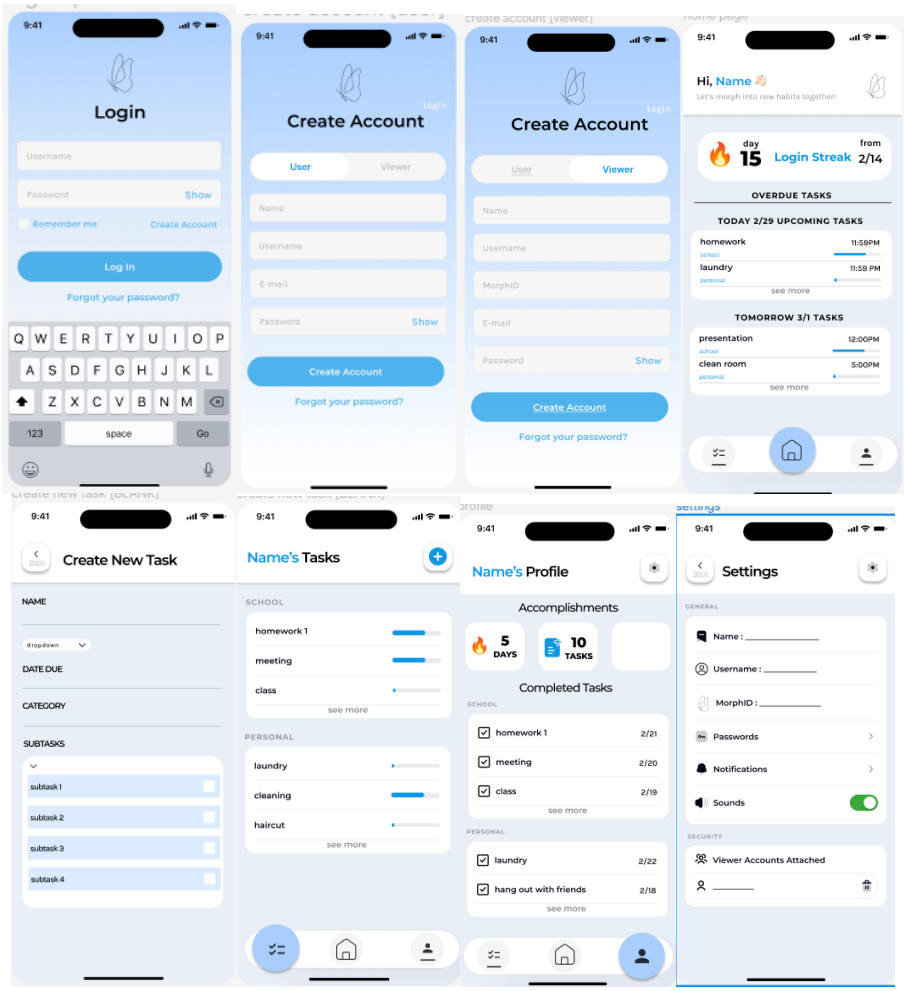

Figure 3: Figma High Fidelity Mockup

Prototypes like the ones in Figure 3 are created using tools like Figma to visualize the UI/UX design as a whole. The design also had thought in regards to icons, gamification, and personalization. By including the user's name on the top, the application becomes more personalized and connected while also reminding the user of what page they are on. Accessibility features such as icon navigation and minimal distractions are prioritized to accommodate users with sensory sensitivities. Gamification is integrated in our design in the form of accomplishments with login streaks, tasks completed, and progress bars, where, based on the goal gradient effect, will propel more engagement. " Gamification techniques or the art of employing games in the classroom are a complement to increase extrinsic motivation" (Ismail et al., 2021). Overall, this should help to increase user engagement and retention rate.

2.3 Focus Groups

A focus group composed of seven of Dr. Romanczyk's graduate and undergraduate research students was conducted to evaluate the prototyped solution, utilizing both qualitative and quantitative analysis. The quantitative survey involved ranking five attributes on a scale of 1 to 7. For the qualitative survey, participants responded to five questions, providing opinions and elaborations. In regards to feedback, the application's efficacy in addressing the problem statement was deemed useful for time management and for organization, according to the focus group. In turn, they did have suggestions, which included refining task prioritization features and enhancing user customization options. While some participants expressed

confidence in the application's potential to aid individuals with executive functioning challenges, others emphasized the need for distinct features to differentiate it from similar organizational apps.

Within focus groups, it is imperative that we prioritize feedback and feasibility within our time and scope. A lot of the ideas that were given to the group were considered but given the time and effort they would require, they were deemed out of scope. However, the focus group did allow insight into the approach to the problem statement, highlighting areas of strength and areas for potential improvement in the proposed solution. One idea we plan to implement was giving more accessibility within the application. This would be in the form of information icons prompting users to break up their tasks into smaller subtasks, as well as help points to facilitate user experience.

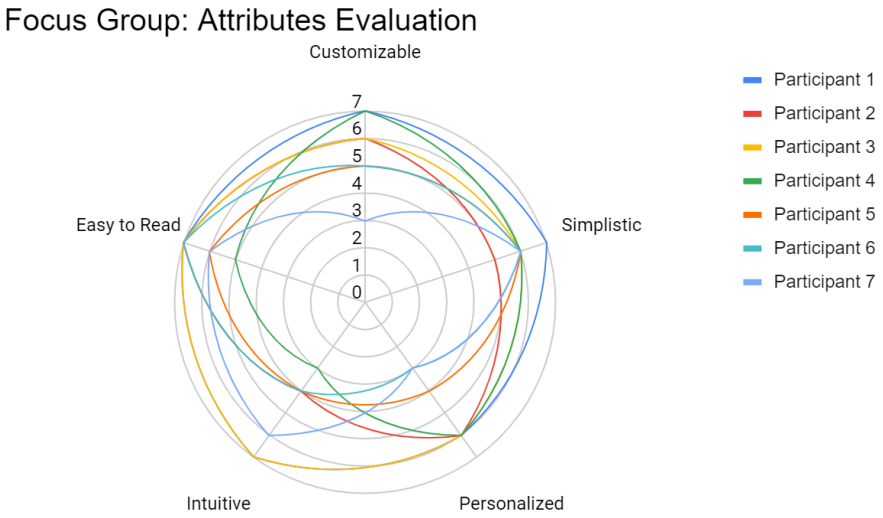

Figure 4: Radar Plot of Focus Group Results

The team has future focus groups planned as well. A focus group with the staff of SSD will be held April 9th, 2024 to gauge their thoughts on the helpfulness of the application. We hope to have a final focus group at the end of April with students with ASD as well.

2.4 Development Process

After designing what the application will look like using Figma, the team switched to the development of the application itself. This was done using the FlutterFlow application. FlutterFlow is a free-to-use online application developer that allows us to build a functional application. The application was designed based on the mockups created in Figma, with functionality being implemented to create a working application. This is the phase of development that the team is still carrying out. Because this is the most labor-intensive portion of our entire project, we allotted the most time for development. Through close communication and assistance with staff, we are staying on target to complete development of the application by our deadline of April 4th, 2024.

So far, we have acknowledged some important aspects of our project. We have realized that our final deliverable will resemble more of a high-fidelity prototype than a fully-tested beta version due to stringent security concerns related to the sensitive data of individuals with ASD. The ICD has emphasized the importance of ensuring the security and integrity of this data. Consequently, the database must be properly managed to protect against potential security breaches, safeguarding the privacy and confidentiality of users with ASD. This stringent security protocol necessitates that the implementation of backend security measures and data protection mechanisms be undertaken by the ICD itself. This explains why our prototype cannot be actually beta tested and launched in the app store. Therefore, our development phase is working towards a high-fidelity prototype of the application when we hand it off to the ICD.

2.5 Success Metrics

Success metrics for our project encompass a multifaceted approach to evaluation. Firstly, Net Promoter Score (NPS), derived from user feedback, will gauge overall satisfaction and likelihood of recommendation. Our main success metric has to deal with actually solving the problem statement. In order to do so, we will gauge success through continuous feedback loops and surveys to provide qualitative insights into user experiences, preferences, and areas for improvement. If Morph was actually to launch as an app at the end of the project, we have also thought of some key performance indicators. Task completion rate will serve as a quantitative measure of user engagement and application usability, indicating how effectively users are able to accomplish their intended tasks. To clarify, these tasks are created by the users themselves. Additionally, retention rates will indicate the application's ability to maintain user interest and utility over time, reflecting its long-term viability. In all, defining success for our application involves a holistic consideration of various criteria as well. Throughout our development, we measured success through team efficiency and our ability to mitigate risks. Ultimately, success will be achieved by delivering a user-centric solution that effectively addresses the identified problem statement, garners positive user feedback, and demonstrates tangible improvements in user productivity and satisfaction.

3. Conclusion and Future Work

In conclusion, the development and design of Morph, a skill-tracking application tailored for college students with ASD, represents a significant step towards addressing the executive function challenges faced by this population. At the time of writing this paper, the team is working on the development process to code and recreate the mockups, allowing for a working application. The usage of FlutterFlow will take up the majority of the rest of the project. The team hopes to host another focus group with Binghamton students with ASD afterwards to gauge the final changes. This will help us to refine our application to create the best possible version to assist people with ASD. The overall interactive deliverable will be debugged before being handed over to the ICD by the end of May. In all, Morph aims to empower individuals with ASD by enhancing organizational, time management, and task prioritization skills. Based on the surveys and focus groups already held, Morph has proven its commitment to inclusivity and user experience. Many participants appreciate the simplistic, easy-to-read attributes of the application. We truly believe that Morph's adoption could significantly improve the lives of college students with ASD, fostering skill development and personal growth.

In the future, other than handing off our final deliverable to ICD, we envision several enhancements and expansions for Morph. One hope is to position Morph within university student disability services as a unique opportunity for differentiation from existing skill-tracking applications. Integrating the application with prominent educational platforms like BlackBoard and Brightspace would elevate Morph's prominence and utility within academic settings. Incorporating additional customizable cosmetic options for those with more high-functioning executive function would also allow the application to suit various needs on the wide spectrum of ASD.

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