A PERCEPTIVE PROGRAM TO ASSIST REMOTE LEARNING FOR STUDENTS WITH LEARNING DISABILITIES USING SCREEN AND BLUETOOTH OUTPUT TRACKING

Angelina Zhao[1], Jonathan Sahagun[2]

[1]Crean Lutheran High School, 12500 Sand Canyon Ave, Irvine, CA, 92618
[2]Computer Science Department, California State Polytechnic University, Pomona, CA 91768

ABSTRACT

In the United States, approximately 1 out of every 44 infants born fall under the autism spectrum, leading them through a life of hardship in the future [7]. Their parents or guardians must pay extra attention to them, as they are not the best at communication and voicing their opinions. As they grow up, their education can fall behind as they struggle in school. Our program allows students to stay on task since a teacher or an adult is always watching over them and guiding them into the right direction. Developed using Python, Thunkable, and Firebase, this program includes 3 major components. The UI component is responsible for the various interactive buttons and boxes [8]. The recording component does the bulk of the job by sending off the data gathered on the student's movements down to the third component, the database which stores all of their information under each individual user ID.

KEYWORDS

Python, iOS, Firebase

1. INTRODUCTION

With the number of students who require extra assistance in order to achieve what others around them are able to achieve, the utilization of assistive technology has increased [1]. Parents of these children have spent hours guiding their young ones to the right direction in succeeding in school, however, the burden that is growing upon their shoulders may eventually be too much to bear. It has been scientifically proven that parents of those whose children may be on the autism spectrum have suffered significantly larger amounts of stress in their everyday lives [2]. The management of family affairs added onto the time spent caring for the child would be the culprits of this additional stress. They must stay attentive to their child in order to correctly teach them the ways of life and success as they see fit. Since the COVID-19 pandemic outbreak in early 2020, many previous classroom based help such as additional teachers have not been able to assist these students in ways that they had before [3]. Their academic progressions have been put on pause since remote learning has proven to be a struggle amongst all students, not just ones who struggle with learning disabilities. Students tend to stray off track and let their mind wander while their teachers make an attempt to educate them through a device screen. In the long run, these COVID-19 students will be faced with difficulties when applying to higher education or landing jobs since they weren't taught the necessary academic skills.

David C. Wyld et al. (Eds): CCSEA, AIFU, EMSA, NLCAI, NCOM, SIPRO, SEA, DKMP, BDML, BIoT, CLOUD - 2023
pp. 165-173, 2023. CS & IT - CSCP 2023 DOI: 10.5121/csit.2023.130514

The first methodology aimed to encompass all possible forms of various ways of learning into one physical sensory device to allow students to learn in the best way that they see fit. Some children may prefer audio over tangible, while others may enjoy sensory over visuals. This solution is extremely beneficial in in-person school, however, it may pose a struggle during online school.

Our proposed method of properly providing these struggling students with a means of focus during class is real time updating data of the student's keystrokes and mouse movements. This would allow teachers to check up on their students and what they're doing in order to ensure maximum participation and concentration. When a student is pressing keys or moving their mouse when they're not supposed to, the teacher or tutor can gently remind them to stay on task to learn the material. We believe that this is the beginning of an extremely effective solution as it allows the teacher to follow up on the child's interactions due to the rapidly updating data collection and the precision of the location of the mouse and the clicks. Due to the nature of those children who fall under the autism spectrum or struggle with school due to a learning disability, they can quickly become distracted or disengage in the lessons. Thus, the accuracy and feedback that the program delivers back to the teacher would reduce the time spent on nonacademic thinking [9]. We've also created a notes section to allow teachers to leave notes of where the child left off on their lesson or if any parents would like to check in on their student's engagement. Not only would this would prove to be efficient in advancing online education, but it would also significantly reduce the stress that would be placed on the parents' shoulders as they have one less thing to worry about. This ensures that students receive proper care and attention without needing to place additional pressure on their guardians.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. The Child's Device Privacy After the Class Ends

A component that might pose as a challenge is the child's device privacy after the class ends. If the program continues to record private information outside of classroom hours, it would cause heavy conflict between the two parties. I could use a function that would allow the student to control when the program would be running, thus protecting their privacy. This function would include a pause button as well, incase emergencies or breaks might occur during classtime. This function could also be implemented on the teacher's side of the app in case a student accidentally turns it off during classtime.

2.2. Sorting the Students

Another component that would cause problems is sorting the students. Two students might have the same name or be born on the same day and so if we were to just use simple names or birthdays to identify and track each student, it would cause heavy confusion as one student may be able to login into another's database. Due to this, I could assign each student a unique, long user ID that would be unable to result in duplicates. This user ID would be assigned to them through the child's email and would show up on the teacher's side with their first and last name.

2.3. A Possible Error when Signing Up

The third challenge that would result from this program is a possible error when signing up. For example, if a student were to not enter an email or enter a password that they typed wrong, it would be difficult to go back into the system and change their information as a user ID would already have been created [6]. Therefore, I could use a method of double checking. For example, I could implement a second “confirm password” box or I could make the code fail to run if the email box is left blank. Both of these features, if applied to the program, would help reduce the number of struggles when using this app.

3. SOLUTION

The program is split into 3 major components that all link together. The UI component, recording component, and the database. When the teacher first downloads the app, they will be met with various buttons and textboxes. They are able to create an account or log into an existing one through the first screen. Once logged in, they are able to add students or view ones that they had previously had and through each student, they will be able to see everything update in real time if the student is running the program. For the authentication component, we decided to use Firebase [10]. Each adding each student, they are linked with a unique user ID and that would be how each student is identified in the database. The database consists of each teacher that has created an account in the app along with each of their student’s names, emails, and last known collected positions or keys pressed.

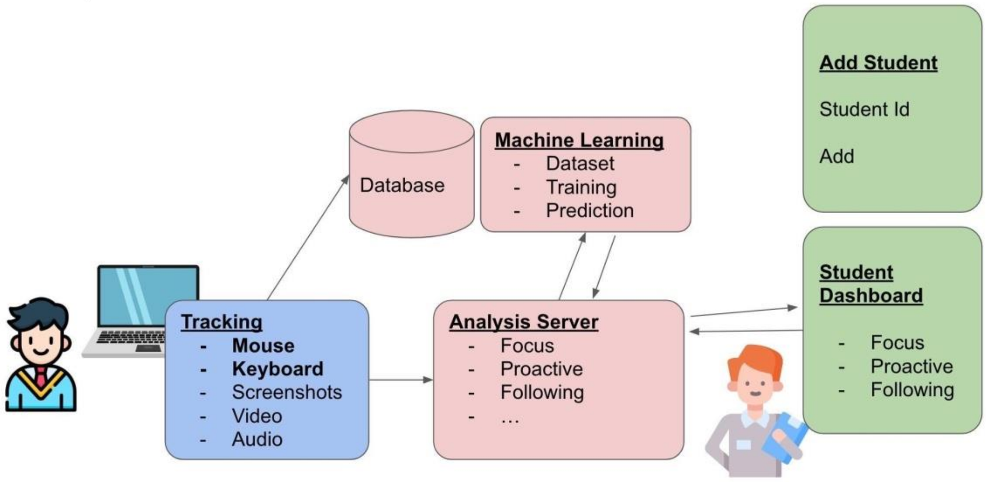

Figure 1. Overview of the solution

The UI component is what the user first sees when they download the application. They are met with a screen that has two buttons, one prompting the user to sign up and the other allows the user to sign in if they are already an existing user. We decided to use Thunkable to approach the UI component.

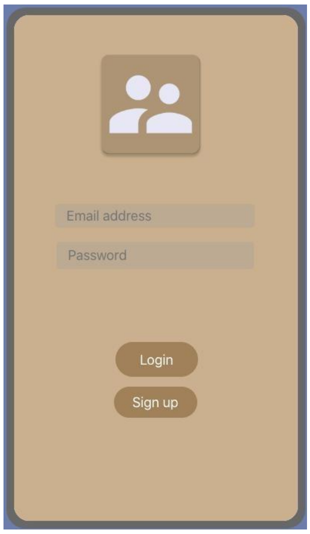

Figure 2. Screenshot of main page

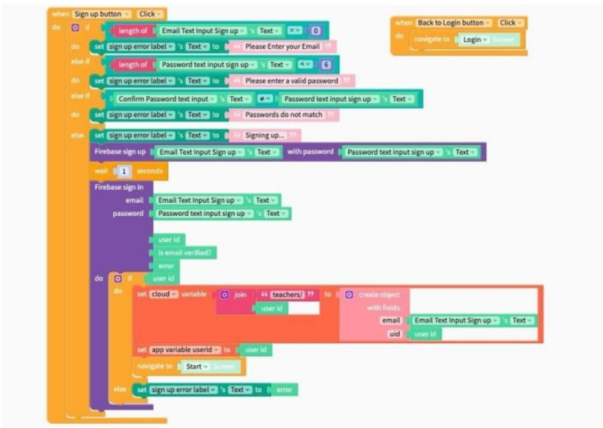

Figure 3. Screenshot of Thunkable page

Since we decided to use Thunkable for the creation of the UI component aspect of our program, the set up is quite simple [15]. At the very beginning of the program, the user is prompted to sign up or sign in. In the signup screen, the code makes sure that the user enters an email and that their entered passwords match. This takes them to the next screen which is their student screen. The buttons allow for the teachers or users to easily access each component for a smoother experience. In the login screen, each of the text boxes are matched with the proper login information in the database so the program can swiftly check if the entered information exists. If there is any mistake, there will be an error popping up on the screen. The verification is for security purposes and allows each teacher to manage each of their students separately and privately.

The recording component is the bulk of the program. We used Python to code the program out. This code tracks the student's movements and presses which then sends the data into the database for the teacher to view. There is a recording stop and start button on the student's end of the program that allows the program to stop tracking their movements once class ends.

Figure 4. Screenshot of tracking movements 1

```python
def key_press(key):
    global upload_data
    now = str(int(time()*1000))
    k = str(key)
    upload_data["live"]["last_key"] = k
    upload_data["live"]["keystrokes"][now] = k
    print("you pressed {0}".format(
        key
    ))

def key_release(key):
    print("you released {0}".format(
        key
    ))

def on_mouse_click(x, y, button, pressed):
    global upload_data
    now = str(int(time()*1000))
    clickdata = {"x": x, "y": y}
    upload_data["live"]["clicks"][now] = clickdata
    print("you {0} at {1}".format(
        "pressed" if pressed else "released",
        (x, y)))

def on_mouse_scroll(x, y, dx, dy):
    print("you scrolled {0} at {1}".format(
        "up" if dy > 0 else "down",
        (x, y)))

def on_mouse_move(x, y):
    global upload_data
    upload_data["live"]["x"] = x
    upload_data["live"]["y"] = y
    print('you moved the mouse to {0}".format(x, y)')
```

Figure 5. Screenshot of code

We used various functions to track the keyboard and mouse movements. Once the Start Recording button is pressed, all of these functions run simultaneously. The key press function not only identifies if a key was pressed or not, but it also reports what key was pressed. The key release function lists when the key previously pressed was released and what key was released.

The mouse click function constantly updates when and where the mouse clicks and when it gets released. The fourth function allows the program to report back when the user scrolls and the direction and placement of the scroll. The last function that the recording would deal with is the mouse direction movement. This would continuously update where the mouse moved until the user decides to stop the recording. All of these functions can be quickly stopped by pressing the enter key if the stop recording button fails.

The last major component of my program is the database aspect. After we made sure everything previously had worked, we needed a place to store all the data in order to ensure the users would be able to track the students using the program. Without a place to store the information, the movements and tracking would not be able to be written down. We decided to use Firebase to store all the information for not only the teacher accounts, but also the student accounts and each individual's movements.

Figure 6. Screenshot of update note

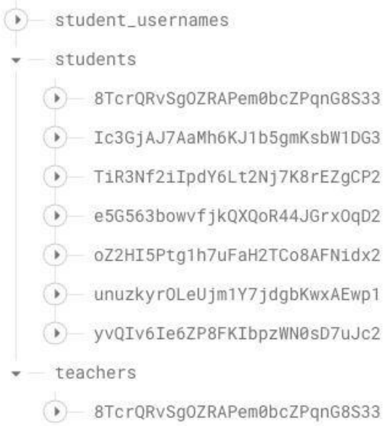

Figure 7. Screenshot of tracking movements 2

The code above tells the program that the data collected should update in to the firebase. The firebase would then show the results in the app that the teacher would use. The database stores all of the student's information so that the teacher can reflect on what the student has done throughout the duration of the class. This also prevents users from losing their information or students needing to create a new account as each user is registered into the database upon signing up. The students and teachers are each uniquely classified by their user ID and upon clicking the drop down arrow, we are able to see all the details that the student or teacher has. Firebase keeps all the data precise so we don't need to worry about error, as long as the program is functioning as expected. Then, the firebase would update the information into the app, allowing teachers to view it from their mobile devices.

4. EXPERIMENT

4.1. Experiment 1

An issue we face with this app is latency [11]. We want our app to be able to see what students are typing in real time. Lag can affect this so we want to minimize it.

We devised a test to measure latency. The test works by creating timestamps measured in milliseconds of when a keystroke is registered on the students' application. That timestamped is uploaded to our database hosted by Firebase [12]. On the instructor's application add code to record the current time again in milliseconds when the data is retrieved from Firebase. We subtract the time recorded on Firebase from the time recorded in the instructor's application to calculate the latency [13]. This process is repeated multiple times and we take the average of the latencies.

Trial	Time Data Uploaded (ms)	Time Data Retrieved (ms)	Latency (ms)
1	1670097143283	1670097144175	892
2	1670097550420	1670097551078	658
3	1670098731909	1670098732288	379
4	1670099004928	1670099006090	1162
5	1670099465699	1670099466577	878
Average			793.8

Figure 8. Table of experiment

Having a latency time of less than 1 second allows us to accurately measure the students' interactions with the application in real-time. This is important for providing feedback to the students on their typing and attention to the task at hand. This also ensures that the instructor has access to up-to-date information on the students' progress, allowing them to make adjustments to the instruction if necessary. Overall, the results of our experiment are encouraging, and we are confident that our application will provide valuable insights into students' focus.

To truly measure the effectiveness of our app, we need to see if students use it and if it can be a useful tool for instructors.

For this experiment, we gathered students and instructors to test our app to test our app. The experiment simply asked the student on a scale of 1-10 how easy the app was to set up and if they noticed the app while it was in use. For the instructor's side we asked how on a scale of 1-10 how useful information provided was and how likely they were to use the app again.

Students involved in the trial: 10
Instructors involved in the trial: 8

Student Experiment Data:

Ease of set up: average score 8

App distraction:

- 3 students noted a difference
- 7 students noted no difference

Instructors Experiment Data:
Useful information provided: average score 9
Likelihood of using app again: 7

Figure 9. Result of experiment

From the preliminary results, we can conclude our app is on the correct path of being effective for monitoring students' focus. We realize we have a small sample size but we are positive in expanding our app and trials to more users to further gather and compile more data on the effectiveness of this type of student monitoring.

5. RELATED WORK

Raja, S. K. S., & Balaji, V. developed a sensory learning based device that would help children with learning disabilities. It allows for the child to intake learning information in different forms as some may prefer audio over visual and vice versa [4]. This is quite different from our application since it relies on the child to be present in person to be able to access this sensory device. This solution is a great approach, however, due to the state of the environment as of now, it's not in our best interest to expose these children to any more viruses than necessary which is why our believe my program covers the online aspect.

Purnama, Y., Herman, F. A., et al created an application that is meant to be installed and used from a tablet. It incorporates different activities such as identifying opposite words or matching images given a set example, with various difficulties to the student's liking [5]. We believe that this solution can be quite effective for the younger students, however it would pose a challenge to create such interactive activities for the older students who are learning more advanced things.

Our program is different as it monitors the movement of the students instead of providing the problems that the student would be completing.

6. CONCLUSIONS

We believe that a limitation to our project is the mouse trail. Hypothetically, if the mouse was moved from point A to point B, our program as of now, has no record of whether or not the mouse moved directly from point A to point B or if the mouse circled around before stopping. We would implement a mouse tracer that would map out the route that the mouse took before it landed in a specific spot. This would ensure that the teachers would be able to see exactly what their student is drawing or writing. Another limitation to my project would be the attention span of the student. If we had more resources and time, we would consider implementing a software that would report to the teachers if the student was paying attention to the screen or not. A camera would be able to track the pupils and attention focus point and would allow for even higher rates of engagement.

The future of the children who lie the autism spectrum is always slightly improved every time someone believes that they are able to help those who need it [14]. Although our program has many aspects that can be improved for the future good of it, it strives to better these children's academic careers.

REFERENCES

[1] Raskind, Marshall H., and Eleanor L. Higgins. "Assistive technology for postsecondary students with learning disabilities: An overview." Journal of Learning Disabilities 31.1 (1998): 27-40.

[2] Bonis, Susan. "Stress and parents of children with autism: A review of literature." Issues in mental health nursing 37.3 (2016): 153-163.

[3] Frankova, Helena. "The impact of COVID-19 on people with autism, learning disabilities and mental health conditions." Nursing and Residential Care 22.6 (2020): 1-3.

[4] Raja, S. Kanaga Suba, and V. Balaji. "Sensor based learning device for children with autism." Materials Today: Proceedings 50 (2022): 307-311.

[5] Purnama, Yudy, et al. "Educational software as assistive technologies for children with Autism Spectrum Disorder." Procedia Computer Science 179 (2021): 6-16.

[6] Fergus, Paul, et al. "Interactive mobile technology for children with autism spectrum condition (ASC)." 2014 IEEE 11th Consumer Communications and Networking Conference (CCNC). IEEE, 2014.

[7] Johnson, Chris Plauché, and Scott M. Myers. "Identification and evaluation of children with autism spectrum disorders." Pediatrics 120.5 (2007): 1183-1215.

[8] Sun, Xiaolei, Tongyu Li, and Jianfeng Xu. "Ui components recognition system based on image understanding." 2020 IEEE 20th International Conference on Software Quality, Reliability and Security Companion (QRS-C). IEEE, 2020.

[9] Zhang, Li-fang. "Validating the theory of mental self-government in a non-academic setting." Personality and Individual Differences 38.8 (2005): 1915-1925.

[10] Khawas, Chunnu, and Pritam Shah. "Application of firebase in android app development-a study." International Journal of Computer Applications 179.46 (2018): 49-53.

[11] Iorio, Marco, Fulvio Risso, and Claudio Casetti. "When latency matters: measurements and lessons learned." ACM SIGCOMM Computer Communication Review 51.4 (2021): 2-13.

[12] Moroney, Laurence, and Laurence Moroney. "An Introduction to Firebase." The Definitive Guide to Firebase: Build Android Apps on Google's Mobile Platform (2017): 1-24.

[13] Moroney, Laurence, and Laurence Moroney. "The firebase realtime database." The Definitive Guide to Firebase: Build Android Apps on Google's Mobile Platform (2017): 51-71.

[14] Newschaffer, Craig J., et al. "The epidemiology of autism spectrum disorders." Annu. Rev. Public Health 28 (2007): 235-258.

[15] Klemisch, Kerstin, Ingo Weber, and Boualem Benatallah. "Context-aware UI component reuse." Advanced Information Systems Engineering: 25th International Conference, CAiSE 2013, Valencia, Spain, June 17-21, 2013. Proceedings 25. Springer Berlin Heidelberg, 2013.