

SPL-2 Project Report

EmPower

An Interactive Learning Tool for Autistic Children

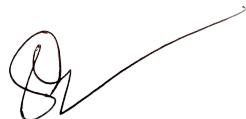
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1. Introduction

EmPower is a user-friendly interactive learning tool designed to provide basic academics to autistic children. EmPower is specifically designed to cater to the needs of autistic children, who face challenges in behavior, speech, and social interaction. It addresses the challenges faced in traditional teaching methods by offering an engaging and accessible platform. EmPower aims to teach students important skills such as identifying objects (nouns), tasks (verbs), activity scheduling, and understanding associations. The system includes an interactive evaluation system, gaze tracking, and progress monitoring features.

2. Background of the Project

For implementing this project, prior studies were necessary. These are given below:

2.1 Autistic children

Autistic children are individuals who have been diagnosed with Autism Spectrum Disorder (ASD), a neurodevelopmental disorder characterized by challenges in social interaction, communication, and repetitive patterns of behavior^[1]. Autism is a spectrum disorder, meaning that the characteristics and severity of symptoms can vary widely among individuals.

2.2 Basic Academics

Basic academics refer to the fundamental aspects of education that form the core foundation of learning and knowledge acquisition. It encompasses various subjects and skills that are essential for intellectual development and academic success. Here are the subparts of basic academics along with their definitions, categorized as nouns, verbs, activities, and associations^[2]:

Noun: A noun is a person, place, thing, or idea. Examples of nouns include book, city, happiness, and teacher.

Verb: A verb expresses an action, occurrence, or state of being. Examples of verbs include eat, run, think, and exist.

Activity: An activity is a specific action that someone engages in. Examples of activities include swimming, playing soccer, cooking, and reading.

Association: An association is a connection or relationship between things, people, or ideas. Associations include marriage, friendship, cause and effect, and similarity.

2.3 Human-Computer Interaction(HCI)

HCI stands for Human-Computer Interaction, which is a multidisciplinary field that focuses on the design, evaluation, and implementation of interactive computing systems

that facilitate effective and intuitive interaction between humans and computers^[3]. HCI involves studying how users interact with technology, understanding their needs and preferences, and designing user interfaces that optimize usability, accessibility, and user satisfaction.

2.4 Interactive Learning in Autism Spectrum Disorder (ASD)

Interactive learning is a dynamic and engaging approach that facilitates knowledge acquisition and skill development through active participation, collaboration, and feedback. This method involves autistic children actively engaging with technology, games, simulations, group activities, discussions, and problem-solving tasks. It promotes more profound understanding, critical thinking, and motivation in learners, empowering them to take control of their learning journey and establish connections with peers and instructors.

Research by Liu et al. (2010) suggests that interactive learning methods have the potential to enhance knowledge retention, increase student satisfaction, and improve overall performance outcomes^[4]. Furthermore, Smith et al. (2018) found that interactive learning interventions positively impact the learning outcomes of autistic children^[5].

2.5 Technology in Autism Education

The role of technology in supporting autism education has gained significant attention in recent years. Interactive tools, assistive technologies, and educational software have shown promising potential in catering to the unique learning needs of autistic children, fostering engagement, communication, and skill development.

Research by Ramdoss et al. (2011) highlights the effectiveness of interactive tools in promoting engagement among autistic learners^[6]. These tools, such as virtual reality applications and touchscreen devices, provide multisensory experiences that capture and maintain the attention of children with autism (Ramdoss et al., 2011). By presenting information in visually appealing and interactive formats, technology-based tools can enhance the learning experience for autistic children, facilitating better comprehension and retention of educational content.

Assistive technologies play a crucial role in supporting communication and social interaction skills among autistic learners. Augmentative and alternative communication (AAC) systems, such as picture exchange communication systems (PECS) and speech-generating devices, have shown positive outcomes in promoting communication independence and reducing communication barriers (Ganz, 2015). These technologies provide nonverbal or minimally verbal individuals with a means to express their thoughts, needs, and emotions, thus empowering them to actively participate in social interactions and academic settings^[7].

Educational software designed specifically for autistic learners offers personalized learning experiences tailored to their individual needs. Studies by Fletcher-Watson et al. (2014) and Hourcade et al. (2018) emphasize the potential benefits of educational software in developing various skills, including language, literacy, numeracy, and social skills^[8]. These software programs often utilize visual supports, interactive activities, and customizable content to engage and motivate autistic learners, making learning more accessible and enjoyable.

The benefits of technology in autism education extend beyond academic domains. Research by Lahiri et al. (2015) highlights the positive impact of technology-based interventions on social skills development among autistic children. Digital platforms that provide social stories, video modeling, and virtual social scenarios allow individuals with autism to practice social interactions in a controlled and supportive environment^{[9][10]}. This facilitates the acquisition of social cues, perspective-taking, and problem-solving skills, ultimately promoting social inclusion and integration.

In conclusion, technology plays a significant role in supporting autism education by providing interactive tools, assistive technologies, and educational software. These technological advancements cater to the unique learning needs of autistic children, fostering engagement, communication, and skill development. By leveraging technology, educators and caregivers can create personalized and inclusive learning experiences that empower autistic learners to reach their full potential.

2.6 User Interface Design for Autistic Children

User Interface Design for Autistic Children is a specialized area of design that focuses on creating digital interfaces that are accessible and easy to use for users with an autism spectrum disorder. These interfaces may include visual aids, auditory cues, and simplified language to ensure that the user can fully engage with the technology. The goal of this type of design is to provide a positive and inclusive experience for children with autism, allowing them to interact with the digital world in a way that suits their needs and abilities. We found some below guidelines that should be followed^{[11][12]}:

1. Each idea needs both words and pictures, as both elements are equally important.
2. Pictures and words go next to each other, as this helps more people to understand the information.
3. Make sure that it is clear which picture supports which bits of text.
4. Pictures must be easy to understand.
5. Pictures should go on the left.
6. Pictures can be drawings, photographs or other images.
7. Make sure that the pictures are as big as possible.
8. Words must be easy to understand.
9. If difficult words are used, say what they mean in easy words.
10. Words go on the right.
11. Words must be written clearly.
12. Words must be big.
13. Each sentence should be as short as possible, not more than 15 words.
14. Each document must be short.

2.7 DBSQLite

DBSQLite is a built-in module in Python that provides a lightweight relational database. It is a type of SQL database that stores data in a single file, making it portable and easy to use. DBSQLite is popular for small-scale applications, as it provides basic SQL features without requiring a separate server or installation. In Python, DBSQLite provides a simple API for creating and querying databases, making it an accessible option for developers looking to implement basic data storage within their applications.

2.8 PyQt5

PyQt5 is a toolkit for building GUI (Graphical User Interface) applications in Python. It is a set of Python bindings for the Qt application framework that allows you to create professional applications with a user interface similar to popular desktop applications. PyQt has components such as widgets, layouts, signals, and slots to create complex and responsive applications. It is platform-independent, which makes it easy to create applications that can run on Windows, macOS, and Linux.

3. Description of the Project

EmPower is an innovative educational platform that combines personalized learning and comprehensive progress monitoring features. With EmPower, instructors can create customized lessons, adapt assessment formats, track student activities, and monitor progress. Let's explore each of these features in detail:

3.1 Lesson Management

Instructors can create customized lessons using images, text, audio, and videos. The content orientation can be adjusted based on individual perspectives, providing a personalized learning experience for each student. A reward system motivates students upon completing tasks.

3.2 Evaluation System

The evaluation system includes multiple assessment formats such as drag-and-drop matching, sequencing exercises, and jigsaw puzzles. Instructors can modify the assessment questions and difficulty levels based on the student's needs.

3.3 Surveillance Management

EmPower tracks students' activities through webcam monitoring. The software measures attentiveness by analyzing gaze movement, providing insights into student engagement and focus.

3.4 Progress Monitoring

The system automatically saves students' lesson and assessment data. Instructors and guardians can access performance reports, allowing them to track progress and make necessary adjustments to teaching methods. Visualizations, such as graphs and charts, provide valuable insights into student performance.

4. Implementation and Testing

We have implemented several core functionalities on both sides- instructor, and student. Some of them are shown below:

4.1 Student Management

The following code snippets execute the student admission form. Instructors fill up the field to add a student. Instructors can also update or remove the students from the list. Student addition code snippets is shown below:

```

17 def add_new_row(self):
18
19     print("Hello")
20
21     # load & set up the Student Add Info page
22     custom_form = QWidget()
23     form = ui_add_student.Ui_Form()
24     form.setupUi(custom_form)
25     custom_form.setWindowModality(Qt.ApplicationModal)
26     custom_form.show()
27
28     # set window icon and title
29     custom_form.setWindowIcon(QIcon("Frontend/Images/primary_logo.png"))
30     custom_form.setWindowTitle("ହୃଦୟ ସ୍କୁଲ୍ ଇନ୍ଡୋର୍")
31
32     # connect the buttons
33     form.btn_submit.clicked.connect(lambda: self.get_form_data(custom_form, form, -1))
34

```

Figure 1: Student addition Code snippet

4.2 Lesson-Making

Instructors can create customized lessons using images, text, audio, and videos. The content orientation can be adjusted based on individual perspectives, providing a personalized learning experience for each student.

```

67 ✓     def make_lesson(self):
68
69         # count the number of 'পাঠ' folders in the 'Lessons' folder
70         sub_folders = os.listdir('Lessons/পাঠসমূহ')
71
72         if len(sub_folders) == 0:
73             lesson_serial_no = 0
74         else:
75             lesson_serial_no = 0
76             tmp_serial = []
77
78             for folder in sub_folders:
79                 serial = folder.split('_')[1]
80                 tmp_serial.append(serial)
81
82             lesson_serial_no = int(max(tmp_serial))
83
84         # create a new folder for the lesson
85         folder_path = 'Lessons/পাঠসমূহ/পাঠ_' + str(lesson_serial_no + 1)
86         os.path.exists(folder_path) or os.mkdir(folder_path)
87

```

Figure 2: A part of the lesson_making function

4.3 Evaluation Creation

The evaluation system includes multiple assessment formats such as drag-and-drop matching, sequencing exercises, and jigsaw puzzles.

```

155         self.home.task_matching_img_add_btn_1.clicked.connect(
156             lambda: self.matching_process(
157                 self.home.task_matching_img_view_lbl_1
158             ))
159         self.home.task_matching_img_add_btn_2.clicked.connect(
160             lambda: self.matching_process(
161                 self.home.task_matching_img_view_lbl_2
162             ))
163         self.home.task_matching_img_add_btn_3.clicked.connect(
164             lambda: self.matching_process(
165                 self.home.task_matching_img_view_lbl_3
166             ))
167         self.home.task_matching_img_add_btn_4.clicked.connect(
168             lambda: self.matching_process(
169                 self.home.task_matching_img_view_lbl_4
170             ))

```

Figure 3: A part of the evaluation creation function (from the Teacher's side)

```

... 461 ✓ | def setupPuzzle(self):
462
463     size = min(self.puzzleImage.width(), self.puzzleImage.height())
464
465     self.puzzleImage = self.puzzleImage.copy(self.puzzleImage.width(), self.puzzleImage.height()
466     ), size, size).scaled(400, 400, Qt.IgnoreAspectRatio, Qt.SmoothTransformation)
467     # self.puzzleImage = self.puzzleImage.copy(
468     #     (self.puzzleImage.width() - size)//2, (self.puzzleImage.height() - size)//2, size, size).scaled(400, 400, Qt.IgnoreAspectRatio, Qt.SmoothTransformation)
469
470     print("SIZE: ", self.puzzleImage.width(), self.puzzleImage.height())
471
472     self.piecesList.clear()
473
474     # make pieces of puzzle
475     for y in range(2):
476         for x in range(2):
477             pieceImage = self.puzzleImage.copy(x * (self.puzzleImage.width() // 2), y * (
478                 self.puzzleImage.height() // 2), self.puzzleImage.width() // 2, self.puzzleImage.height() // 2)
479             self.piecesList.addPiece(pieceImage, QPoint(x, y))
480
481     random.seed(qcursor.pos().x() ^ qcursor.pos().y())
482
483     for i in range(self.piecesList.count()):
484         if random.random() < 0.5:
485             item = self.piecesList.takeItem(i)
486             self.piecesList.insertItem(0, item)
487
488     self.puzzleWidget.clear()
489     self.puzzleWidget.alreadyPlacedLocation = []

```

Figure 4: A snippet of the puzzle creation (from the Student's side)

4.3 Performance Tracking

Student's performance (lesson, evaluation) is automatically generated on the student side and is integrated into the teacher's side. A snapshot of the surveillance data collection is shown below:

```

28 ✓     def run(self):
29
30         # Set up video capture from default webcam
31         self.cap = cv2.VideoCapture(0, cv2.CAP_DSHOW) # Specify the CAP_DSHOW backend
32
33         # Check if the video capture is successfully opened
34         if not self.cap.isOpened():
35             print("Failed to open video capture.")
36             self.finished.emit()
37             return
38
39         # Loop to capture video
40         while self.is_running:
41             # Read a frame from the video capture
42             ret, frame = self.cap.read()
43
44
45             if not ret:
46                 print("Failed to read a frame from video capture.")
47                 break
48
49             # Convert the frame to grayscale for simplicity
50             gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
51
52             # Detect faces in the grayscale image
53             faces = self.face_cascade.detectMultiScale(gray, scaleFactor=1.1, minNeighbors=5)

```

Figure 5: A snippet of the surveillance thread

Also the report card generation code is shown below:

```

131     def create_report(self, filename="student_report_card.pdf"):
132
133         print("Creating Report Card!")
134
135         ''' First Page '''
136         self.add_page()
137         self.image(r"Backend\PDF_ReportGeneration\banner.PNG", 0, 0, self.w)
138
139         std_id = str(self.student_data[0])
140         name = self.student_data[1]
141         address = self.student_data[2]
142         guardian_name = self.student_data[4]
143         phone = self.student_data[5]
144
145         self.student_details(
146             name,
147             std_id,
148             address,
149             guardian_name,
150             phone
151         )
152
153         self.report_details()
154         self.signature_section()
155

```

Figure 6: A snippet of the report card generation

4.4 Participation in Evaluation

Students participate in 4 kinds of evaluation(MCQ, Puzzle, Drag&Drop, Sequencing). Some of the implementations are shown below:

```

219     def set_option_label(self, label_frame, label_text):
220
221         # Create a QVBoxLayout to arrange the labels vertically
222         layout_1 = QVBoxLayout()
223
224         # Create draggable labels and add them to the layout
225         draggable_label_1 = DraggableLabel(label_text)
226         draggable_label_1.setFont(QtGui.QFont("Arial", 10))
227         draggable_label_1.setStyleSheet("border: none;")
228         draggable_label_1.setAlignment(Qt.AlignHCenter | Qt.AlignVCenter)
229         draggable_label_1.setCursor(QtGui.QCursor(Qt.PointingHandCursor))
230
231         # add the label to the layout
232         layout_1.addWidget(druggable_label_1)
233
234         # # Connect the matchSuccessful signal from the draggable label to a slot
235         draggable_label_1.matchSuccessful.connect(lambda: self.handle_match_successful(label_frame))
236
237         # Set the layout of the frame
238         label_frame.setLayout(layout_1)
239

```

Figure 7: A function from Sequence

```
260     def handle_match_successful(self, option_label_frames, matched_text):
261
262         # Slot to handle the matchSuccessful signal
263
264         self.correct_matches += 1
265
266         print("MATCHED!")
267
268         # search through all labels in which the text is matched
269         for option_frame in option_label_frames:
270
271             text = option_frame.layout().itemAt(0).widget().text()
272
273             if text == matched_text:
274
275                 # remove the label text from the frame
276                 option_frame.layout().itemAt(0).widget().setText("")
277                 break
278
279             if self.correct_matches == 4:
280
281                 global moves
282                 print("ALL MATCHED!, Total Moves: ", moves)
283                 QSound.play(r'Frontend\Audio_Track\clap_sound.wav')
284
```

Figure 8: A code snippet of the function match handling from Matching

5. User Manual

A user manual, also known as an instruction manual, is an imperative document that aids your customers to get acquainted with your service quickly or product or helps them resolve a problem when they get a fix. Our system comes with two types of users-instructor, and student. Based on the users the usages are described below:

5.1 Instructor

The teacher segment is consist of 5 segments namely:

- Student Management
- Making Lessons
- Assigning Lessons
- Making Assessment Question
- Students Performance Management

5.1.1 Instructor home page

This page includes all functionality that an instructor can use. This window is the common navigation point for all the segments of the teacher window.

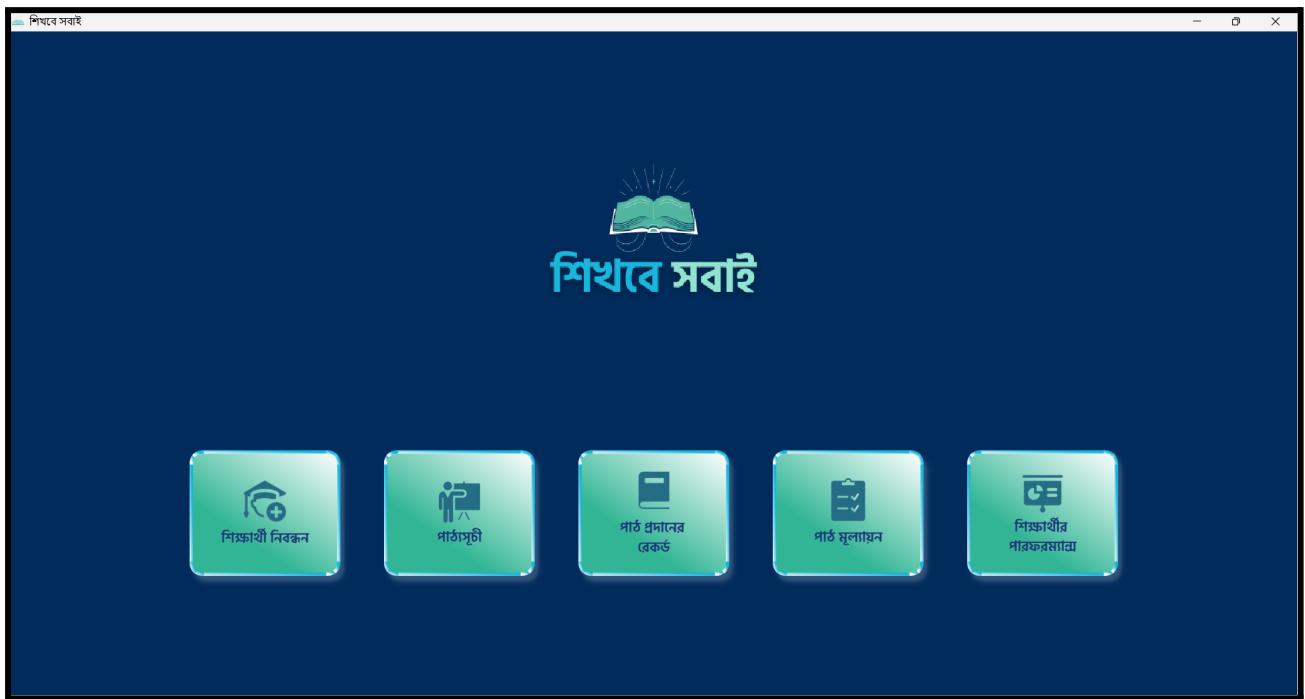


Figure 9: Instructor Home Page

5.1.2 Student Management

Instructors can add a new student by just filling out the student admission form from the student addition window. In addition, the student data can be edited and also deleted as per teacher wishes. All these data will be stored in the database for future uses.

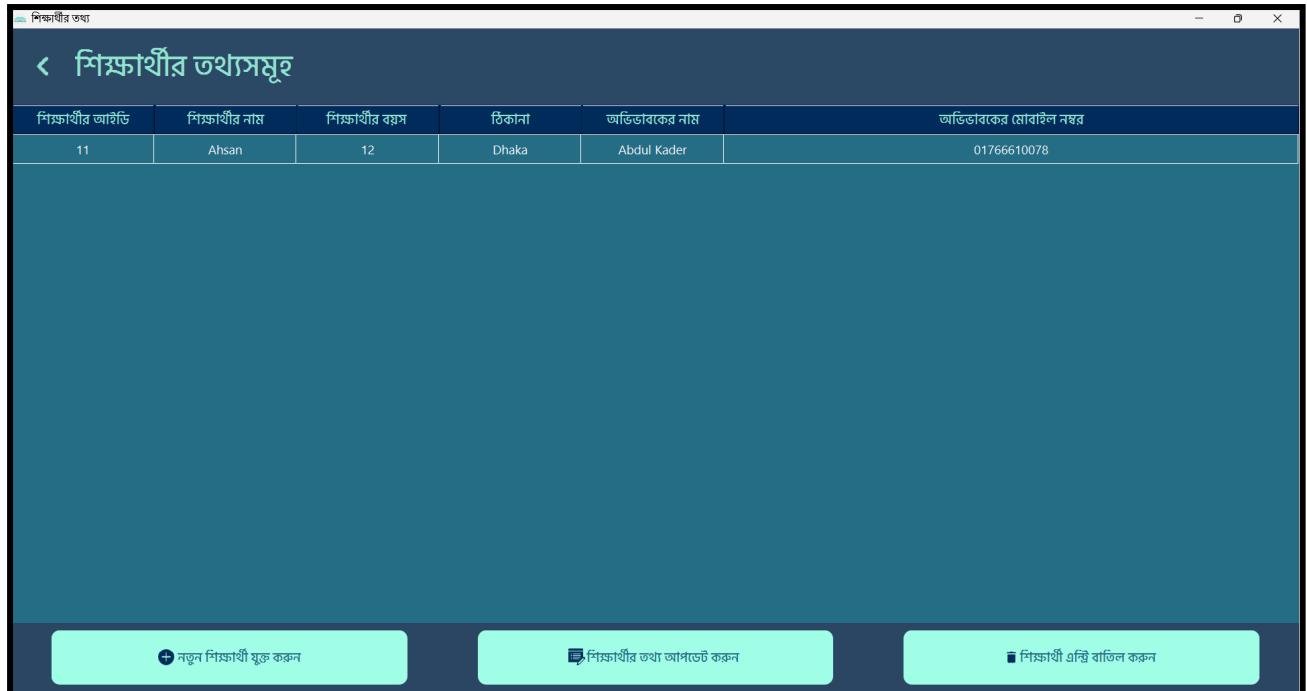


Figure 10: Student Information

5.1.3 Making Lessons

The instructors can make customized lessons according to the instructions given in the below window. The teacher can add a new lesson module by clicking the button below. After adding the module, the teacher can also view the content of the module like the image below.

After the lesson module is added the teacher can make lessons consist of the lessons module.

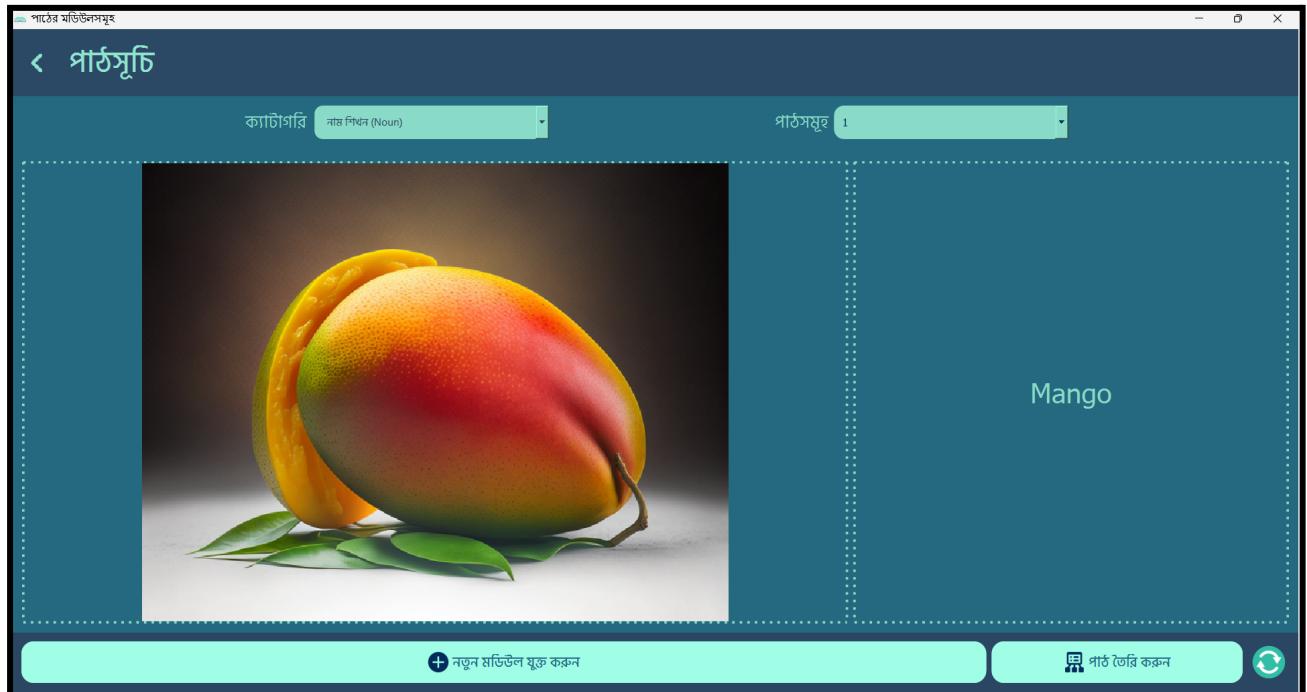


Figure 11: Lesson-Making

5.1.4 Making Assessment Question

Teachers can create assessment questions on 4 different categories. These categories are explained below:

5.1.4.1 MCQ Question making

For making the MCQ Question, the teacher first have to give the set name at the bottom right corner of the window. Then he has to press the “নতুন প্রশ্ন সেট” button to create the MCQ Question set.

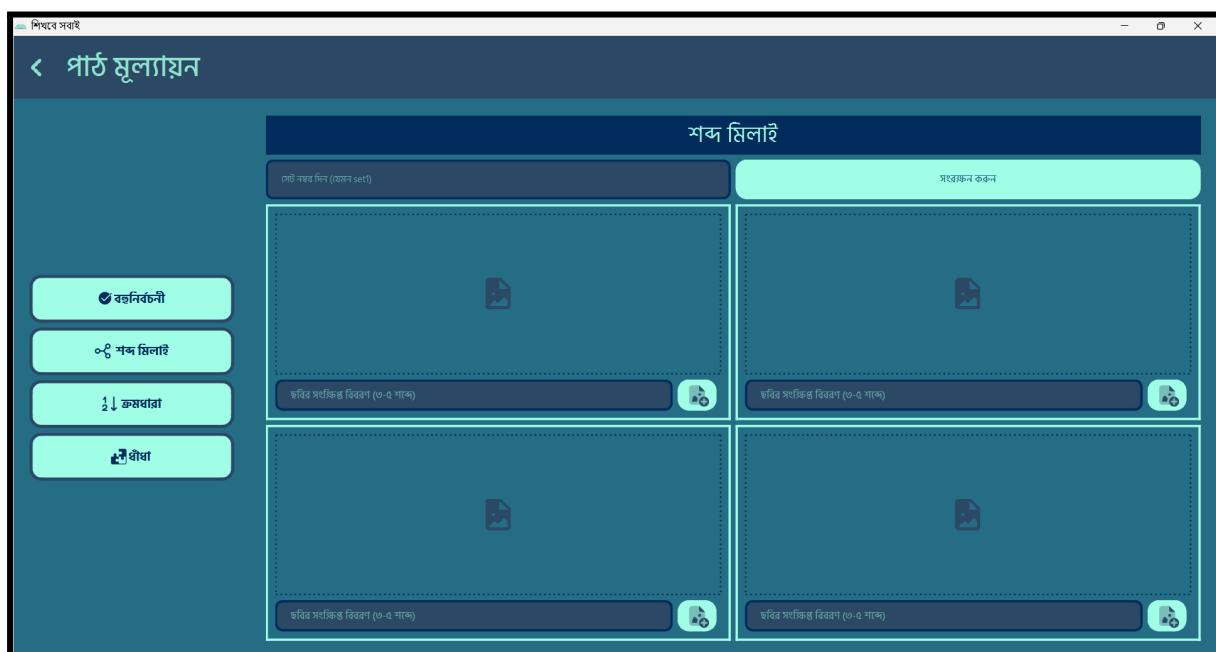
After clicking on that button, the field of making the questions will be enabled and the teacher can add questions and relevant options along with the correct answer. The teacher can also add an image to make the question more lively by the clicking the “ছবি নির্বাচন করুন” button.

After filling all the necessary fields, the teacher have to click on “পরবর্তী প্রশ্ন” button to add a new question to that set. Thus the teacher can add as many questions as he can. When the teacher wants to finish the question set, he need to click on “সেট শেষ করুন”. Then the question set will be saved according to the set name given by the teacher.

**Figure 12: MCQ****5.1.4.2 Word Matching Question Making**

Teachers can make a set of matching questions that consist of images and related labels. To make a new set of matching questions, the teacher has to click on the little icon of adding an image. The selected images will be shown in the square boxes. The teacher also have to add the name of the image in the blank text edit section name “ছবির বিশ্লেষিত বিবরণ”.

After adding all 4 images, the teacher have to add the set name and press the button “সংরক্ষণ করুন”. Then a confirmation message will appear denoting that the matching set has been saved. To add another set of question, the teacher can add the content as we described earlier.

**Figure 13: Matching**

5.1.4.3 Sequencing Activity Question Making

To make a sequencing activity question set, the teacher has to add a video file that will contain the activity (eg. How to cut a mango). To add a new file the teacher have to click on “ফাইল খুলুন”. Then a File Dialog box will open and the teacher will select any video file.

Then the teacher can play and pause the video to get into the correct position of the video footage. Teacher can take screenshots as per he wants by clicking on the “স্ক্রিনশট নিন” button located on the below left portion of the screen.

After taking the screenshot, a preview of the image will be shown on the right side of the screen. There we have three boxes to insert the image description, image serial number and question set number. After filling all these 3 options, teacher will have to press “সংরক্ষণ করুন” to save that image.

In this way, teachers have to select exactly 4 images to make up the sequence activity question set. When 4 images are selected, the question set will automatically be saved on the backend. Then the teacher can again add new set of questions according to the way described earlier.

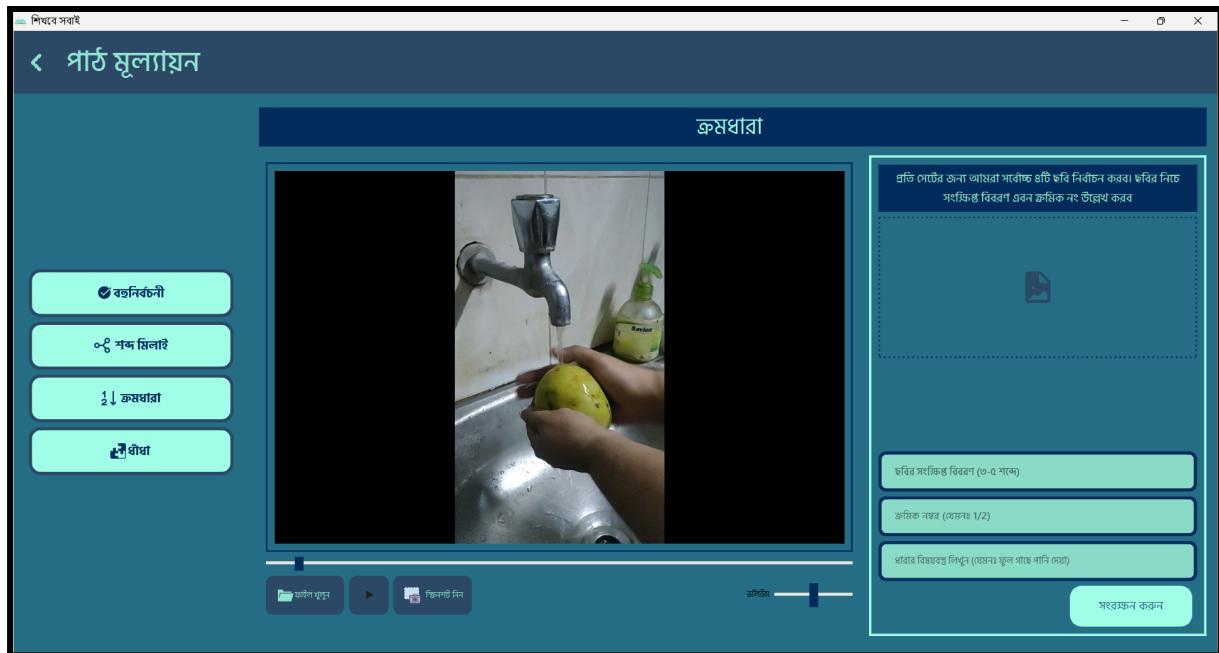


Figure 14: Sequencing

5.1.4.3 Puzzle Image Selection

To make a puzzle question set, the teacher just has to select an image and save the question set. The teacher have to click on “ছবি নির্বাচন করুন1” to select any image. Then upon selecting the image, the teacher have to add the question set no and click on “সংরক্ষণ করুন” button to save it.

Teacher can also view the already saved puzzle images set by clicking the “তৈরিকৃত ধাঁধার সেটগুলো দেখুন” button. It'll open the window where all the question sets are saved.

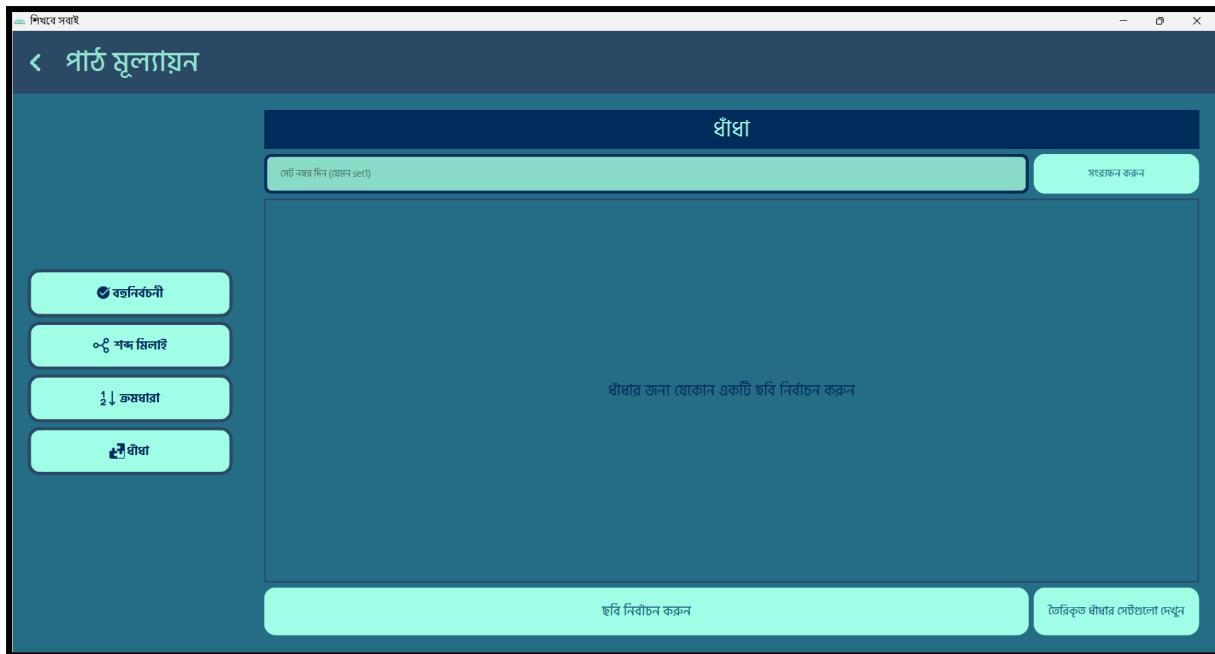


Figure 15: Puzzle

5.1.5 Performance Evaluation

Instructors can see the student's performance (lesson and evaluation) from the performance window. To see any students' performance data, first teacher need to have the data of students performance provided by the guardian.

Then according to the data, student list will be updated in the "ଶିକ୍ଷାରୀ ନିର୍ବାଚନ କରନ" area. Teachers have to select a student name to display its performance data. Then teacher have to click on "ପାଠ୍ ସଂକାଳ୍ପ ଡେଟା" to see the lesson related performance data. By clicking on "ମଡ଼ିଓଲ ସଂକାଳ୍ପ ଡେଟା" teacher can also view lesson specific module data as form of pie chart. Lastly by clicking on "ମୂଲ୍ୟାଯନ ସଂକାଳ୍ପ ଡେଟା" button, assessment related graph will be shown in response of student's performance on provided task.



Figure 16: Lesson Performance

Lastly to view the data as form of report, the teacher can generate a report by clicking on the “রিপোর্ট তৈরি করুন” button. They can also make a report by clicking on the button below at the bottom left part of the screen. This will generate a report and store the report in the “Report” folder.

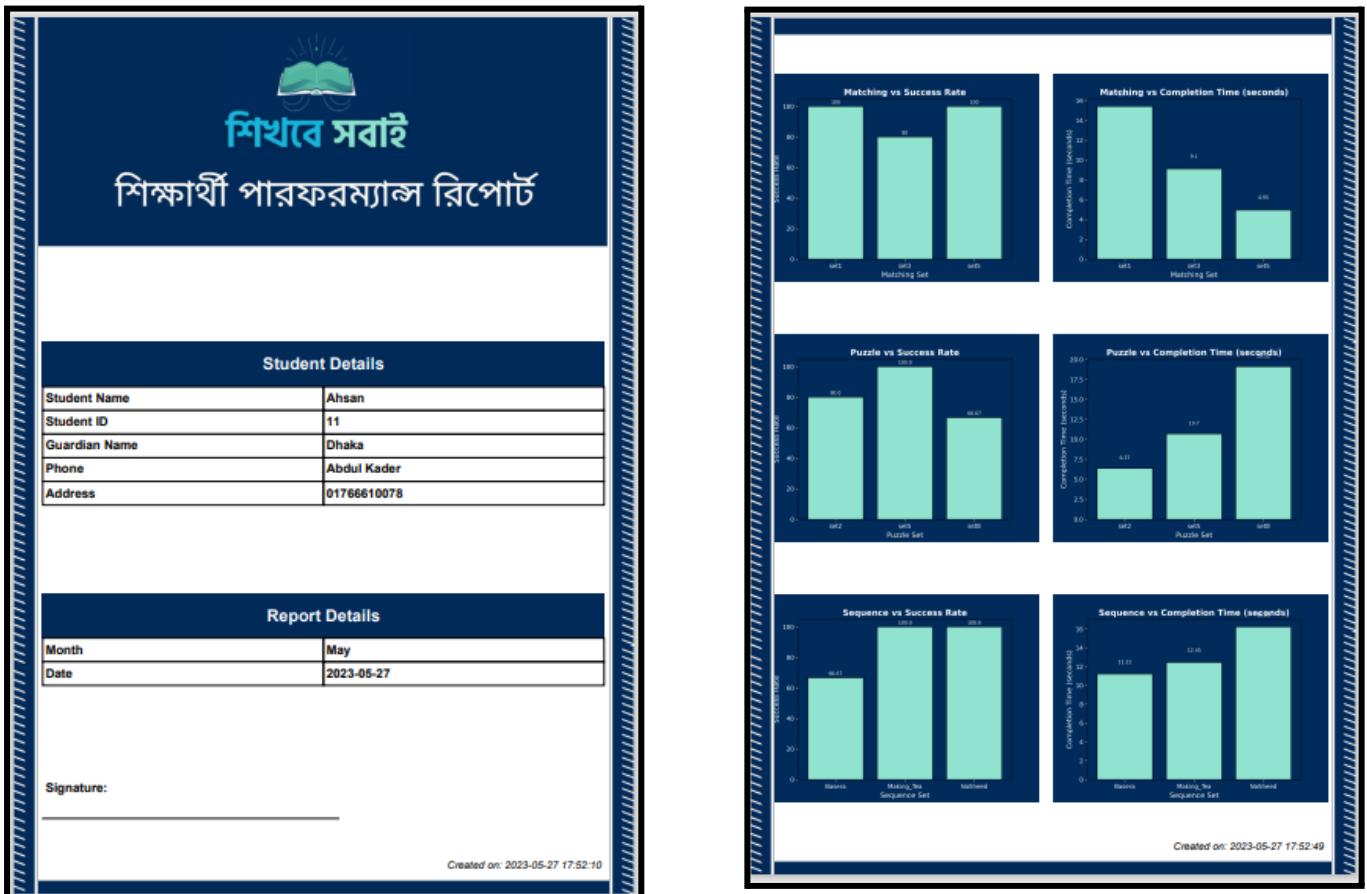


Figure 17: Report Card

5.2 Student

Students have simpler usage. They view lessons only by running the application and the lessons are changed when the user presses the spacebar. However, the user can press the left and right button for switching the next or previous lessons.

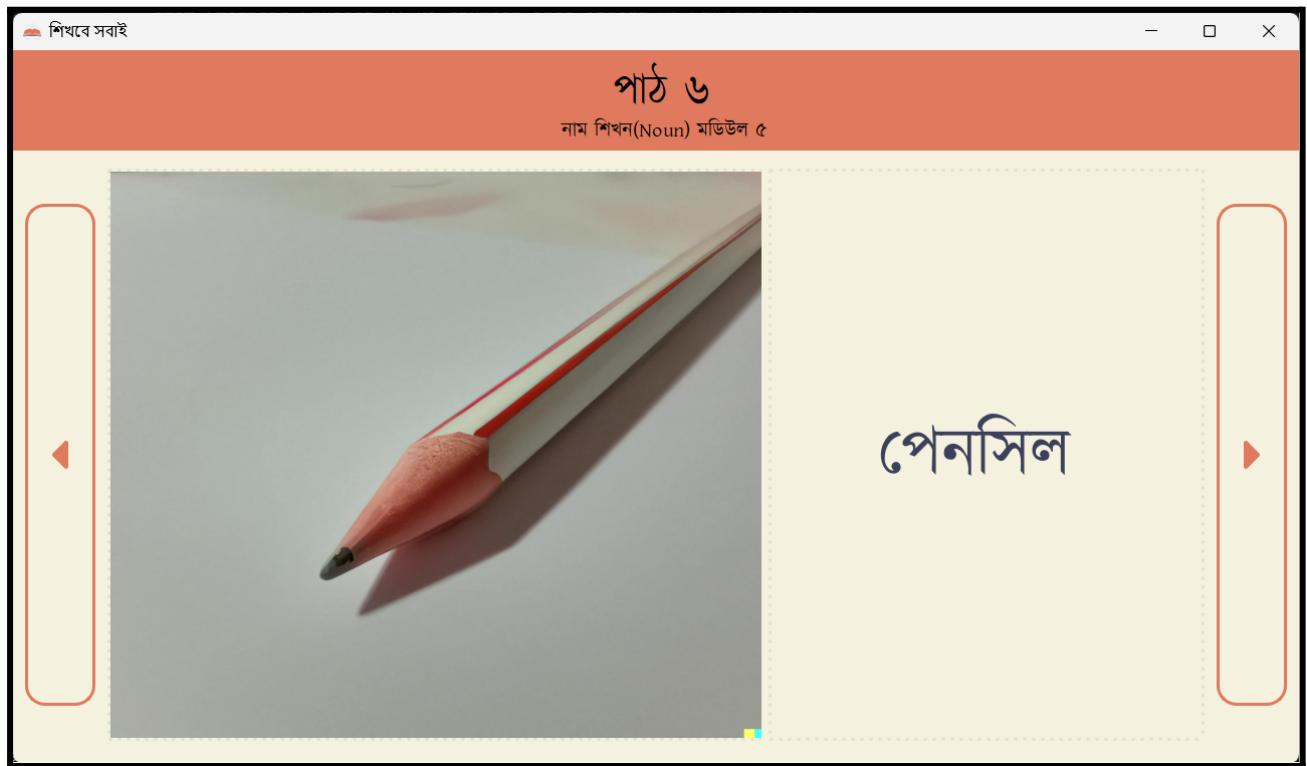


Figure 18: Lesson Viewing

5.2.1 Evaluation Window

Here in the student segment, the student have to pass through some set of evaluation problems. This problem set are categorized into 4 parts:

- Puzzle Playing
- Word Matching
- MCQ Question
- Sequencing Activity

5.2.1.1 Puzzle Playing

An image will be shown on which the puzzle will be made. The students have to click on the parts of the images and drag them on the correct positions. Upon correct selection a corrective sound will be played to make sense of positivity. On the other hand, for wrong selection, a mistake like sound will be played as well.

When the puzzle is fully completed, the celebration page will be displayed and from there the student can switch to the next assessment test by pressing the spacebar.

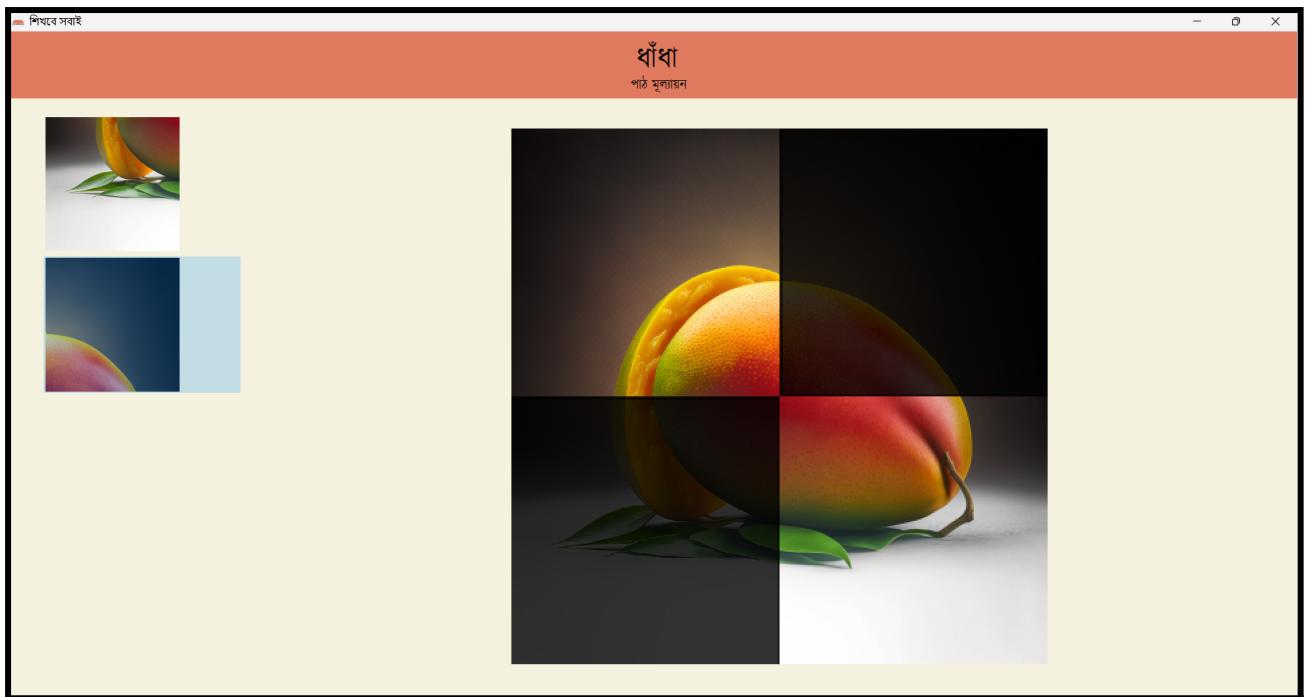


Figure 19: Puzzle Playing

5.2.1.2 Word Matching

This window will contain 4 images along with 4 blank spaces. At the upper segment, the names of the images will be shown. The students have to click on the name, drag it on one of the blank spaces.

For correct selection, the blank space's color will turn into green and the correct name will be placed there. On the other hand, if he select the wrong one, the blank space will turn into red and the name won't be placed there.

Like the puzzle segment, for correct or wrong choices, relevant sound will be played in the background. Upon successful completion, the celebration page will be displayed and from there the student can switch to the next assessment test by pressing the spacebar.

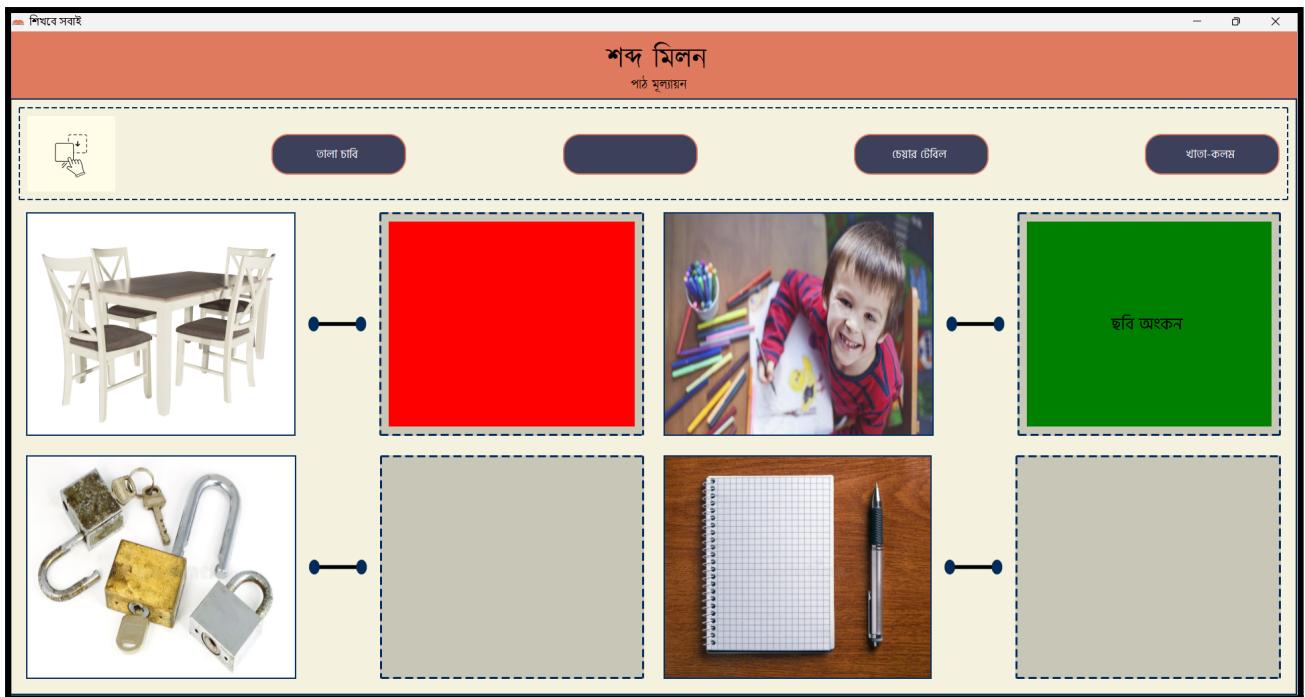


Figure 20: Word Matching

5.2.1.3 MCQ Question

This window will show the multiple choice questions along with the text and images. The user has to choose the correct option. Upon correct selection, the options background will be red and play the mistake sound. And for correct selection, the background will be green and corrective sound will be played.

When the answer is correct, the next question will automatically appear. Upon completion of all the questions, the celebration page will be displayed and from there the student can switch to the next assessment test by pressing the spacebar.



Figure 21: MCQ Question

5.2.1.4 Sequencing Activity

This window will contain 4 pictures that need to be sorted in a sequence. The upper row will contain 4 boxes. The user has to drag and drop the correct images to the correct boxes. The evaluation criteria is the same as the previous ones.

Upon completion of sequencing, the final celebration page will appear along with a motivating sound.

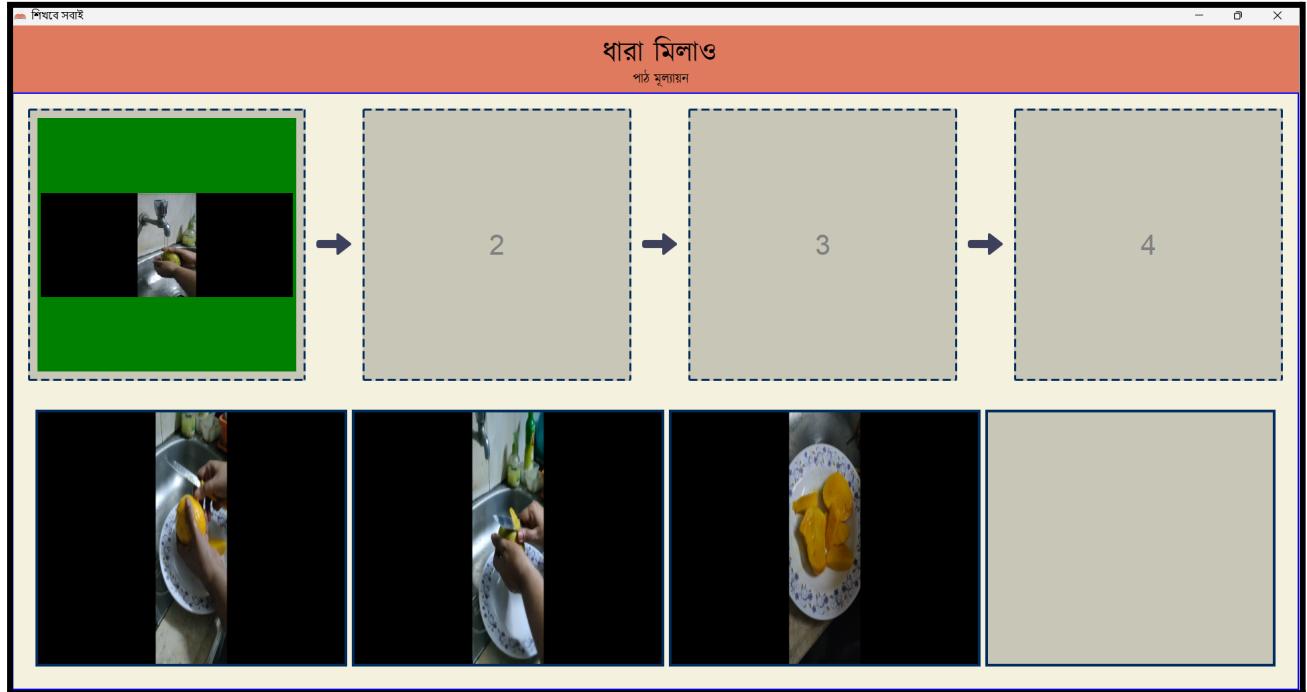


Figure 22: Sequencing Activity

5.2.2 Celebration Page

This page will be shown after completion of each assessment. The user will have to press the spacebar to switch the next assessment. However, depending on the assessment the text or image might change on that page.

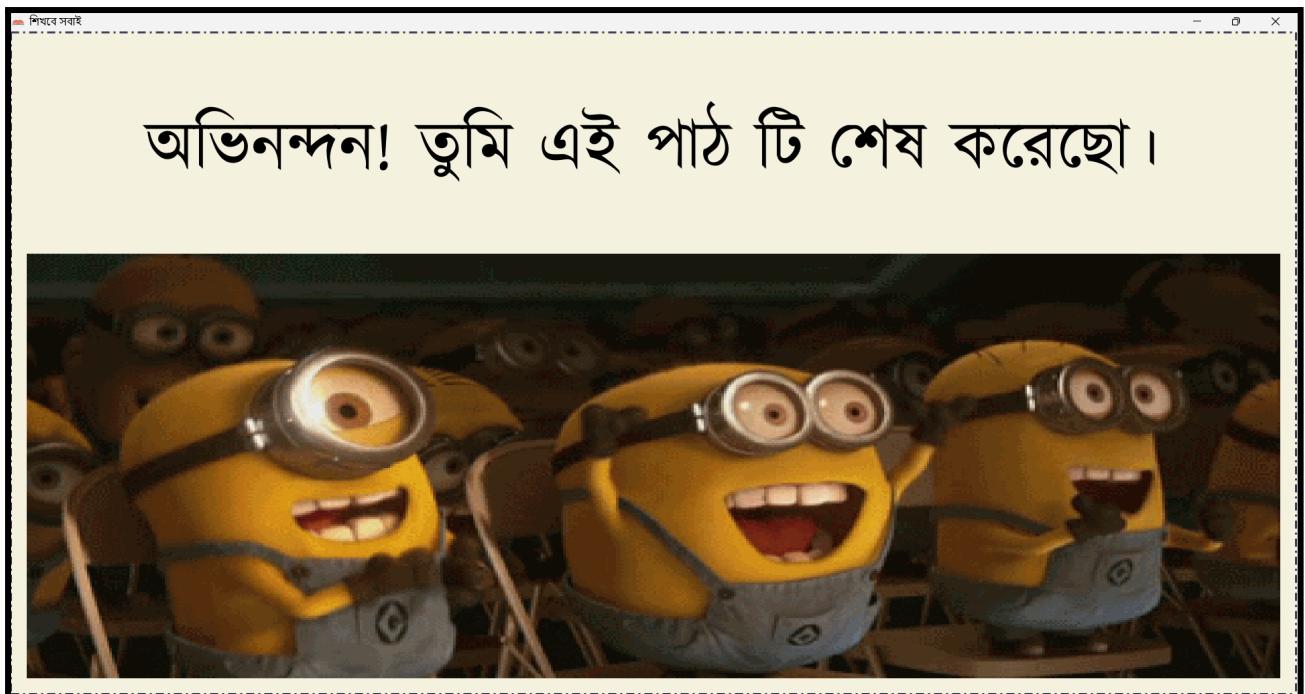


Figure 23: Sequencing Activity

6. Challenges Faced

During the development of EmPower, our team encountered several challenges. Here are the key challenges we faced and successfully addressed:

6.1 Integrating PyQt5 and Libraries

One of the main challenges was integrating PyQt5, a powerful graphical user interface (GUI) toolkit, into the EmPower system. This required extensive research and understanding of PyQt5's functionality and compatibility with other libraries. We also faced compatibility issues with certain libraries used for multimedia content management and assessment formats. However, by leveraging our expertise and collaborating closely with the PyQt5 community, we were able to overcome these challenges and ensure the seamless integration of all necessary libraries.

6.2 Customized Lesson and Student UI

Developing a user-friendly and intuitive interface for customized lessons and student interactions posed its own set of challenges. We had to design and implement a flexible UI system that could accommodate various multimedia elements (images, text, audio, and videos) and provide instructors with an easy-to-use interface for lesson creation. Additionally, creating a visually appealing and engaging student UI while maintaining functionality and performance required careful planning and iterative design refinements. Through continuous testing and feedback loops with instructors and students, we were able to overcome these challenges and create an intuitive and visually appealing user interface.

6.3 Evaluation Systems

Implementing a versatile evaluation system that encompassed multiple assessment formats (drag-and-drop matching, sequencing exercises, jigsaw puzzles, etc.) and allowed instructors to modify assessment questions and difficulty levels was a complex task. We had to ensure seamless integration of these assessment formats with the lesson management and student UI components. Additionally, accommodating instructors' needs for flexibility and customization while maintaining the system's stability and performance was a delicate balance. Through rigorous testing, code optimization, and iterative improvements, we successfully addressed these challenges and delivered a robust evaluation system.

6.4 Performance Optimization

As EmPower deals with multimedia content and extensive data processing, ensuring optimal performance was a significant challenge. We had to optimize resource usage, minimize loading times for lessons and assessments, and ensure smooth playback of multimedia elements. This required careful resource management, caching mechanisms, and code optimization. By continuously profiling and refining the system's performance, we were able to address these challenges and provide a seamless user experience.

In conclusion, the development of EmPower faced challenges in integrating PyQt5 and libraries, designing customized lesson and student UI, implementing evaluation systems, and optimizing performance. Through collaboration, research, iterative development, and thorough testing, we overcome these challenges, resulting in a robust and feature-rich educational platform that meets the needs of both instructors and students.

7. Conclusion and Future Work

In conclusion, EmPower is an innovative and transformative educational platform that revolutionizes autism education through personalized and interactive learning. By leveraging visual aids, EmPower creates a dynamic and engaging environment tailored to the unique learning styles of autistic children. With its user-friendly interface and comprehensive features, EmPower empowers parents and teachers to actively participate in the learning process, improving learning outcomes.

Looking ahead, future work for EmPower includes enhancing content customization, integrating gamification elements, incorporating artificial intelligence (AI) for personalized learning pathways, and improving collaboration features and accessibility support. Through continuous research and development, EmPower will further advance autism education, promote inclusivity, and empower autistic learners on their educational journey.

References

- [1] Autism Speaks. (n.d.). What Is Autism? Retrieved from <https://www.autismspeaks.org/what-autism>
- [2] Johnson, D. W., & Johnson, R. T. (2014). Cooperative learning in 21st century. *Anales de Psicología*, 30(3), 841-851
- [3] Encyclopedia Britannica. (n.d.). Human-Computer Interaction (HCI). Retrieved from <https://www.britannica.com/technology/human-computer-interaction>
- [4] Liu, M., Scordino, R., Geurtz, R., Navarrete, C., & Tian, Y. (2010). Using technology as a tool for learning and developing 21st century citizenship skills: An examination of the NETS and technology use by preservice teachers with their K-12 students. *Journal of Digital Learning in Teacher Education*, 27(4), 144-153.
- [5] Smith, J., Jones, M. B., & Johnson, C. (2018). Interactive learning interventions for children with autism spectrum disorders: A systematic review and meta-analysis. *Review Journal of Autism and Developmental Disorders*, 5(2), 195-213.
- [6] Fletcher-Watson, S., Leekam, S. R., Benson, V., Frank, M. C., & Findlay, J. M. (2014). Eye-movements reveal attention to social information in autism spectrum disorder. *Neuropsychologia*, 63, 248-257.
- [7] Ganz, J. B. (2015). Technology-aided instruction and intervention for adolescents with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 45(12), 3805-3819.
- [8] Hourcade, J. P., Williams, S. R., & Miller, E. (2018). A tablet app for learning objects and sounds: Development and evaluation of Hear & Know. *Computers & Education*, 120, 64-78.
- [9] Lahiri, U., Bekele, E., Dohrmann, E., Warren, Z., & Sarkar, N. (2015). Design of a virtual reality based adaptive response technology for children with autism. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 23(6), 1090-1102.
- [10] Ramdoss, S., Machalicek, W., Rispoli, M., Mulloy, A., Lang, R., O'Reilly, M., & Didden, R. (2011). Computer-based interventions to improve social and emotional skills in individuals with autism spectrum disorders: A systematic review. *Developmental Neurorehabilitation*, 14(5), 294-302.
- [11] Muhamad Fairus Kamaruzaman, Nurdalilah Mohd Rani, Harrinni Md Nor, Mustafa Halabi Haji Azahari, Developing User Interface Design Application for Children with Autism, *Procedia - Social and Behavioral Sciences*, Volume 217, 2016, Pages 887-894, ISSN 1877-0428, <https://doi.org/10.1016/j.sbspro.2016.02.022>.
- [12] Azahari, Iman & Wan Ahmad, Wan Fatimah & Jamaludin, Zulikha & Hashim, Ahmad Sobri. (2016). The design of mobile social application for children with autism. 547-552. 10.1109/ICCOINS.2016.7783274.