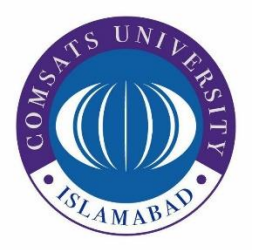


**COMSATS University Islamabad (CUI)**

**Software Requirement Specification**

**SRS DOCUMENT**

**for**

# Brain Wave Decoder

Version 1.0

***By***

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***Bachelor of Science in Software Engineering (2017-2021)***

**Revision History**

| Name | Date | Reason for Changes | Version |
|---|---|---|---|
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**Application Evaluation History**

| **Comments (by committee)**<br>***include the ones given at scope time both in doc and presentation** | **Action Taken** |
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**Supervised by**

**Dr. Uzair Iqbal Janjua**

Signature_____

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## 1. Introduction

Brain Computer Interface (BCI) systems is the next thing that has the potential to affect our lives like Artificial Intelligence has done. BCI systems presents diverse horizons oscillating from extracting important information from the brain to helping disabled people make their lives better. People with low motor response, auditory abilities can be helped in a way no other technology of the 21st century has done. The primal focus of research in the domain of BCI systems mostly revolves around distinguishing different types of brain activities. A putting uniqueness of BCI technology is that the type of actions it allows appears to dissent from human actions, because, effects within the world square measure led to by devices like robotic arms, prosthesis, or different machines, and their execution runs through a BCI system directed by brain signals.

BCI systems revolve around EEG. Examining EEG datasets can be successfully used to measure emotions and other psychological modes of a subject, especially now that the progressions in technology and the convenience wireless devices that can offer sound accuracy in measuring brain activity similar to that provided by luxurious medical equipment.

A novel approach while using Non-invasive EEG classifies brain waves into three categories: theta activity (4 - 8 Hz), alpha activity (8 - 12 Hz), beta activity (12 - 25Hz) and gamma activity (greater than 25Hz). Each category is affiliated with different states of a subjects brain mode. Theta activity spikes in drowsiness, meditation and arousal; it is associated with relaxed and meditative states. Alpha activity is the relaxed and alert mode of the brain. Linguistic processing often spikes down the alpha wave activity. The beta activity is highest in active and active concentration, the proposed system will provide access to two sub-bands in the beta zone – 12 – 18 hz.

From the fact that no region of the brain can perform a certain task individually, instead, the interactions and exchange of information between different regions have to be done for any mental or motor functionality to be performed. The proposed system uses the over-all activity of the brain to measure stress and focus of the subject. Using the waves generated by facial expressions such as eye movement the system allows the subject to control the user interface.

### 1.1 Purpose

The application is build to solve the problem of learning for disabled children. Specifically physically disabled children below the age of 10 will benefit from the system. Physically disabled children have a hard time learning in their adolescence years because conventional learning methods seize to work so this application presents an all new, innovative solution using the state of the art non invasive EEG headset. Paralyzed children can use the system at capacity using their brains. Furthermore, children with hearing imparement will also benefit from the system as they can also use the system at capacity for learning purposes. Users will have registered profile and based on their activity on the application, the system will make recommendations on their future learning trends

### 1.2 Scope

The system solves the problem of learning for physically disabled *special children* of the age ranges from 5-8 years. Physically disabled children who have lost their upper bodily movements such as arm, hand, backbone movements will be benefited by this project only. The learning application will teach only the knowledge and implementation of the follow categories:

- Letters
- Colors
- Numbers

International standardized techniques and processes will be adopted throughout the learning process which the system uses for teaching the aforementioned categories to physically disabled children. The emotion detected process includes the following performance metrics:

- Interest
- Stress
- Focus
- Excitement

Moreover, for recreational learning purposes, two games will be developed that shall be played using only brain commands. Detecting emotions such as happy or sad is out of the scope of this project. The brain activity recorded by the EEG does not include deep brain waves thus further deep study being conducted on those waves is not possible. The improvement of individual learning process based on the state of emotions is highly subjective.

Our system is able to detect brain waves from the human scalp and turn them into commands understandable by computer and perform certain activities as instructed to it such as taking quiz of children, making them learn basic language and games.

Our system is also capable of detecting emotions of children and recommend either the child is satisfied by the system or not. If the "Interest" parameter raises from the normal amplitude, the system understands that the user is satisfied and if it's decreasing or if it's stable, it means that system isn't able to provide something new for the child.

## 2. Overall Description

### 2.1 Product Perspective

Brain Wave Decoder is basically a desktop Application specially designed for disabled children having lost their upper body movement: spinal cord injuries, limb injuries, muscular dystrophy, body movement lost in accidents, polio patients.

Using non-invasive EEG, child will interact with the system. An EEG machine processes and records the electrical activity in the cerebral cortex, the outer layer of the brain, during an EEG session. Using their brain activity, physically disabled subjects will interact with the system thus eliminating the need to use their physical attributes. Pointing on the screen, clicking, drag and drop, traversing through different interfaces, starting and exiting the system will all be possible using only their brain activity in real-time.

There is no such work done for the special children although there are specific techniques that are applied to teach them. BWD is the first ever BCI based system of learning for disabled children by which they can learn and at the same time their learning can be evaluated through a quiz. The system also includes entertaining learning games for students and be given as a reward once student does the quiz. The system we are developing is the first ever system designed for special children using BCI (Brain Computer Interface).

### 2.2 Operating Environment

OE-1: The system shall work correctly with Emotiv Insight Headset.
OE-2: The system shall be implemented in C# and Python.
OE-3: The system shall work correctly on windows 7 and above.
OE-4: The system shall work with a remote database.

### 2.3 Design and Implementation Constraints

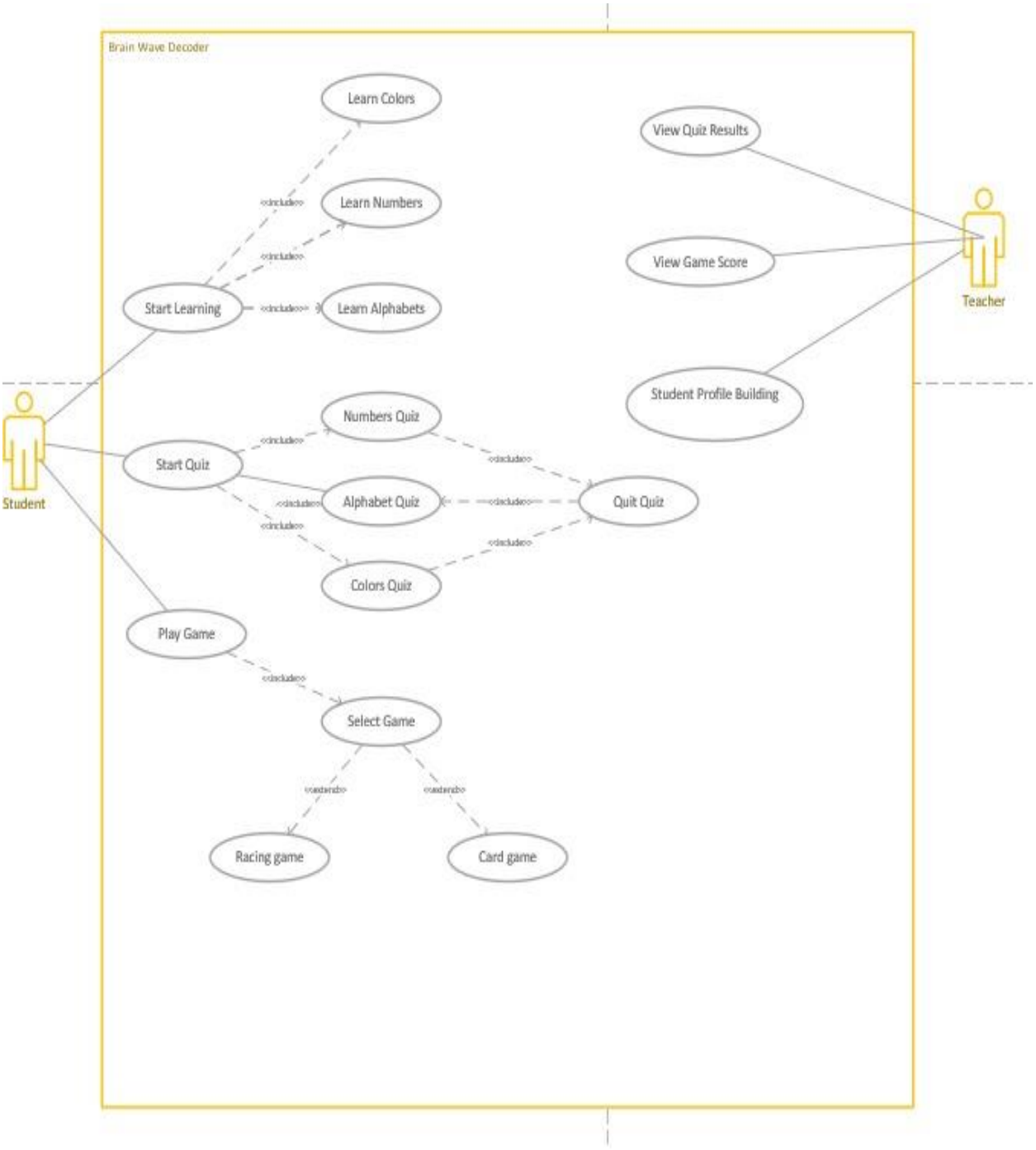
CO-1: The system shall be coded in python 3.
CO-2: The system shall use Cortex API for working with the Emotiv Headset.

## 3. Requirement Identifying Technique

The techniques used for deriving requirements and functional requirements are

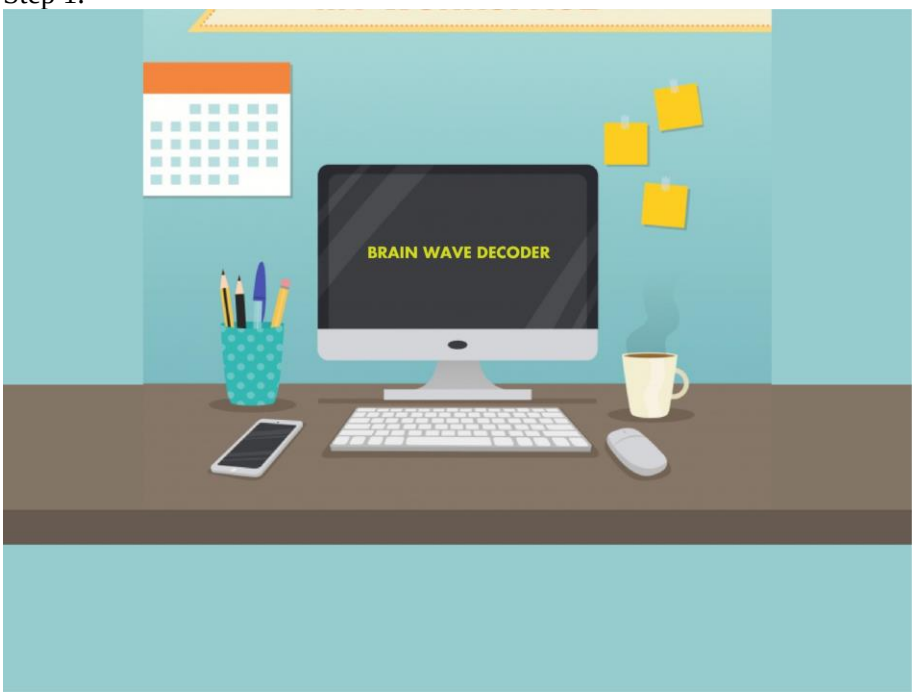
- Use cases
- Event response tables
- Story boarding

### 3.1 Use Case Diagram

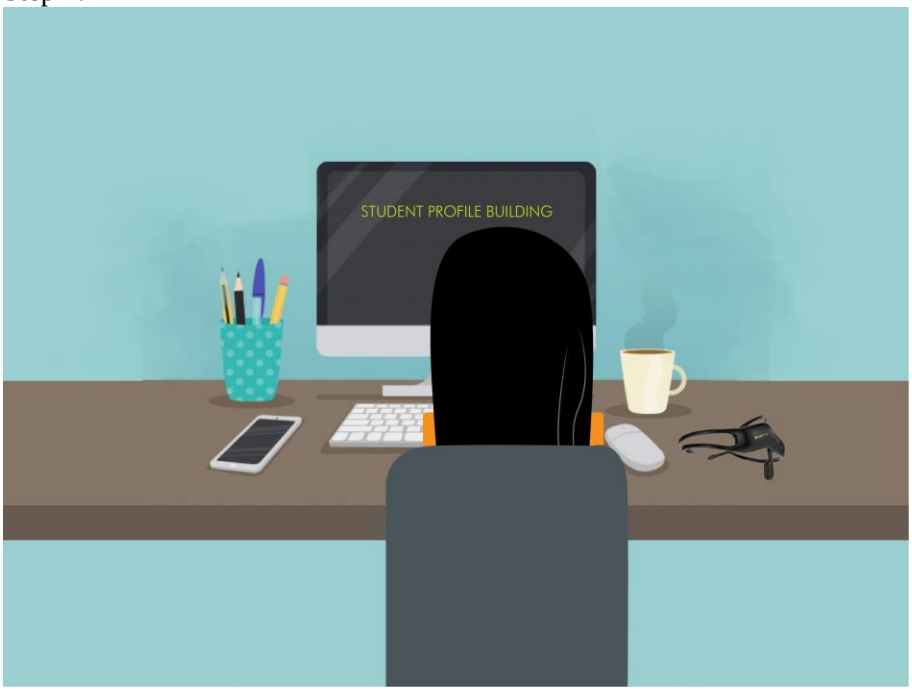


### 3.2 Story boarding

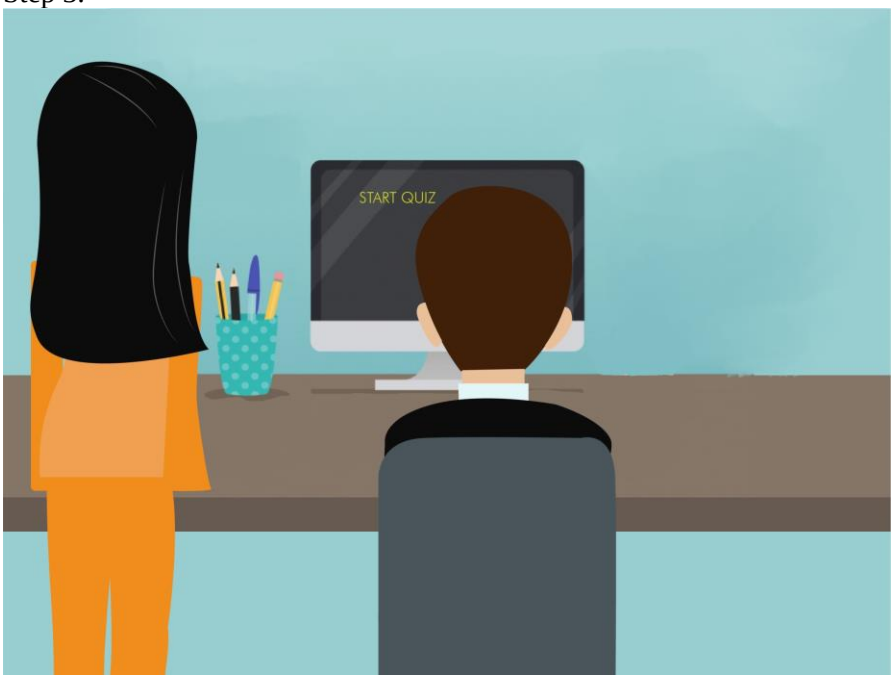
Step 1:



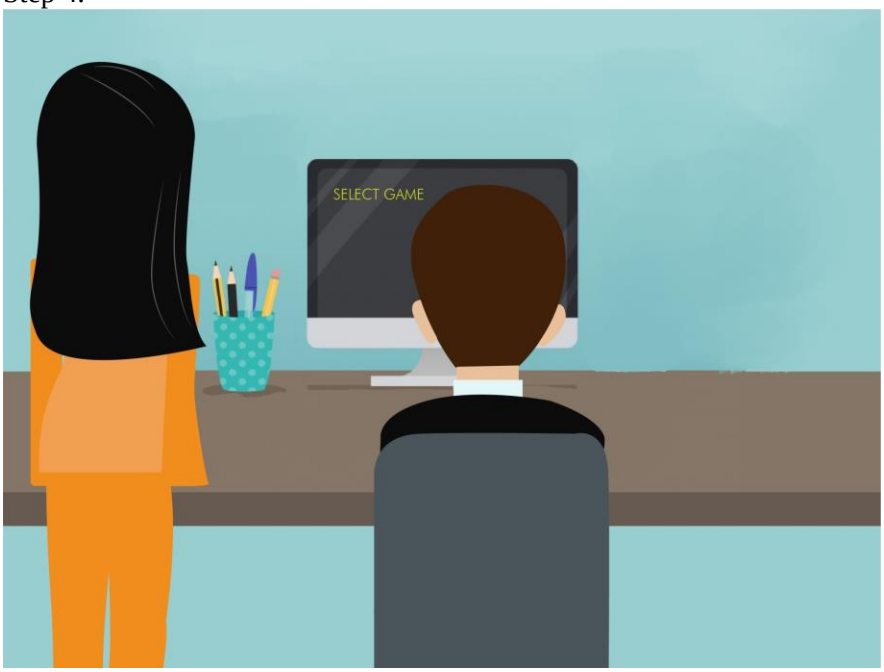

Step 2:



Step 3:




Step 4:



### 3.3 Use Case Description

| | |
|---|---|
| **Use Case ID:** | UC-1 |
| **Use Case Name:** | Child Learning |
| **Actors:** | Primary Actor : Student |
| **Description:** | User will be prompted to start learning by blinking their eye. By blinking his/her eyes user selects the Child Learning option out of other options on the menu. |
| **Trigger:** | User wants to start learning and blinks their eye. |
| **Preconditions:** | PRE-1. User profile has been created by the teacher.<br>PRE-2. User is wearing the headset and connectivity must be 95%+. |
| **Postconditions:** | POST-1. User starts learning.<br>POST-2. BWD randomly selects which subject to learn from; numbers, colors, letters. |
| **Normal Flow:** | 1. User wishes to start learning.<br>2. User blink his/her eye.(see 1.1)<br>3. BWD selects Child Learning from UI.<br>4. BWD prompts "Greetings, let's start learning".<br>5. After 10 seconds, BWD moves to next randomly selected subject learning. |
| **Alternative Flows: [Alternative Flow 1 – Not in Network]** | 1.1 User blinks his/her eye.<br>1. BWD gives no response.<br>2. BWD prompts after 5 seconds "Select again".<br>3. Normal flow continue from 2. |
| **Exceptions:** | E1: User doesn't focus on the learning part.<br>System does not unlock the quiz stage and he/she cannot move forward to the next stage.<br>E2: User does not learn and wants to repeat the learning process.<br>User has the option to restart the learning process by moving their head in downward direction. |
| **Business Rules** | BR1: Second lecture must be started after 1 minute break. |
| **Assumptions:** | Assumption-1 User Blinks his/her eyes in one swift go.<br>Assumption-2 User can blink his/her eye. |

| | |
|---|---|
| **Use Case ID:** | UC-2 |
| **Use Case Name:** | Play Game |
| **Actors:** | Primary Actor: Student |
| **Description:** | User plays the game using his/her brain such as card game or any learning game which will help child to focus and enjoy while playing. |
| **Trigger:** | User blinks his/her eye for playing the Game. |
| **Preconditions:** | PRE-1. User profile has been created by the teacher.<br>PRE-2. User must have passed the Quiz stage to unlock the Game. |
| **Postconditions:** | POST-1. User plays the game of his own choice. |
| **Normal Flow:** | 1. User shall be logged into the system.(see 1.1)<br>2. User should attend the Learning class first.<br>3. User must attempt the quiz once he/she passed through the Learning stage.<br>4. User must score more then 70% marks to unlock the Game Section.(see 1.2)<br>5. User plays the game after passing the quiz. |
| **Alternative Flows:**<br>**[Alternative Flow 1 – Not in Network]** | 1.1. User is already logged into the system.<br>1. Return to step 2 of normal flow.<br>1.2. User does not score 70% marks.<br>1. Return to step 3 of normal flow. |
| **Exceptions:** | E1 User doesn't focus on the learning part<br>1. System does not unlock the quiz stage and he/she cannot move forward to the next stage.<br>E2 User doesn't score 70% marks in the quiz.<br>2. Message is displayed "you failed" and system redirects the user back to the learning stage.<br>E3 User quits in the middle of game.<br>3. Message is displayed "You quit" and the use case is terminated. |
| **Business Rules:** | BR1: Game is only played when first two stages are cleared.<br>BR2: Game must be completed within 10 minutes. |

| | |
|---|---|
| **Use Case ID:** | UC-3 |
| **Use Case Name:** | Quit game |
| **Actors:** | Primary Actor: Student |
| **Description:** | During the game, if user stays idle for 15 seconds, the system will prompt the user if he/she wants to quit. Moving head upwards will end the game and redirect the user to the main page and moving head downwards will continue the game. And BWD measures the interest of the user, if interest level are minimum for 80 seconds, BWD prompts, "You look bored, (username), do you want to quit and take a break?" Moving head upwards will end the game and redirect the user to the main page and moving head downwards will continue the game. |
| **Trigger:** | User stays idle for 15 seconds or users interest levels are low for 80 seconds. |
| **Preconditions:** | PRE-1. User profile has been created by the teacher.<br>PRE-2. User is wearing the headset and connectivity is 95%+.<br>PRE-3. User has chosen learning.<br>PRE-4. User has completed the learning stage.<br>PRE-5. User has successfully passed the quizzes.<br>PRE-6. User is playing the game. |
| **Postconditions:** | POST-1. Game ends.<br>POST-2. User redirected to main page. |
| **Normal Flow:** | 1. User stays idle for 15 seconds or interest levels are low for 80 seconds.<br>2. BWD prompts, "Do you want to quit the game?"<br>3. User moves his head upwards to quit the game.(see 1.1)<br>4. Game ends, user redirected to main page. |
| **Alternative Flows:**<br>**[Alternative Flow 1 – Not in Network]** | 1.1 User moves his/her head upwards to quit the game.<br>1. BWD does not respond.<br>2. User moves his/her head upwards again after 5 seconds of previous blink.<br>3. Normal flow resumes from step 4. |
| **Exceptions:** | E1: If user stays idle for 50 sec and then eventually focuses again.<br>System will automatically detect the idle states and after 3 attempts it will prompt the message "Stay in the game". |
| **Business Rules** | BR1: User must remain idle for at least 80 sec to quit the game<br>BR2: User must be well aware of how to quit the game. |
| **Assumptions:** | Assumption-1 User moves his/her head upwards in one swift go.<br>Assumption-2 User can move his/her head upwards. |

| | |
|---|---|
| **Use Case ID:** | UC-4 |
| **Use Case Name:** | Start Quiz |
| **Actors:** | Primary Actor: Student |
| **Description:** | After learning stage, user is enters the quiz stage where his/her learning from the previous stage is tested. The quiz can be in any one of the form e.g. Letters, Numbers, Colors. He/she just has to think of the appropriate answer and perform some mental command such as push, pull, left or right to point towards the correct answer. |
| **Trigger:** | Quiz starts after blink of an eye. |
| **Preconditions:** | PRE-1. User profile has been created by the teacher.<br>PRE-2. User must have passed the Learning stage to unlock the Quiz. |
| **Postconditions:** | POST-1. Score of quiz will be displayed.<br>POST-2. User enters into the game stage after passing the Quiz. |
| **Normal Flow:** | 1. User logs into the system.(see 1.1)<br>2. User has completes the Learning class first. (E1)<br>3. System prompts "Are you ready to attempt the quiz?"<br>4. System starts 10 minute quiz timer.<br>5. User attempts the quiz.(see 1.2, E3)<br>6. User clicks the Submit Quiz button using his/her head movements.(see 1.2)<br>7. System displays the results.<br>8. User passed quiz with more than 70% score.(see 1.3, E2)<br>9. System prompts "You passed, do you want to play a game?"<br>10. User blinks his eye to play game. |
| **Alternative Flows:**<br>**[Alternative Flow 1 – Not in Network]** | 1.1 User is already logged into the system.<br>1. Return to step 2 of normal flow.<br>1.2 User attempts the quiz.<br>1. User doesn't complete the quiz in 10 minutes.<br>2. System prompts "Time over"<br>3. User scores more than 70%.<br>4. Use case resumes from normal flow 9.<br>1.3 User passed quiz with more than 70% score.<br>1. User doesn't score more than 70% marks.<br>2. System redirects user to learning stage.<br>3. Use case terminates. |
| **Exceptions:** | E1 User doesn't focus on the learning part<br>1. System does not unlock the quiz stage and he cannot move forward to the next stage.<br>E2 User doesn't score 70% marks in the quiz.<br>2. Message is displayed "you failed" and system redirects the user back to the learning stage.<br>E3 User quits in the middle of Quiz.<br>3. Message is displayed "Are you sure you want to quit?" If yes, then use case is terminated. |
| **Business Rules:** | BR1: Quiz must be completed within 10 minutes.<br>BR2: Quitting the quiz will end the Application. |

| | |
|---|---|
| **Use Case ID:** | UC-5 |
| **Use Case Name:** | Submit Quiz |
| **Actors:** | Primary Actor: Student |
| **Description:** | After learning stage, user is enters into the quiz stage where his learning from the previous stage is tested. The quiz can be in any one of the form e.g. Letters, Numbers, Colors. He/she just has to think of the appropriate answer and perform some mental command such as push, pull, left or right to point towards the correct answer.<br>If the user completes the Quiz before the Time allotted, he can submit it or if he doesn't know the answers, he can submit it then too. |
| **Trigger:** | User moves his head towards the submit quiz button. |
| **Preconditions:** | PRE-1. User profile has been created by the teacher.<br>PRE-2. User must have passed the Learning stage to unlock the Quiz. |
| **Postconditions:** | POST-1. Score of quiz will be displayed.<br>POST-2. User enters into the game stage after passing the Quiz. |
| **Normal Flow:** | 1. User logs into the system.(see 1.1)<br>2. User has completes the Learning class first.(E1)<br>3. System prompts "Are you ready to attempt the quiz?"<br>4. User blinks to start the quiz.<br>5. System starts 10 minute quiz timer.<br>6. User attempts the quiz.(see 1.2, E3)<br>7. User clicks the Submit Quiz button using his/her head movements.(see 1.2)<br>8. System displays the results.<br>9. User passed quiz with more than 70% score.(see 1.3, E2)<br>10. System prompts "You passed, do you want to play a game?"<br>11. User clicks the Play Game button using his/her head movements. |
| **Alternative Flows:**<br>**[Alternative Flow 1 – Not in Network]** | 1.1 User is already logged into the system.<br>1. Return to step 2 of normal flow.<br>1.2 User attempts the quiz.<br>1. User doesn't complete the quiz in 10 minutes.<br>2. System prompts "Time over"<br>3. User scores more than 70%.<br>4. Use case resumes from normal flow 9.<br>1.3 User passed quiz with more than 70% score.<br>1. User doesn't score more than 70% marks.<br>2. System prompts "Learn again to score more marks"<br>3. System redirects the user to learning stage. |

| | |
|---|---|
| **Exceptions:** | E1 User doesn't focus on the learning part<br>1. System does not unlock the quiz stage and he cannot move forward to the next stage.<br>E2 User doesn't score 70% marks in the quiz.<br>2. Message is displayed "you failed" and system redirects the user back to the learning stage.<br>E3 User quits in the middle of Quiz.<br>3. Message is displayed "Are you sure you want to quit?" If yes, then use case is terminated. |
| **Business Rules:** | BR1: Quiz must be completed within 10 minutes.<br>BR2: Quitting the quiz will close the Application. |

| | |
|---|---|
| **Use Case ID:** | UC-6 |
| **Use Case Name:** | Select Game |
| **Actors:** | Primary Actor: Student |
| **Description:** | User after passing the quiz stage can now play one of any two games of his/her own choice by moving his/her head upward for one game and downward for the other one. |
| **Trigger:** | User moves his/her head upward/downward for selecting the game. |
| **Preconditions:** | PRE-1. User must have passed the learning stage.<br>PRE-2. User must have passed the quiz stage. |
| **Postconditions:** | POST-1. User plays the game of his/her own choice. |
| **Normal Flow:** | 1. User logs into the system.<br>2. User completes the Learning stage.<br>3. User attempts the quiz once he/she passed through the Learning stage.<br>4. System redirects the user to game section.<br>5. User selects the card game by moving his/her head upwards.(1.1, E1)<br>6. User plays the card game. |
| **Alternative Flows: [Alternative Flow 1 – Not in Network]** | 1.1. User selects the card game by moving his/her head upwards. (see E1)<br>1. User selects the racing game by moving his head downwards.<br>2. User plays the racing game. |

| | |
|---|---|
| **Exceptions:** | E1: User doesn't move his head upward/downward<br>System prompts "Move your head to select the game".<br>E2: User doesn't respond to the message In E1<br>System automatically plays the game of its own choice after 10 sec of inactivity. |
| **Business Rules:** | BR1: Game is only played when first two stages are cleared.<br>BR2: Game must be completed within 10 minutes.<br>BR3: User must move his head upward/downward for selecting the game. |

| | |
|---|---|
| **Use Case ID:** | UC-7 |
| **Use Case Name:** | Student profile building |
| **Actors:** | Primary Actor: Teacher |
| **Description:** | Teacher will create profile of the student because student himself/herself can't create profile as he/she is disabled and the system does not yet support profile building using BCI. |
| **Trigger:** | Teacher clicks the Student Profile Building button. |
| **Preconditions:** | PRE-1. BWD desktop application must be running.<br>PRE-2. Student waiting for profile to be built so he/she can start using the application. |
| **Postconditions:** | POST-1. Student profile built.<br>POST-2. Student can start using the application<br>POST-3. System prompts "Welcome Student". |
| **Normal Flow:** | 1. Teacher runs the BWD desktop application.<br>2. Teacher clicks on the Student Profile Building button.<br>3. Student profile building UI opens.<br>4. Teacher enters student name, age, class, DOB.<br>5. Teacher finishes student profile building.<br>6. BWD prompts "Student profile successfully created"<br>7. BWD redirects to next interface. |
| **Exceptions:** | E1: Teacher enters student name, age, class, DOB<br>BWD prompts "Child should be less than 10 years old", normal flow starts from step 2. |
| **Business Rules:** | BR1: Child must be less than 10 years old.<br>BR2: A child can have only one profile. |

| | |
|---|---|
| **Use Case ID:** | UC-8 |
| **Use Case Name:** | View quiz results |

| | |
|---|---|
| **Actors:** | Primary Actor: Teacher |
| **Description:** | Teacher can view the quiz results of a student. |
| **Trigger:** | Teacher clicks the view quiz result button on specific student profile interface. |
| **Preconditions:** | PRE-1. Student must have profile.<br>PRE-2. Student profile must be logged in.<br>PRE-3. BWD desktop application must be running.<br>PRE-4. Student must have attempted quizzes section.<br>PRE-5. Student must have completed the learning section. |
| **Postconditions:** | POST-1. Student results displayed. |
| **Normal Flow:** | 1. Teacher runs the desktop application by double clicking on the icon.<br>2. Teacher logs in the student to his profile.<br>3. Teacher clicks view quiz results on the student profile interface.<br>4. BWD displays quiz results.<br>5. Teacher views the results. |
| **Alternative Flows:**<br>**[Alternative Flow 1 – Not in Network]** | 1.1. Teacher is already logged into the system.<br>1. Return to step 3 of normal flow. |
| **Business Rules:** | BR1: Quiz results must only be viewed by teacher.<br>BR2: Teacher must not disclose student login credentials to anyone. |

| | |
|---|---|
| **Use Case ID:** | UC-9 |
| **Use Case Name:** | View Game Score |
| **Actors:** | Primary Actor: Teacher |
| **Description:** | Teacher can view the game score of a student. To view the game scores, the student must have played the game once or more, only then the game scores will be available. |
| **Trigger:** | Teacher clicks the view game score button on specific student profile interface. |

| | |
|---|---|
| **Preconditions:** | PRE-1. User profile has been created by the teacher.<br>PRE-2. BWD desktop application must be running.<br>PRE-3. Student must have played the games. |
| **Postconditions:** | POST-1. Student game scores displayed. |
| **Normal Flow:** | 1. Teacher runs the desktop application by double clicking on the icon.<br>2. Teacher logs in the student to his profile.<br>3. Teacher clicks view game score on the student profile interface.<br>4. BWD displays game score.<br>5. Teacher views the game scores. |
| **Alternative Flows:**<br>**[Alternative Flow 1 – Not in Network]** | 1.1. Teacher is already logged into the student profile.<br>1. Return to step 3 of normal flow. |
| **Business Rules:** | BR1: Quiz score must not have decimal values. |

**Event Response Table:**

| **Event** | **System State** | **Response** |
|---|---|---|
| System has to select one of three categories in the learning stage. | System is logged in. Ready to start learning. | System randomly selects one of the three categories and start learning stage. |
| After first stage, System has to go to the next learning category. | System has completed the first learning category. | System jumps to the second category of learning and start next learning category. |
| System completed the second stage and wants to go to the third category of learning. | System has completed the second category of learning. | System transfers its control to the third category of learning. |

| | | |
|---|---|---|
| System has to transfer its control to the quiz stage. | System has completed the User learning stage. | System diverts its control to the quiz stage. |
| System has to select one of three categories in the Quiz stage. | System is waiting for the start of Quiz. | System selects one of the three categories and starts quiz. |
| After first category, System has to go to the next category. | System has completed the first category of quiz. | System jumps to the second category and starts taking quiz. |
| System completed the second category of quiz and wants to go to the third. | System has completed the second category of quiz. | System transfers its control to the third category of quiz. |
| System wants to go to the game stage. | System has just completed the quiz stage | System transfer its control to the Game stage. |
| After 10 sec of inactivity by the user, System automatically selects the game. | System just goe into the game section. | System randomly selects a game and starts it. |
| System generates email to Care-takers | System finished the Quiz stage | System generates progress and emails to care takers of student. |
| User loss of focus while attempting quiz | System is busy | System prompts “Do you want to quit”? |
| User loss of interest while playing game | System is busy | System prompts “Do you want to quit”? |
| Retry learning level | System just finished the first learning lesson | System prompts “Do you want to restart the lesson ”? |

## 2 Functional Requirements

The section includes the Functional requirements of our system.

## 2.2 Functional Requirement

**Table 1: Description of FR-1**

| | |
|---|---|
| **Identifier** | FR-01 |
| **Title** | Start learning |
| **Requirement** | The User shall be able to choose the start learning option on the UI by blinking his/her eye once. |
| **Source** | Student |
| **Rationale** | To enable the User to start learning about alphabets, number and colors. |
| **Business Rule (if required)** | BR1: User must be physically disabled and under the age of 10. |
| **Dependencies** | FR-2 |
| **Priority** | High |

**Table 2: Description of FR-2**

| | |
|---|---|
| **Identifier** | FR-02 |
| **Title** | Randomized subject learning |
| **Requirement** | If the student has successfully entered learning section, the system shall randomly select a subject from numbers, alphabets or colors for learning. |
| **Source** | Student |
| **Rationale** | For commencing the learning process. |
| **Business Rule (if required)** | BR1: 1 minute break must be given to student after every lesson. |
| **Dependencies** | FR-3, FR-4, FR-5, FR-16 |
| **Priority** | High |

**Table 3: Description of FR-3**

| | |
|---|---|
| **Identifier** | FR-03 |
| **Title** | Alphabet learning |
| **Requirement** | The student shall be able to learn about alphabets when the randomly selected subject to be learned is Alphabets. |
| **Source** | Student |
| **Rationale** | To teach the student about alphabets. |
| **Business Rule (if required)** | BR1: Lecture should not exceed more than 5 minutes.<br>BR2: System should wait for 15 sec after one lecture. |
| **Dependencies** | FR-2, FR-4, FR-5 |
| **Priority** | High |

**Table 4: Description of FR-4**

| | |
|---|---|
| **Identifier** | FR-04 |
| **Title** | Color learning |
| **Requirement** | The student shall be able to learn about colors when the randomly selected learning subject is Colors. |
| **Source** | Student |
| **Rationale** | To teach the student about colors and how they differ from each other. |
| **Business Rule (if required)** | BR1: Student must be given a chance for playing the lesson again.<br>BR2: Lecture should not exceed more than 5 minutes. |
| **Dependencies** | FR-5, FR-2, FR-4, |
| **Priority** | High |

**Table 5: Description of FR-5**

| | |
|---|---|
| **Identifier** | FR-05 |
| **Title** | Number learning |
| **Requirement** | The student shall be able to learn about number when the randomly selected learning subject is Numbers. |
| **Source** | Student |
| **Rationale** | To teach the student about numbers (0-9). |
| **Business Rule (if required)** | BR1: Student must be given a chance for playing the lesson again.<br>BR2: Lecture should not exceed more than 5 minutes. |
| **Dependencies** | FR-6, FR-2, FR-3, FR-4, |
| **Priority** | High |

**Table 6: Description of FR-6**

| | |
|---|---|
| **Identifier** | FR-6 |
| **Title** | Quizzes |
| **Requirement** | If student has completed all three lessons, the system shall display the quiz. |
| **Source** | Student |
| **Rationale** | For testing the learning outcome of the lessons. |
| **Business Rule (if required)** | BR1: Quiz should include a timer of 10 minutes.<br>BR2: Student should not divert his/her attention from quiz for more than 15 sec. |
| **Dependencies** | FR-7, FR-8 |

| | |
|---|---|
| **Priority** | High |

**Table 7: Description of FR-7**

| | |
|---|---|
| **Identifier** | FR-7 |
| **Title** | Attempting quiz |
| **Requirement** | The student shall be able to attempt the quiz. |
| **Source** | Student |
| **Rationale** | The student should be able to attempt the quiz without any problems using his brain. |
| **Business Rule (if required)** | BR1: Quiz should not exceed more then 10 minutes.<br>BR2: Learning is necessary before attempting quiz. |
| **Dependencies** | FR-8, FR-7, FR-6 |
| **Priority** | High |

**Table 8: Description of FR-8**

| | |
|---|---|
| **Identifier** | FR-8 |
| **Title** | Results |
| **Requirement** | Once the user has attempted the quiz, the system shall display results. |
| **Source** | Student |
| **Rationale** | The student must know how well he/she scored on the quiz. |
| **Business Rule (if required)** | BR1: Results must be displayed with the correct options highlighted. |
| **Dependencies** | FR-7 |
| **Priority** | High |

**Table 9: Description of FR-9**

| | |
|---|---|
| **Identifier** | FR-9 |
| **Title** | Play game |
| **Requirement** | The student shall be able to play a game after he/she has passed the quiz. |
| **Source** | Student |
| **Rationale** | For rewarding the student for his/her excellent understanding of the subjects. |
| **Business Rule (if required)** | Br1: Game must be selected by moving user head upward/downward.<br>BR2: Game should not exceed more than 10 minutes. |
| **Dependencies** | FR-10 |

| | |
|---|---|
| **Priority** | High |

**Table 10: Description of FR-10**

| | |
|---|---|
| **Identifier** | FR-10 |
| **Title** | Quit game |
| **Requirement** | The student shall be able to quit the game while he/she is playing it. |
| **Source** | Student |
| **Rationale** | To allow the student to quit the game when he/she wishes. |
| **Business Rule (if required)** | BR1: lack focus will Automatically pause the game. |
| **Dependencies** | FR-9 |
| **Priority** | High |

**Table 11: Description of FR-11**

| | |
|---|---|
| **Identifier** | FR-11 |
| **Title** | Interest levels |
| **Requirement** | The system shall be able to detect the interest level of the student. |
| **Source** | Student |
| **Rationale** | To make sure the learning process is effective. |
| **Business Rule (if required)** | BR1: Student does not have direct access to this. |
| **Dependencies** | FR-3,FR-4,FR-5,FR-6 |
| **Priority** | Medium |

**Table 12: Description of FR-12**

| | |
|---|---|
| **Identifier** | FR-12 |
| **Title** | Facial expression recognition |
| **Requirement** | The student shall be able to navigate through the UI using facial expression such as eye blink, head movements. |
| **Source** | Student |
| **Rationale** | For providing innovative usability for the student. |
| **Business Rule (if required)** | BR1: One blink for “yes” command. |
| **Dependencies** | FR-1, FR-2, FR-3, FR-4, FR-5 |
| **Priority** | Medium |

**Table 13: Description of FR-13**

| | |
|---|---|
| **Identifier** | FR-13 |
| **Title** | Select game |
| **Requirement** | The student shall be able to navigate through the UI using head movements such as moving his/her head up/down |
| **Source** | Student |
| **Rationale** | For providing innovative usability for the student. |
| **Business Rule (if required)** | BR1: Head up for selecting one game<br>BR2: Head down for selecting the other game. |
| **Dependencies** | FR-1, FR-2, FR-3, FR-4, FR-5 |
| **Priority** | Medium |

**Table 14: Description of FR-14**

| | |
|---|---|
| **Identifier** | FR-14 |
| **Title** | Quit Quiz |
| **Requirement** | The student shall be able to Quit the quiz by the blink of his/her eye. |
| **Source** | Student |
| **Rationale** | For providing innovative usability for the student. |
| **Business Rule (if required)** | BR1: Quiz will be quitted using mental commands only. |
| **Dependencies** | FR-7 |
| **Priority** | Medium |

**Table 15: Description of FR-15**

| | |
|---|---|
| **Identifier** | FR-15 |
| **Title** | BWD Desktop Application |
| **Requirement** | The system shall allow the teacher to access the desktop application and use it. |
| **Source** | Teacher |
| **Rationale** | For providing innovative usability for the student. |
| **Business Rule** | BR1: User must have valid credentials to access the Application. |
| **Dependencies** | None |
| **Priority** | Medium |

**Table 16: Description of FR-16**

| | |
|---|---|
| **Identifier** | FR-16 |
| **Title** | Next Lesson |
| **Requirement** | When any of the following lessons; Alphabet learning, Color learning or number learning, ends the system shall randomly choose the next lesson and switch to it. |
| **Source** | System |
| **Rationale** | To switch to the next lesson. |
| **Business Rule (if required)** | BR1: Lecture should not exceed more than 5 minutes.<br>BR2: System should wait for 15 sec after one lecture. |
| **Dependencies** | FR-2, FR-4, FR-5 |
| **Priority** | High |

**Table 17: Description of FR-17**

| | |
|---|---|
| **Identifier** | FR-17 |
| **Title** | Email parents |
| **Requirement** | The system shall email the caretaker the report of quizzes and learning out come. |
| **Source** | Parents |
| **Rationale** | To notify caretakers of their child's progress. |
| **Business Rule (if required)** | BR1: The email of parents shall not be disclosed to anyone else.<br>BR2: Email will be sent after the quiz has been attempted.<br>BR3: Email should contain only the quiz results. |
| **Dependencies** | FR-11 |
| **Priority** | High |

**Table 18: Description of FR-18**

| | |
|---|---|
| **Identifier** | FR-18 |
| **Title** | Create user profile |
| **Requirement** | The system shall allow the teacher to create profile of a student. |
| **Source** | Student |
| **Rationale** | For the student to use the system, the teacher must create profile of a student only then will he/she be able to use the system at capacity. |
| **Business Rule (if required)** | BR1: A user can have single profile.<br>BR2: Information about user will not be disclosed to any marketing agency. |
| **Dependencies** | FR-18 |
| **Priority** | High |

**Table 19: Description of FR-19**

| | |
|---|---|
| **Identifier** | FR-19 |
| **Title** | Quiz failed |
| **Requirement** | If the student has scored less than 70% on the quiz, the system shall prompt the user to learn the three subjects again. |
| **Source** | Student |
| **Rationale** | The students' understanding about colors, alphabets and number should be sound enough. |
| **Business Rule (if required)** | BR1: Quiz will be considered fail if scored percentage is less 70%.<br>BR2: Next quiz will not be displayed until the current quiz is passed. |
| **Dependencies** | FR-2, FR-3, FR-4, FR-5 |
| **Priority** | High |

**Table 20: Description of FR-20**

| | |
|---|---|
| **Identifier** | FR-20 |
| **Title** | View quiz results |
| **Requirement** | The teacher shall be able to view the quiz results of a student if the student has completed the learning section and attempted the quizzes. |
| **Source** | Teacher |
| **Rationale** | Student quiz result evaluation. |
| **Business Rule (if required)** | BR1: Quiz will be considered fail if scored percentage is less 70%.<br>BR2: Quiz results must not be disclosed to third parties. |
| **Priority** | Medium |

**Table 21: Description of FR-21**

| | |
|---|---|
| **Identifier** | FR-21 |
| **Title** | View game score |
| **Requirement** | The teacher shall be able to view the game scores of a student if the student has played the games. |
| **Source** | Teacher |
| **Rationale** | The games are of learning nature so they'll the game scores will provide a better understanding to the teacher about the progress of their student. |
| **Priority** | Medium |

**Table 22: Description of FR-22**

| | |
|---|---|
| **Identifier** | FR-22 |

| | |
|---|---|
| **Title** | Student profile building |
| **Requirement** | The teacher shall be able to create profile of a student for him/her to start learning by using BWD. |
| **Source** | Student |
| **Rationale** | To use the system the student must have a profile. |
| **Business Rule (if required)** | BR1: A student can have only one profile. |
| **Dependencies** | FR-2, FR-3, FR-4, FR-5, FR-6, FR-9 |
| **Priority** | High |

## 3 Non-Functional Requirements

Following are the Non-functional requirements of our system that are described as:

### 3.2 Usability

USE-1: The BWD shall allow the user to quit the Quiz with a blink of an eye.

USE-2: The BWD shall allow a user to quit the game by just monitoring his focus/engagement waves.

USE-3: The BWD shall allow the user to select the game by moving his/her head upward/downward.

USE-4: The BWD shall allow the user to replay the learning lesson if he doesn't understand it for the first time.

### 3.3 Performance

PER-1: Every time user ends the quiz; the system shall be able to generate the results within 10secs.

PER-2: Whenever user finishes one step of learning, system should wait for 1 minute before beginning the next lesson.

PER-3: User shall be able to complete the quiz within 10 minutes.

PER-4: Whenever user finishes the game, system shall be able to display the score within 5 seconds.

PER-5: Whenever user finishes one Quiz, system should wait for 20 sec before starting the next Quiz.

PER-6: The system shall be able to give user a 1-minute break after ending of each section. i.e. Learning, quiz.

### 5.3. Portability

PORT-1: The system shall be portable to allow the user to use it if he/she are sitting on a chair or lying on a bed.

### 5.3 Scalability

SCA-1: The system shall be designed in a way which leaves gaps for additional functionality when need be for example Urdu learning shall be added in the future.

### 5.4 Compatibility

COM-1: BWD shall be compatible with windows OS.
COM-2: BWD shall be compatible with Emotiv Insight head which is used to record and manipulate brain waves.

## 4 External Interface Requirements

External interfaces are stated as:

### 4.2 User Interfaces

1. Colors of user interface must be attractive so that children get attracted easily.
2. No long paragraphs to be included as it's difficult for child to read it out.
3. Buttons to be placed where user can easily move his head through motion sensor.
4. Game icons must be colorful.
5. Resolution of screen must be HD/1080p so children do not have any difficulty while using it.
6. Font size must be kept large for children having eye-sight problems.
7. Images must be kept simple and colorful so children can catch them easily.

### 4.3 Software Interfaces

The software interfaces the system will interact with are: Emotiv BCI application, which will be used to record the brain activity of the child, Firebase will be used to save profiles of children.

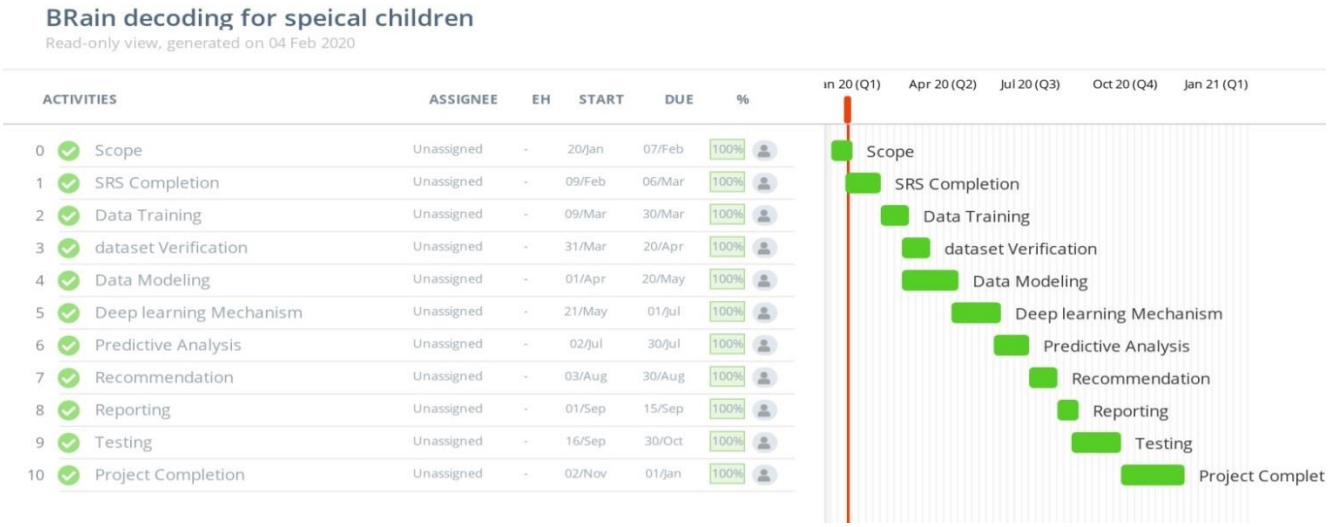
### 4.4 Hardware Interfaces

The system will interface with Emotiv Insight headset which will be used to measure and record the brain activity of a child.

### 4.5 Communication Interfaces

The communication interfaces that the system will interact with are: Cortex API, which shall be used be used to take the brain waves and send it to the desktop application. A web socket will be created to send the brain activity data from the Emotiv BCI application to the Cortex API and then to the desktop application. SMTP will be used to send email to parents about their child's progress. TCP will be used to connect with the online Firebase server when the system is installed and run.

## 5 Project Gantt Chart




## 6 References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## 7 Plagiarism Report