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Headway – Tracking Kid's Brain Development.

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Abstract: Headway Project seeks to understand Development of a kid's brain. Brain, the leader of human body is related to changing cognitive abilities of child as they develop. The research team developing the Headway product to develop kid's cognitive skills and pedagogical level using android application. This application includes some Brain Development activities such as; Logic & Thinking, Music, Mathematics & Numbers. Each category consists of five activities. The main objective of this project is to calculate the performance of the child in education, in different subjects. In Sri Lanka, developing country, the hospitals are using a manual system based on United States standards. Due to that reason it is important to introduce an automated process. There are some games based on kids brain development (Toca town, Reader rabbit, Brain Game and etc.), but those do not provide any detailed report for the parent and not included more than three activities. Even though there are so many international standardized psychometric tests are available to scale out the intelligence of children. Therefore the research team found a way to solve the identified issues by developing an Android application to track the progress of kid's brain by giving detailed report for the parent according to the psychiatric algorithm. Headway system is implemented using Java language, Android software development kit and the integrated development environment is Android Studio version 0.4.2. The development teams' sole effort is to formulate a test bench for Sri Lankan children who are in age limit of 4 to 6 years in reverence to our culture & social requirement.

Keywords: Brain Development; Cognitive Skills; Pedagogical Level; Psychometric; Predictions; Android Application.

I. INTRODUCTION

We all have born with a brain that is partially developed. The kid's brain development will depend on several factors like, family background, culture, language, health issue and etc. Even though the kid grows perfect, physically, the brain might not.

By studying the existing Literature, it was found that there was no automated way to track the kid's brain development and the main problem that came up was how to track the progress of kid's brain development. There are some games to helps kid's brain development, but those do not provide any detailed report for the parent and not included more than three activities. Even though there are ways to monitor the kid's brain development in various hospitals in Sri Lanka, all are doing it manually by keep records according to the user manual of United States standards.

The research team decided to develop a tool kit to measure the kid's brain development by giving a detailed report for the parent by analyzing several Brain Development (BD) activities [1][2]. The application would be able to obtain the Brain Development of the kid via an Android application and generate a report that measures kid's brain development.

Human intelligence can be characterized by perception, consciousness, self-awareness, and volition. Through their intelligence human possess the cognitive abilities to learn, comprehend ideas, capacities to recognize patterns, plan, to solve problems, and use language to communicate. It has been observed that there are seven distinct types of intelligence among humans. They are logical-mathematics, linguistic, spatial, musical, kinesthetic, interpersonal, and intra-personal [2].

In compatibility to the above, the children intelligence means is the measure of cognitive capabilities. In other words, children's cognitive abilities are their abilities to perform mental operations, to pay attention, to remember, & to communicate about what they have learned. Basically there are four separate cognitive factors that governess the intelligence of a child [1]. They are:

- Verbal reasoning (e.g. the ability to solve verbal problems & to demonstrate language mastery through demonstrations of vocabulary knowledge & sentence comprehension).
- Quantitative reasoning (e.g. the ability to solve math problems with number crunching)
- Short-term memory (i.e. the ability to hold facts in memory for short period of time. e.g. puzzles).

- Musical intelligence (i.e. have excellent pitch, responses to environment)

Based on above mentioned factors, the research team decided to develop android application by answering following research questions.

- How to track Kids' Brain Development (KBD) progress using an android application?
- What are different areas that should take into consideration when designing the activities?
- What are the kids' brain development activities?
- Should there be multiple graphs for one child in multiple categories, or one single graph regarding all the categories?

II. LITERATURE REVIEW

In Sri Lanka there is no standard technique to measure the kids' brain development. Current brain development standards are taken from Unites States (almost not same). And there are brain development theories, how the child should be taught, what are the categories child brain should develop. In Sri Lanka 4 to 6 age group are taught in preschools in limited amount of time period. In Sri Lanka commonly both parents are working and parental assistance is limited during the day time to teach the kid. Today education has become an important thing in the society. Parents want to give a good education to their children. There are no applications that focus on overall brain development of children who are in 4-6 years. There are little games that can check spelling mistakes, little math's puzzles but they do not provide a good report to the parent. The Capacity to Hold in Mind in the children was deferent from one to another in age of 2 some can identify their parents but some are don't. People think talking is a simple activity but it wouldn't because for talking he or she must see something then eye process the image to brain. Brain take the details and give instruction to mouth to do the speaking. All of activities are complex all of them are based on brain [13].

Video games are a good method we can use to educate the children as today's children doesn't like to read books. Applications for children could be implemented to read the book. A lot of games have multiple objectives that the player should accomplish. There are games that can improve child's memory capacity some of them can develop spelling accurate using games is good for study. [16]

There are lots of video games that can harm children's mind and there are games that can teach the children. The creator must design the game with the responsibility of teaching the child. This research was done by different learning theories in the field, namely behaviorism, cognitivist, constructionism and the socio-cultural approach. Every game had a task to complete if the child plays that game him or her gains the ability to identify the tasks he or she must done [8].

N.Thalagala [1] has researched on determining the age specific normative patterns in order to identify whether the children can "do" or "know" in growing age. He has found four development domains

- Social and emotional
- Language and communication
- Physical
- Cognitive Sensorial

The physical area of development covers skills and ability develop with body movements. Social and emotional area includes abilities to involve in relationships and check whether that signaling emotions in there growing age. Cognitive development refers to increasing competency of the child's intellectual and mental abilities. This domain check weather that child can recognize objects. Language development occurs at a very early period of life. He has define Child developmental standards (age percentile and age percentile range) process of early child development by drafting those domain and masher the growth [1].

Article of news week (Your Child's Brain) said that "A baby's brain is a work in progress, trillions of neurons waiting to be wired into a mind. The experiences of childhood, pioneering research shows, help form the brain's circuits for music and math, language and emotion" [2].

1. The Logical Brain

Math and logic

This skill develop in Birth to 4 years .Circuits for math reside in the brain's cortex near those for music. Toddlers taught simple concepts like one and many, do better in math. Music lessons may help develop spatial skills: Play counting games with a toddler, Have him set the table to learn one-to-one relationships - one plate, one fork per-person [2].

2. The Language Brain

Language

This skill develops in Birth to 10 years. Circuits in the auditory cortex, representing the sounds that form words, are wired by the age of 1. The more words a child hears by 2, the larger her vocabulary will grow. Hearing problems can impair the ability to match sounds to letters. To further development talk to your child a lot. If you want her to master a second language introduce it by the age of 10. Protect hearing by treating ear infections promptly [2].

3. The Musical Brain

Music

This skill develops in 3 to 10 years. String players, have a larger area of their sensory cortex dedicated to the fingering digits on their left hand. Few concert-level

performers begin playing later than the age of 10. It is much harder to learn an instrument as an adult. To further development sing songs with children. Play structured melodic music. If a child shows any musical aptitude or interest, get an instrument [2].

This article divide kid's brain in to 3 parts and suggest activity's to develop the brain [2].

P.L.Maki have develop a new model of theory of mind predict a cognitive deficit which could explain a crucial component of the social impairment in childhood autism (alone). He divide children in to three groups as normal children, Down's syndrome children and autistic children they test categories with some activities. In the results normal children was above both autism and Down's syndrome category's and the second place was taken by the Down's syndrome category in this research they showing that even the mantel age was so high autistic children ware preforming very low than other two category and they need interesting education method to teach them [3].

P.L.Maki. says they are trying to develop an assessment plan to learn about student learning. When Assessment student trying to do it anyway and there is doubt that he/she doing this correctly or not assessment are given to motivate the child to learn these researchers suggest give the guide lines check whether they doing the assessment according to the guidelines and give the marks [4].

C.R.Almli et.al said that structural and functional development of the human brain is advancing through evolution of magnetic resonance technology. Magnetic resonance imaging has become the premier tool for the quantitative, non-invasive study of childhood brain development. In the mythology they select the child from year 4 as brain developing age [5].

H.C. Hill et.al talk about how teacher's mathematical knowledge for teaching contributes to gains in students' mathematics achievement. They use grade 3 students. Used a linear mixed-model methodology in which third graders' mathematical achievement gains over a year .they select student and teachers and survey and student achievement data from students and teachers in 115 elementary schools. They found that teachers' mathematical knowledge was significantly related to student achievement gains in third grades [6].

Every class room has lot of kind of children some of children are normal, some of them are not they are not listing to the teacher but they score more marks than others, this research tells just by studying , it doesn't increase a person's knowledge [12].

R.M. Lerner's published a book about child psychology and how child do, what is the likeness, how the child brain works. In early stage how the child identify his parents. What is his favourite colours (Green, Red, Yellow) how his brain works while he doing a work how he do it what kind ok things make him happy (encouraging) [7].

J. P. Gee states that games are the effective way to teach children. Games can give multiple task to the child and train them to handle different situations in same time. Lots of children like to play video games more than reading books. Game makers can give games like if the child finish the level he or she can learn a thing [8].

Table 1: Past Researches

Brain games (P.A.C) [9]	This android game provide activity's in category wise. This app provide six types of brain development games • Speed • Memory • Reasoning • Planning • Calculator • Concentration Player can choose one of those category's and continue player having 3 attempts when the chance are over app generate the report. This android application is targeting in teen age players and this application more advance to the small children and this cant analyze that player having an development or not
Reader Rabbit[10]	This app provide learning environment for the kid. This is an educational game the main corrector was a rabbit target audience are the pre-school students. This game thought spellings how to spell words, and teach schoolchildren basic reading. This application base on the story of a little rabbit. Player should show the correct path to the rabbit to complete the tasks
Tokaboka[11]	This game provide really attractive game interface's and give a boost to play this game

Other than above mentioned applications that the development team have found there are some more games like, Brain Age Test Free [14], Memory Trainer [15], Brain Games-Fast Memory Games [16], Brain Games (NedaRm) [17] and etc.

Child psychology is one of the branch of psychology tree. Child psychology is about how the kid's brain works. Kids brain was so different than others they want colorful imagers to grow there likeness. Child psychology divide in to three category

- The Social Context
- The Cultural Context
- The Socioeconomic Context

The Social Context

Relationships with peers and adults have an effect on how children think, learn and develop. Families, schools and peer groups all make up an important part of the social context [1].

The Cultural Context

The culture a child lives in contributes a set of values, customs, shared assumptions and ways of living that influence development throughout the lifespan. Culture may play a role in how children relate to their parents, the type of education they receive and the type of child care that is provided [1].

The Socioeconomic Context

Social class can also play a major role in child development. Socioeconomic status (often abbreviated as SES), is based upon a number of different factors including how much education people have, how much money they earn, the job they hold and where they live. Children raised in households with a high socioeconomic status tend to have greater access to opportunities, while those from households with lower socioeconomic status may have less access to such things as health care, quality nutrition and education. Such factors can have a major impact on child psychology [1], [7].

Headway application does not give instant result like Brain age test and Brain games [9]. It keep records up to5 activities and then generate the report. After generate the report Headway give predictions of what sort of things that kids good at and give tips to how to improve those skills Also Headway does not allow child to keep doing same category . Head way is not a just a game like toca city it is give educational activities. Headway scoring algorithm is well defend one it doesn't demotivate the kid not giving 0 marks.

III. METHODOLOGY

This segment mention about the method that have been used to develop this application.

A. *Planning*

In the planning phase, the development team gathered information about the technology. After all the necessary information is gathered, the team divided the suitable task within the suitable team members, with each member having an equal amount of work force, but suiting his or her specialized field. The main consideration was timing and the development team used a Gantt chart to help with timing. The methodology that is used to implement this application is prototype methodology.

B. *Analysis*

In this phase, the development team gathered the data which is needed for the project.

The gathering of data was done in two aspects.

- Primary data.
- Secondary data.

The primary data was gained by the interviews the team had with doctors, psychiatrics, and with pre-school teachers and by the questionnaire. In the interviews, the main focus was on the problems the team had, and so, more close-ended questions were asked from the parties. And later, to get a clear idea, the team also asked some open ended questions, since this application is based on child psychology, and there are many occasions we have in psychology which cannot be given a specific answer. In the questionnaire, which was given to parents and pre-school teachers, the team mainly included closed-ended questions, since we needed a definite answer. By primary data, the development team mainly focused on the experience of people, so according to it, the team gathered data.

The team gathered secondary data by analyzing books, articles, similar applications and research papers. Here, the intention was to get, not only experience from people, but mainly the knowledge and information from the psychological aspect, since coming up with an IT solution as a measurement of brain performance was the main section of the application.

After the data is gathered the team ordered them in a correct manner, and as the information type needed.

C. *Design*

After analyzing the data the design plan was implemented. The application can be accessed by both, child and the parent. The data of the application is stored and retrieved from the database. So the application is majorly planed according to perform these two tasks.

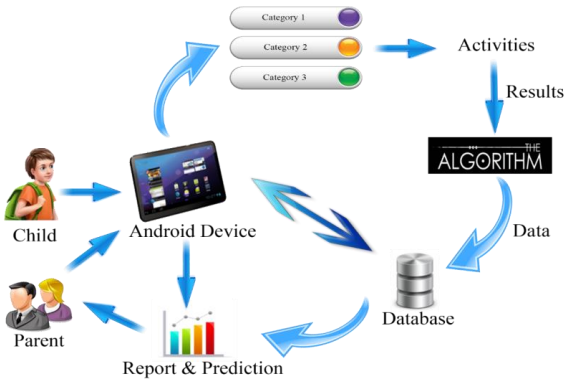

Figure 1: Software Architecture Diagram

Scenario:

- The child select the category and from that category he/she select the activity to play.
- After playing, once the child do the activity correctly, his/her marks will be generated according to the algorithm and the results will be added to the database along with the duration and the number of attempts he/she took.
- The parent can view the report, which shows the child's performance and prediction

D. Implementation

The building of the system is done in the implementation part. To build it, the development team used Android Studio 0.4.2 and for the database, SQLite, which is embedded in Android Studio. The programming language used is Java and Android Studio libraries are being called to the system. In order to come up with a scoring method for the activities, The team have developed an algorithm and this algorithm takes both number of attempts and time takes to complete an activity, in order to come up with a specific score (or marks) for a certain activity. And another algorithm is used for the prediction part. It analyses the marks (scoring) of a specific child in a certain time period in 3 specific categories, and according to that data, the prediction report is given. No external connection is needed for this application.

E. Testing

After completing the application, the development team made a test procedure to check whether the application has any errors or bugs, or failures. First, the team made a test plan that is suitable for the application identifying all the primary needs first, and then the secondary needs. While the system is being built, the team did component testing to each segment of the application, to verify each function works properly. Then after integration is done, the team checked whether each part is connected properly, and finally did a whole system test. After debugging and correcting the errors, the team again did a system test, and after that a performance test to check the performance and capabilities of the application.

Next, the application is given to some kids and their parents to do and with it the team got feedback out of them. And with it, we got a basic idea about the usage of our application.

IV. RESULT & DISCUSSION

'Headway' tracks the Kid's brain development and get predictions using psychiatric algorithm. The target of the team was to develop a system with a high accurate prediction capabilities. In order to get a better result from the system team build a psychiatric algorithm before creating the 'Headway system. Part of the algorithm is given in Listing 1.

```
INTEGER chance → 3
START
        FOR i → 2 TO chance++
                FOR attempt → 2 TO 4
                        answer = 100 / √√ ( ( ( chance * chance )+ attempt ) / 2 )
                        IF attempt < 3
                                answer2 = 100 / √√ ( ( chance * chance )+ ( attempt+1 )
                        ELSE
                                answer2 = 100 / √√ ( ( ( ( chance + 1 ) * ( chance + 1 ) ) +
                        END IF
                        IF timespent ≤ 10
                                finalMarks = answer2 + ( 4 * ( answer – answer2 ) / 4 )
                        ELSE IF timespent ≤ 20
                                finalMarks = answer2 + ( 3 * ( answer – answer2 ) / 4 )
                        ELSE IF timespent ≤ 30
                                finalMarks = answer2 + ( 2 * ( answer – answer2 ) / 4 )
                        ELSE
                                finalMarks = answer2 + ( 1 * ( answer – answer2 ) / 4 )
                        END IF
                END FOR
        END FOR
STOP
```

Listing 1: Part of the Algorithm.

There are three main categories in the system as shown in figure 2.

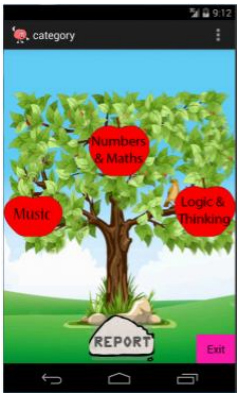

Figure 2: Category Interface

Each category consist of five activities. After completing the fifth activity in each category the kid will get some reward. The main purpose of this rewards is to motivate the kid and get the kids attraction with the application. These categories are choosen from past reserches done by N.Thalagala [1].

The first activity in the Numbers & maths is shown in figure 3. This interface measure the kids basic konwladge about Numbers and Maths.

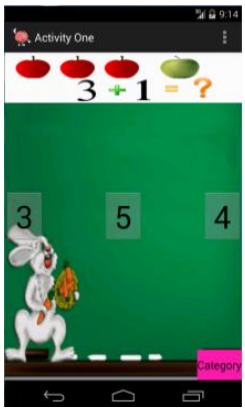

Figure 3: Numbers & maths Activity One

As shown in Figure 3 when the kid completed the activities in Numbers & Math's the development team imagines the kid's brain will develop under this category.

The fifth activity in the category, Logic and Thinking is shown in figure 4. These activities are help to increase the thinking ability of the kid and also the team imagines the kid's brain develop under this category as well.

Figure 4: Logic & Thinking Activity Five

Figure 5: Music Activity One

In the music category system play five songs. After each song the kid was able to give the answer according the question that will ask from the system. The kid must have to listen the song carefully to get the correct answer. This category was helps to develop kids listening skills as well as aesthetic skills. The figure 5 is shown the activity one in music category.

The system finally generates a report by measuring the kid's performance using the psychiatric algorithm. Based on the results the system will give which category the kid was best at. The report interface was shown in the figure 6.

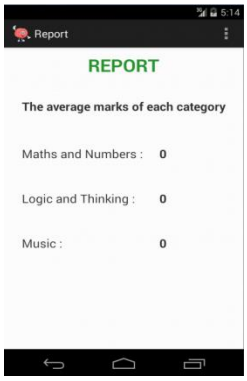

Figure 6: report Interface

"Headway" a system to track kid's brain development still implemented and tested up to prototype level. The team didn't test this application with public yet. Because of that still we can only assume the system "Headway" will helps to develop kid's brain development by considering the past researches and interviews that the team had.

V. CONCLUSION

The conclusions of this paper is to describe the usefulness of tracking kid's brain development using android application. Based on the Results and Discussion, Statistical analysis of the responses for the questionnaire, and the interviews with doctors, pre-school teachers was

very helpful for implemented the project 'Headway' success. Because there is sufficient evidence found from the literature review as well.

When considering the limitations of the research project, Headway, will be operated on android smart mobiles running Gingerbread version or higher version. So this will not be available for all personnel who are using mobile phone running other various operating systems. The limitations faced by the development team are as follows;

- Since the system cannot measure the skills of the kid exactly like a human doctor, 100% of accuracy cannot be achieved.
- Sometimes the kid will not be good at cognitive skills but at other areas like sports. These cannot be measured.
- The system cannot provide physical caring for the kid such as parental love and caring which has a huge impact on brain development.

There are a number of points the development team is willing to modify in the system in future. Headway system could be upgraded with the following features:

- Solve the above mentioned limitations by updating the system time to time.
- Increase number of activities.
- Make the game more accurate, efficient and user friendly manner.
- Merge the system with other devices.

According to the analysis of responses the team conclude that there is a significant usefulness of develop an android application to track the kids brain development. To summarize, 'Headway'- A system to track kid's brain development is very useful for Sri Lankan children age between 4 to 6 years.

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