Studying the Impact of using Mental Arithmetic Courseware for Preschool Children

Ruzinoor Che Mat, Mohd Hafiz Mahayudin, Norani Nordin

Abstract: Currently, the application of mathematical courseware is increasingly popular among children in preschool. Most of this application involves the use of multimedia elements to attract children in learning. In this study, Mental Arithmetic Courseware is developed by incorporating multimedia elements together with mental arithmetic techniques interactively. The objective of this paper is to study the impact of the courseware among the preschool children. This application can be divided into four modules, namely the Introduction, Tutorials, Quizzes and Games. Each module has its own unique characteristics and connection between each other. The courseware was exposed to the preschool children to perform simple mathematic calculations using mental arithmetic techniques. The testing phase has been conducted in three different preschool which have different demographic which are rural, town and near education center. The test was split into pre-test and post-test. Post-test results showed that children have improved understanding of mental arithmetic techniques by about 28 percent compared to the pre-test. This is may be due to with the help of the courseware which illustrates mental arithmetic technique in a better way with the help of multimedia elements.

Keywords: Mental Artihmetic, Mathematic, Courseware, Pre-school

I. INTRODUCTION

It takes a long time for new learners, especially pre-schoolers, to improve the process of learning mathematics, such as numbers and basic operations such as addition and subtraction. Even though they already know and understand them, they find it difficult to memorize the numbers and mathematical concepts. Technology is currently being used and computers are one of the main aspirations and are integrated in curricula of education [1]. With the evolution of computer technology, to attract their attention and interest, learning mathematics for pre-school children can be improved with the help of multimedia tools. In addition, at an early age, the child-ren is already exposed to computers.

Multimedia is a computer-based interactive environment that combines texts, voices, images and animations[2]. Thus, by using it as an alternative teaching tool, teachers can teach more consistently and effectively. This is different from the traditional method where, due to the lack of tools, only the exercise book is used as its single source in mathematics learning. This leads to an unexciting environment and tends to cause children to lose focus.

Revised Manuscript Received on April 15, 2019.

Ruzinoor Che Mat, School of Creative Industry Management and Performing Arts, Universiti Utara Malaysia

Mohd Hafiz Mahayudin, School of Multimedia Technology and Communication, Universiti Utara Malaysia

Norani Nordin, School of Technology Management and Logistic, Universiti Utara Malaysia

Mental Arithmetic technique can help kids build cognitive thinking where they need to use mental representations and fingers to do basic operational exercises. With multimedia support, their imagination of mathematical concepts can be higher. This enhances their performance and enables them to be more active and excited during learning sessions by using multimedia elements. The aim of this paper is to study the impact of pre - school children's mental arithmetic courseware.

II. LITERATURE REVIEW

Most children use only exercise books as their source of information in the traditional method environment. Children will easily get bored and lose interest without an alternative learning tool. As a result, their focus on mental representations of mathematical concepts decreases. This can affect their future performance in mathematical skills, particularly when they are in primary school.[3]

Mental arithmetic can be defined as adding numbers together, multiplying them and other mathematical operations through the use of the brain, without writing them down on a piece of paper or using calculators[4]. In mathematical operations such as simple addition and subtraction, this technique is usually used. Mental arithmetic is also one of the techniques for counting numerical values[5][6] and the working brain using finger movement. For example, Ahmad, Rosmani, Ismail, & Shakeri[7] states that after building their imagination in the brain, children move their real fingers to start the counting process.

Children's Cognitive Thinking

The processes of recognizing, understanding, and learning something are cognitive or mental processes[8]. The evolution of technology must be parallel to the development of the cognitive thinking and ability of children to ensure that they can communicate in the future to the real world. Cognitive skills in children can be sharpened by interaction and communication with computers, according to Gelderblom and Kotze[9]. Based on the theory of Piaget, children between the ages of five and eight can acquire the skills of objects, events, people, and use the symbols to imagine and represent real life, and some examples are symbols of words, numbers, and images.

Element in Multimedia

Multimedia is defined as an interactive computer base comprising texts, images, audio, video, and animations[2, 7, 10, 11]. Using multimedia can attract the interest and attention of the children in learning mathematics.

An interactive multimedia is made up of many elements that are important for providing attractive prototype learning for children. Animation is used primarily to illustrate the concepts and ideas. Because of their characters, which are attractive and motivating, children usually like to learn from the moving images at an early age [12]. Animation is essential for enhancing understanding and bringing out young learners ' interests [12]. Other than that, images or graphics are considered as part of multimedia where in a learning session creativity and imagination are required. Using graphics can help sharpen your memory[12] and stimulate representations of mental models[13]. The audio or sound also helps the kids get the best attention and provides a way to learn mathematical concepts or terms from the oral speech. According to Ali & Zaman [13], after listening to the spoken explanation, sound implementation can improve learning and pronunciation skills. In addition, text is also the important element in the provision of interaction and information.[10] It also supports the fact that the written text makes multimedia an effective means of communication. In addition, video is also an element of multimedia that contributes to better understanding.

Principles of Multimedia

To have an interesting and attractive design for the multimedia effect, the proposed Multimedia Principles must be followed. There are 7 Multimedia Principles: (1) Multimedia; (2) Spatial Contiguity; (3) Temporal Contiguity; (4) Coherence; (5) Modality; (6) Redundancy and (7) Personalization. The first principle is multimedia, where children are more likely to learn from the use of words and pictures than from single words alone because it can lead to a deeper and better understanding [14, 15] Through the Spatial Contiguity Principle, they also state that during the learning session, learners are deeply focused when the corresponding text and pictures are closely presented to each other rather than in distance.

The third principle is about temporal contiguity in which the children gets better explanation in simultaneous presentations from the corresponding text and graphics rather than consecutively, as stated by Richard E Mayer & Moreno [15] in the research. Young learners can learn more and improve their memory when the Coherence Principle excludes irrelevant materials of words, pictures and sounds from the learning session [15]. They also find that the fifth principle, Modality, is where children generate more problem - solving and deeper cognitive thinking skills by adapting animation and narration rather than animation and on - screen texts.

They also state that the sixth principle, Redundancy, occurs when an animated and narrative learning session is preferred to animations, narrations and on-screen texts because additional on-screen texts restrict the visual working memory. The last principle is Personalization, where children learn profoundly when words and animations are conversational rather than formal [14, 15]. In recent study by Schacter& Jo [16] that uses tablet computer to teach mathematic to pre-school student, results of the test show that preschooler with tablet computer as learning aid have better understanding of the subject comparing to those that do not use any computer assisted learning aid. In another study that use tablet computer as learning aid are Park, Bermudez, Roberts, &Brannon [17]and the study shows significant understanding in the subject comparing to that student that do not use any computer assisted learning aid. In a study by Van der Ven, Segers, Takashima, &Verhoeven[18] mention that tablet assisted math learning aid helps preschooler to understand that subject much better in term of efficiency. It takes a long time to build new learners, especially for preschoolers, to learn mathematics, such as numbers and basic operations such as addition and subtraction. Even though they already know and understand them, they find it difficult to memorize the numbers and mathematical concepts. Technology is currently being used and computers are one of the main aspirations and are integrated with the evolution of computer technology in educational curricula [1].

III. METHODOLOGY

The study was carried out by applying the model of research as shown in Figure 1. This research model contains four phases: 1) Courseware Requirements Collection, 2) Learning Experience Attainment, 3) Exchange of Knowledge, and 4) User Evaluation & Conclusion.

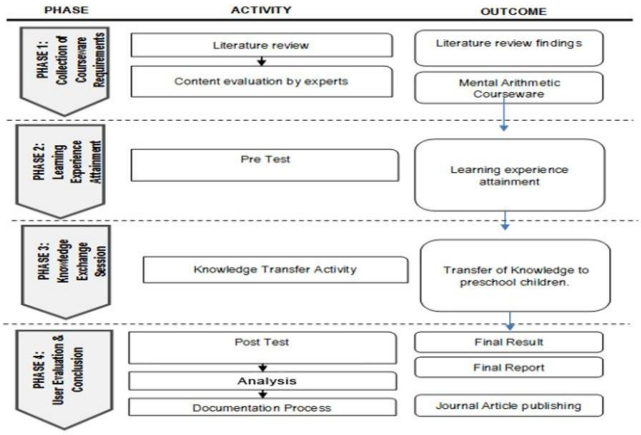

Fig. 1 Research Model

Phase 1: Collection of Courseware Requirements

Phase One of the research started with collecting the requirement of the research by gathering the information from literature review. Other than that, the contents were also evaluated by two experts. The experts were categorized as contents experts in courseware and also experts in mental arithmetic. The interview with this two categorized of experts were conducted. Based on the comments from the experts, the prototype of the courseware for testing purposes was developed. The details of the courseware design were discussed details in the Section 3.5.

Phase 2: Learning Experience Attainment

Phase Two of the research involved preparation of questions for the pre-test. The questions were divided into three parts which are Number Identifying, Addition and Subtractions. In order to conduct the research, there were three different groups from three preschools have been selected based on its demographic and location.

The location and demographic of the preschool was categorized into rural (located in Bukit KayuHitam, Kedah) name as Preschool A, town (located in Changlun, Kedah) name as Preschool B and near education center (located closed to Universiti Utara Malaysia) name as Preschool C. The number of participants for pre-school A is 16, pre-school B is 17 and pre-school C is 16. The pre-test thenbeen conducted at each of the selected preschool. The pre-test session started with preparing the questions. The pre-test questions consist of three parts which are Number Identifying, Addition and Subtractions. The children were gathered in a room to answer the questions for about 15 minutes. The answer is then collected for analysis. The results of the pre-test will be discussed in Section 4.0.

Phase 3: Knowledge Exchange Session

Phase Three of the research exposed the preschool children to the Mental Arithmetic Courseware that has been developed. This phase was conducted after completing the pre-test session. In this phase, the group of the children from this three different preschool were placed in a room with the instructors. The students were exposed to the Mental Arithmetic Courseware by the instructors. This session took for about one hour. The instructors conducted a demonstration and taught the childreneach module available in the courseware. At certain point during the process, the instructors provided a chance for the children to ask the questions and interact with the instructors. At the end of the sessions, all of the children were given a chance to try the courseware by themselves. The children gained a hand on experience with the courseware for more understanding. Hence, this session provided the exposure to the courseware to make the children understand more about the courseware which gave them the knowledge of mental arithmetic technique. After completing this session, the post-test session were conducted.

Phase 4: User Evaluation and Conclusion

Phase Four of the research was user evaluation and conclusion. Inthis phase, the post-test were conducted withthe same group of children. This phase started after completing the Phase Three. The post-test session started with preparing the questions. The post-test questions were also consists of three parts which are Number Identifying, Addition and Subtractions, similar with the pre-test questions. The children were gathered in a room to answer the post-test questions. They were given an ample time for about 15 minutes to answer the questions. The analysis of the results for post-test session will also be discussed in Section 4.0.

Courseware Design

The Courseware for Mental Arithmetic consists of four main menus: 1) Introduction, 2) Tutorial, 3) Quiz, 4) Games. Figure 2 shows Mental Arithmetic Courseware's architecture.

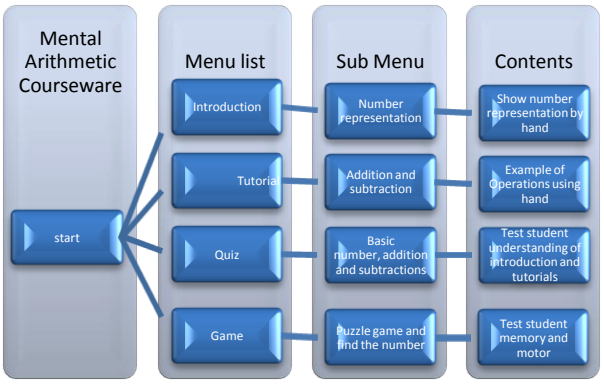

Fig. 2 Mental Arithmetic Courseware application architecture

Introduction

In the Introduction part of the courseware, students are exposed to the mental arithmetic by using images of hand representing number with other object as well audio to explain how mental arithmetic is represented with a single hand. Figure 3 show the introduction part.

Fig. 3 Introduction part

Tutorial

In the Tutorial part of the courseware,childrenwere exposedto the tutorial of the courseware which has been divided into two parts:addition and subtraction.Each of the questions illustrated the image of the hand in doing the calculations. The video button was also available to be used by the children. The videos showed on how to perform the calculation by using metal arithmetic technique. Figure 4 and Figure 5show the sample of the Tutorial.

Fig. 4 Tutorial menu for Addition

Fig. 5 Tutorial menu for Subtraction

Quiz

In the Quiz section, the student was given three choices of question to test their understanding of mental arithmetic. The content was divided into basic numbers, addition and subtractions. Figure 6 to Figure 8 shows the sample of the questions for Quiz.

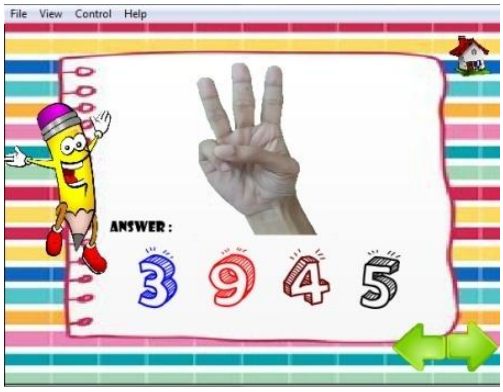

Fig. 6 Basic number quiz

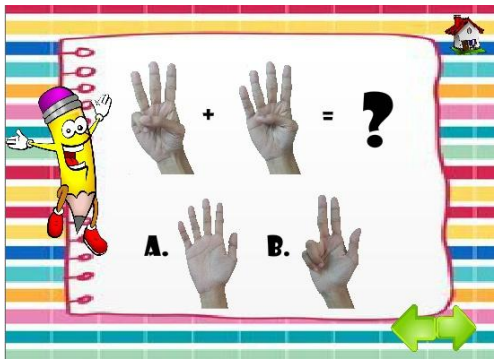

Fig. 7 Addition Quiz menu

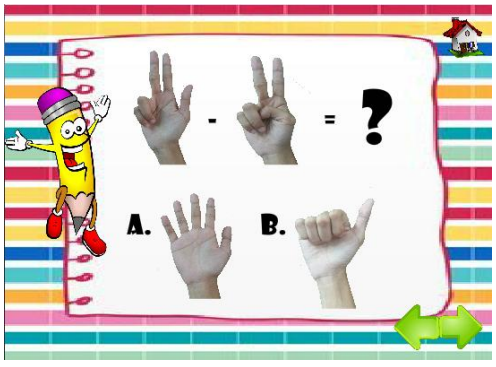

Fig. 8 Subtraction Quiz menu

Games

In the Games section, the children were challenged by two types of game which were Catch the Number and Puzzle. Each game has its own challenge to be explored by the children which they can interact with. Figure 9 and Figure 10 shows the interface of the games.

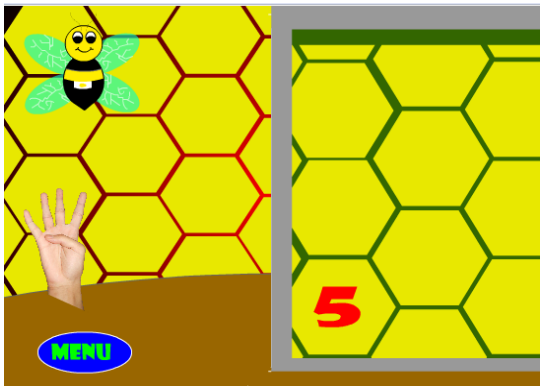

Fig. 9 Catch the Number game

Fig. 10 Puzzle game

IV. RESULTS AND DISCUSSIONS

The overall results for pre-test and post-test were comprised into single pie chart. Figure 11 shows the comprised results of pre-test for all preschools. The results show that 57% children could not answer correctly. Whereby only 43% of children has the correct answer. It shows that majority of the students did not understand about the concept of Mental Arithmetic in the first hand.

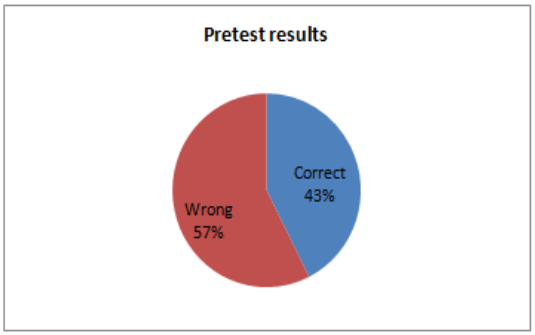

Fig. 11 Pie chart of pre-test results

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

The comprised result of post-test for all of the pre-school was shown in Figure 12.The results shows that 71% of the children answered correctly and only 29% of the children failed to answer the test given. It is then suggested that after the exposure to the learning process using the Mental Arithmetic Courseware in Phase Three, majority of the children seems to understand the concept of Mental Arithmetic. Hence, the number of correct answers has increased about 28% compared to the pre-test results.

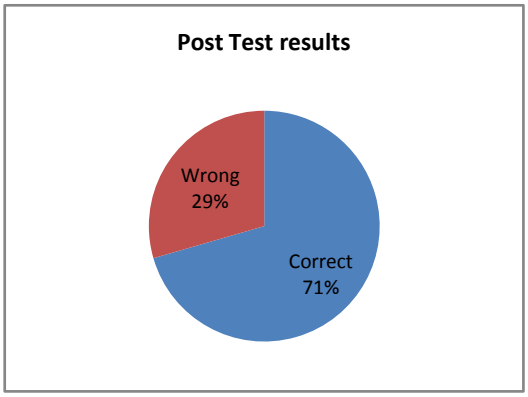

Fig. 12 Pie chart of post-test results

The pre-test and post-test results for each pre-school are shown in Figure 13 and Figure 14 as a bar chart.

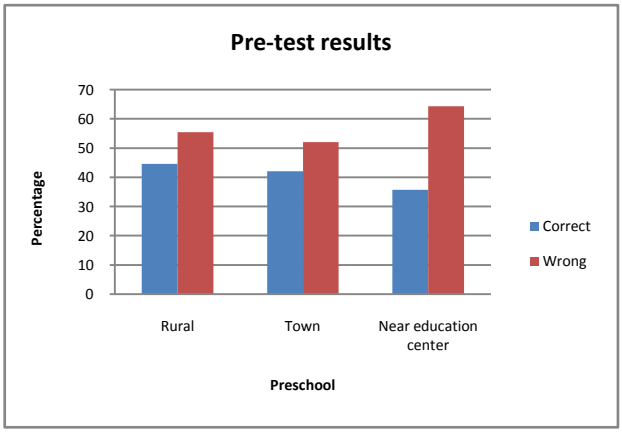

Fig. 13 Bar chart of pre-test results

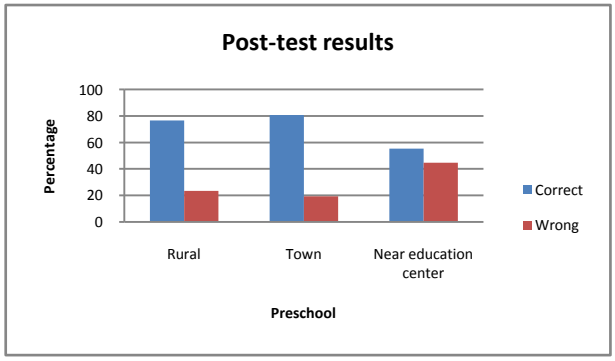

Fig. 14 Bar chart of post-test results

The results for the preschool at rural area shows that more than 70% of the children had answer correctly which increased about 31% compare to the pre-test results. Only 24% of the children failed to answer correctly but 76% of them had answered correctly. While the number of wrong answer also decreased for about 31% compared to the pre-test results.

This result is different with the preschool at the town area where the results shows that more than 80% of the children had answer correctly which increased about 36% compare to the pre-test results. Only 19% of the children failed to answer correctly but 81% of them had answered correctly. While the number of wrong answer decreased for about 36% compared to the pre-test results.

Beside that's, the results for the preschool near education center much more different compared to rural and town area where the results shows that more than 50% of the children had answer correctly which increased about 19% compare to the pre-test results. Only 45% of the children failed to answer correctly but 55% of them had answered correctly. The number of wrong answer decreased to 19% compared to the pre-test results. Based on these three different results, the location of the preschool did not influence the level of understanding of the Mental Arithmetic courseware being introduced in this study. This results is different with the finding by Arora [19] which state that the geographical factor has influence on how the children out to be in their education.

V. CONCLUSION

In conclusion, the analysis results of this study show that after the student have been exposed to understanding mental arithmetic technique by using mental arithmetic courseware, the level of understanding is improved for each preschool. This is proven with the results of post-test increase of 28% for the correct answer from overall results. Besides that, the location of the preschool either rural, town or near education center did not influence the level of understanding of the Mental Arithmetic courseware being introduced in this study. Further observations shows that the children learn more with multimedia assisted learning using all five multimedia elements to attract the attentions of the children. The interaction among teacher and student and also among friends was important for better understanding of the contents.

ACKNOWLEDGEMENT

The authors would like to express their sincere appreciation to Universiti Utara Malaysia for funding this project under Social Innovation Research Grant Scheme (Rolling).

REFERENCES

1. D. Ktoridou, N. Eteokleous, and G. Gregoriou, "Preschoolers Developing Mathematical Understanding through Computer-Based Activities," in Computer as a Tool, 2005. EUROCON 2005. The International Conference on, 2005, pp. 787-790.
2. I. Weiss, B. Kramarski, and S. Talis, "Effects of multimedia environments on kindergarten children's mathematical achievements and style of learning," Educational Media International, vol. 43, pp. 3-17, 2006.
3. S. Z. Ahmad, N. A. Ahmad, A. F. Rosmani, U. H. Mazlan, and M. H. Ismail, "Enhanced interactive mathematical learning courseware using mental arithmetic for preschool children," in Advanced Computer and Communication Engineering Technology, ed: Springer, 2015, pp. 1013-1023.

4. Longman. (2018, 6 April). Mental Arithmetic. Available: https://www.ldoceonline.com/dictionary/mental-arithmetic
5. S. S. Wu, M. L. Meyer, U. Maeda, V. Salimpoor, S. Tomiyama, D. C. Geary, and V. Menon, "Standardized assessment of strategy use and working memory in early mental arithmetic performance," Developmental neuropsychology, vol. 33, pp. 365-393, 2008.
6. E. Klein, K. Moeller, K. Willmes, H.-C. Nuerk, and F. Domahs, "The influence of implicit hand-based representations on mental arithmetic," Frontiers in psychology, vol. 2, p. 197, 2011.
7. S. Ahmad, A. F. Rosmani, M. Ismail, and S. Shakeri, "An Introductory of Mental Arithmetic Using Interactive Multimedia for Pre-School Children," 2010.
8. Longman. (2018, 9 April). cognitive. Available: https://www.ldoceonline.com/dictionary/cognitive
9. H. Gelderblom and P. Kotzé, "Designing technology for young children: what we can learn from theories of cognitive development," in Proceedings of the 2008 annual research conference of the South African Institute of Computer Scientists and Information Technologists on IT research in developing countries: riding the wave of technology, 2008, pp. 66-75.
10. E. Segers, L. Verhoeven, and N. Hulstijn-Hendrikse, "Cognitive processes in children's multimedia text learning," Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition, vol. 22, pp. 375-387, 2008.
11. S. Zhang, W. Shi, Z. Liu, and Q. Hu, "The principles of multimedia teaching design based on cognitive load theory," in Education Technology and Computer (ICETC), 2010 2nd International Conference on, 2010, pp. V3-110-V3-112.
12. M. Betrancourt and A. Chassot, "Making sense of animation," Learning with animations: Research implications for design, pp. 141-164, 2008.
13. B. Ali and H. B. Zaman, "Framework for adaptive multimedia mathematics courseware," in Proceedings of the 2nd IMT-GT regional Conference on Mathematics, Statistics and Applications, 2006, pp. 13-15.
14. R. E. Mayer, Multimedia Learning: Cambridge University Press,, 2012.
15. R. E. Mayer, "The promise of multimedia learning: using the same instructional design methods across different media," Learning and instruction, vol. 13, pp. 125-139, 2003.
16. J. Schacter and B. Jo, "Improving low-income preschoolers mathematics achievement with Math Shelf, a preschool tablet computer curriculum," Computers in Human Behavior, vol. 55, pp. 223-229, 2016.
17. J. Park, V. Bermudez, R. C. Roberts, and E. M. Brannon, "Non-symbolic approximate arithmetic training improves math performance in preschoolers," Journal of Experimental Child Psychology, vol. 152, pp. 278-293, 2016.
18. F. van der Ven, E. Segers, A. Takashima, and L. Verhoeven, "Effects of a tablet game intervention on simple addition and subtraction fluency in first graders," Computers in Human Behavior, vol. 72, pp. 200-207, 2017.
19. M. Arora. (2018, 15 November 2018). Factors That Affect Growth and Development in Children. Available: https://parenting.firstcry.com/articles/factors-that-affect-growth-and-development-in-children