

Determining How Effective Tangrams are as a Tool For Memory Retention and Attention in Preschool Students

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Abstract

In our developing world, lack of attention span and the inability to retain information stand as leading symptoms of many learning disabilities in toddlers (such as ADHD and dyslexia). Until now, efforts to improve these skills among toddlers even without these learning disabilities have been limited. Here we report the results of assigning structured tasks to toddlers and the impact organisation has on their memory and attention span. Moreover, the structured tasks assigned to them include self-designed tangrams of different difficult levels; by the usage of different shapes, sizes and colours; in order to record results for improvements in these two important skills over a span of four weeks. The three variables of measurements included average time taken by toddlers to complete the tangrams, the average number of attempts taken by the toddlers to finish the tangram and lastly the average figures plotted by the toddlers. With each week, the difficulty of the tangrams increased and on average, with each passing week, average time taken by toddlers to complete the tangrams decreased, the average number of attempts taken by the toddlers to finish the tangram decreased while the average figures plotted by the toddlers increased.

Keywords

Preschool education, tangram, memory, attention span, cognitive development, episodic memory, episodic foresight

1. Introduction

1.1 Background Information

We live in a world where it is believed that the higher the educational grade (ranging from middle school, high school and thereby college), the more significant it is in moulding us into the people we are today. We fail to realise the substantial benefits to be gained from focusing on preschool education as much as we do for higher education. By drawing attention to the experiences and environment of toddlers; society can, in the future, curb profuse catastrophic obstacles in its path to promoting better standards of living, such as incarceration, vagrancy, and so much so as the inability to complete the basic high school education (**Pandey, 2020**).

Among innumerable reliable studies stands a meticulous study conducted by Harvard University which concludes that early childhood experiences become 'embedded in the architecture of their developing brains'. (**Centre on the developing child, Harvard University, N.D.**) The study further analyses how any hindrance to their developmental process can seriously incapacitate not only a child's learning capabilities but also their personality type. Another report highlights how the first three years of an individual's life have revealed to be a period of expeditious brain development, drastic receptivity to disparities in their environment, dependence on their communications with adults, which proves to have a longstanding impression on their development process across all possible realms of advancement (**Chazan-Cohen et.al, 2017**).

1.2 Memory

Memory is the sustaining and recollecting of data over a span of time, which relies on the kind of prerequisite, plausible function needed to be executed. Recalling how to ride a bike even after years of no practice, remembering the lyrics of a famous song, reminiscing your favourite birthday and retaining information such as the fact that Delhi is the capital of India , are a few examples of what it means to use memory in our daily lives' seemingly mundane tasks. The concept of memory comprises three significant phases which include : encoding, storage and retrieval (**Craik & Lockhart, 1972**). (**NCERT, 2019**)

The first step is encoding which refers to the inputting of information into the memory system of the brain for the first time, in order to make it valuable and functional. The neural impulses of the brain process and further convert the recently recognized raw data into a form which can be preserved like a memory trace and recollecting later from the brain as perception leaves representation in memory. Retaining the memory trace over a period of time to make it latent and available for use is the second stage : storage. The last phase is retrieval, which refers to the recovering of the encoded memory trace from storage and using available knowledge in cognition and action to thereby execute the required analytical functions such as systematic dissection of a situation or drawing conclusions based on past knowledge. (**NCERT, 2019**)

The concept of memory becomes even more vital to analyse for toddlers as they themselves do not have the intellectual awareness to understand how memory works, resulting in them using no techniques, hardly any methods or ineffective tactics for improving memory retention, which further hinders their psychological development (**Cherry, 2022**). Hence, not following these three steps in the correct order increases chances of inadequate memory retention (**Nairne, 2002**). Henceforth, reasons for incompetent memory retention of toddlers include : inefficient encoding of knowledge, decay of information, increased impedances or distractions, clashing of old data with newly absorbed information and collapses or deterioration in retrieval of input. While powerful memory retention refers to the ability of an individual to recall and recollect data without feeling exerted or overburdened with information (**Lima & Jaeger, 2020**)

Foresight refers to the ability to ascertain the events of the future in order to plan actions in the present in accordance with foresight. Specifically for toddlers, some studies suggest that memory and foresight are intertwined as logical reasoning and remembrance of context go hand in hand. Others suggest that memory is a crucial stipulation in order to think cognitively and anticipate similar future encounters (**Atance & Sommerville, 2014**).

On the other hand, episodic memory is a type of long-term memory which encompasses the remembrance of past experiences, along with the situations which lead up to them, the emotions affiliated with the circumstance, the consequences of past mistakes, etc., like a mental time travel. Another important component of episodic memory for preschoolers is auto-noetic consciousness which is an exclusive type of consciousness that aids the ability of a toddler to be aware of themselves in a subjective time, and thereby recall such situations in future. (**Bauer , Leventon, & Varga, 2012**)

Specifically for toddlers, it is challenging for them to imbibe information coherently and efficiently. However, for those preschoolers who have difficulties in even retaining relatively smaller bits of information, which is an executive function whose inefficiency is determined by personal or professional analysis, may be a result of a lack of usage of working memory retention techniques (**McDermott, 2006**). Working memory for toddlers is simply an active process which is similar to a mental notebook where they process and uphold every information they need and have, available to access at any point of time. Obvious mental tasks which can help them reach a stage where they can automatically access this information, without dilemma, include regularly making them recall directions of known places, helping them remember certain grammatical structures or simply playing a memory card game with them. While these techniques have their pros, problems such as that of having a limited memory retention capacity due to overload of information very quickly, learning disorders like auditory processing issues, nonverbal learning disorders or dyslexia and ADHD specifically, were common even before the COVID-19 pandemic (**Jacobson, n.d.**).

1.3 Attention

Attention span refers to a person's cortical cognitive ability to identify and concentrate on generic environmental stimuli and then determine the most significant stimulus, while disregarding external distractions and the conflicting stimuli. In order to focus, it is trivial that the person engages and assimilates a blend of numerous, practical realms of behaviour which include functional domains such as visceral, intuitive, auditive, kinesthetic, dialect, language, visual-motor, dialect, optic, perceptual and tactile motor skills. **(Psychology Research and Reference)**

Thus, having the capability of using your focus and attention skills effectively, by responding efficiently to the various stimuli of the environment, is crucial to become a lucrative and productive individual. This is also because if the person is able to focus their attention towards employing tactics to respond to positive stimuli which helps them intensify beneficial outputs and diminish adverse or counterproductive outputs, they are able to make their life much more fruitful and proficient **(Mahone and Schneider, 2012)**.

On the other hand, other sources such as the Posner and Peterson (1990) model allege that the functioning of attention in the human brain happens from a network of diverse regions which carry out their own individual functions. The study also advocated a theory that the three constitutional responsibilities of the attentional network include appreciation of cognizant processing of signals, sensory orientation as well as perpetuating alertness. It is also crucial to consider how the processing, retention and application of data are very different from the attentional network **(Posner and Peterson, 1990)**.

Some development experts assert a basic foundation for the attention span of toddlers (who are, on average, four to five years) when given a particular task, which is usually two or five minutes multiplied by their age. On the other hand, other experts strongly disagree such as M.D. Neal Rojas, a developmental behavioural paediatrician, who states 'attention span has to be contextualised'. This refers to how the attention span of toddlers is variable during the whole day due to innumerable psychological, physical and emotional factors ranging from not liking the breakfast that day to possible traumatic events like separation of the parents. **(O'Hanlon, 2021)**

The inadequacy of research and focus on this significant issue and the lack of understanding of individuals regarding how the education we receive as toddlers embodies us into the individuals we are today, is what drives researchers into exploring this field.

2. Methodology

2.1 Aim of the study

The purpose of this research paper is to analyse ways to develop a curriculum that can be developed to implement in preschools in order to facilitate the growth of toddlers

The paper aims to implement a self-made curriculum model, consisting of a set of activities and tools to enhance these skills in toddlers.

2.2 Research Design

This research study is an experimental research design. Experimental Research design refers to the research carried out by adopting a scientific approach taking into account two sets of variables, where the first set is the dependent variable (constant) used to determine the distinctive differences in the independent variable (second set). Independent variables for this study include the memory and attention span of toddlers while the dependent variable is the age for one whole group of toddlers.

2.3 Hypothesis

Null Hypothesis 1: There would be no significant improvement in the number of figures plotted by toddlers over four weeks.

Alternate Hypothesis 1: There would be an increase in the number of figures plotted by toddlers over four weeks.

Null Hypothesis 2: There would be no change in the average number of attempts taken by all toddlers to finish the activity over four weeks.

Alternate Hypothesis 2: There would be a decrease in the average number of attempts taken by all toddlers to finish the activity over four weeks.

Null Hypothesis 3: There would be no change in the average time taken by all toddlers to finish the activity over four weeks.

Alternate Hypothesis 3: There would be a decrease in the average time taken by all toddlers to finish the activity over four weeks.

2.4 Consent and Ethical Issues

All ethical considerations were followed for the current study. Most importantly, informed consent was taken from the parents of all the toddlers that were part of this study, for data collection. Confidentiality and privacy of the respondents were maintained; no data would be disclosed to a third party. No identifiers such as name or pictures were disclosed in the article or while conducting the study.

2.5 Sample

The age group of students was from 2.5 to 6 years. All the toddlers were enrolled in preschool and are geographically located in Delhi NCR. The study was conducted in the English language.

2.6 Scales used

The tangram is usually defined as a two-dimensional re-arrangement puzzle composed of seven geometric shapes : two large triangles, one medium triangle, two small triangles, a parallelogram and a square. It was invented about 200 years ago in China and it represents how shapes can be mismatched and assembled together to design, outline and comprehend innumerable geometrical and numeric theories.

Tangrams fulfil their purpose as they help improve the analytic skills of toddlers such as logical and lateral thinking, creativity, visual-spatial awareness, visceral thinking and cerebral competence at mathematic interpretations like perimeter, area, probability, geometry, symmetry, permutations and combinations, congruency, circle theorems, etc. **(Child Psychology Cork, N.D.)**

However, for the development of the tools in this study, the basic fundamentals of a tangram remain unchanged while other principles become variables. Although the concept of rearranging shapes remains constant, instead of the conventional usage of seven specific shapes, different numbers and types of shapes were incorporated in the design of these special kinds of tangrams. For instance, the tangram designed for week one was made to be easiest so it consists of five shapes : three rectangles (all of different dimensions) and two (similar) triangles. As each week progresses, the difficulty of the tangrams increase which is measured in terms of the number of shapes meant to be arranged correctly by the toddler; the base shape on which all the smaller, cut-out shapes are meant to be arranged; and the complexity of the correct placement of these smaller shapes.

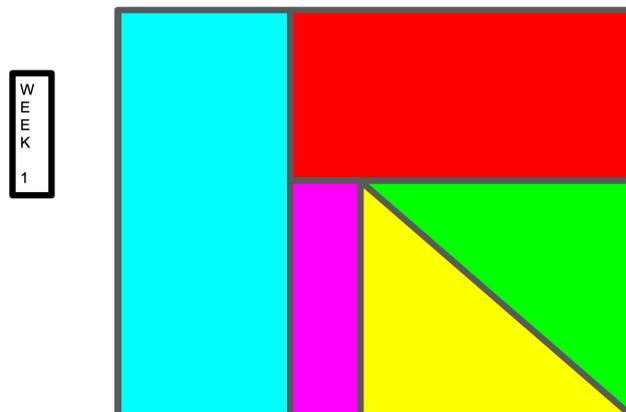


Figure 1 : Week 1 - The image above is the tangram used for Week 1. It has 5 geometrical shapes which include - 3 rectangles and 2 triangles.

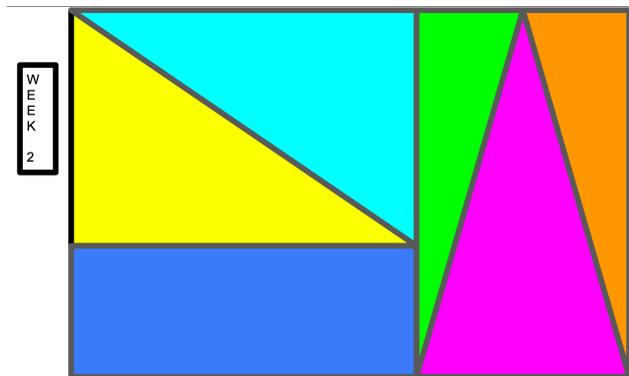


Figure 2 : Week 2 - The image above is the tangram used for Week 2. It has 6 geometrical shapes which include - 1 rectangle and 5 triangles.

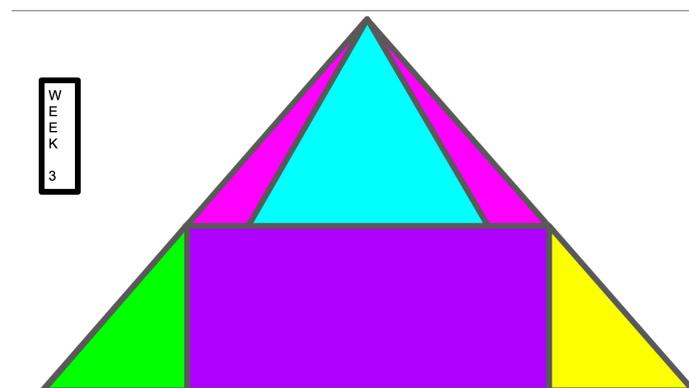


Figure 3 : Week 3 - The image above is the tangram used for Week 3. It has 6 geometrical shapes which include - 1 rectangle and 5 triangles.

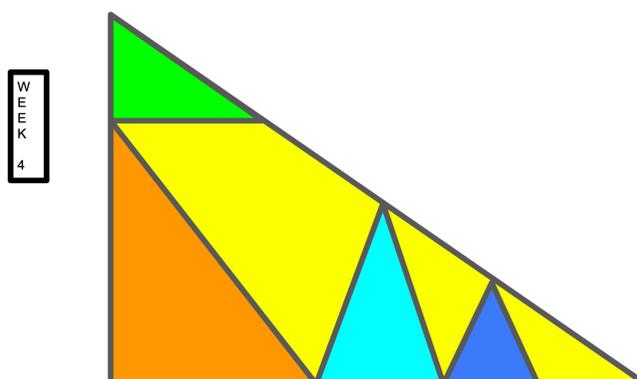


Figure 4 : Week 4 - The image above is the tangram used for Week 1. It has 7 geometrical shapes which include - 1 quadrilateral and 6 triangles.

2.7 Data Collection Procedure

Firstly, required copies of the solved tangram sheets and the bases of the tangrams were printed. Then, cut out the shapes individually from the solved tangram sheets placed in a folder, week wise. Further, the two materials to the teachers of preschool were delivered for every toddler. the teachers were instructed to carry out the activities in the standard way :

- a. Show the sample set of the activity to the toddler for 15 seconds.
- b. The teacher should not assist the child with the activity.
- c. The teacher will give the child 1 attempt to finish the activity.
- d. The teacher will be creating a video of the activity in which the child will complete the activity.
- e. The teacher will jot down the start and finish time of the activity.
- f. Lastly, the teacher will record the data i.e. the video, the tangram picture and a picture of the emotional scale.

All the data from the teachers i.e. the video and the tangram picture was collected for every toddler after each activity was done. The results were recorded in a tabular form.

3. Results

The results obtained from the teachers are presented in tabular and graph form below:

Table 1: Number of figures plotted by all toddlers and their averages. (S = students, n = 7)

	S1	S2	S3	S4	S5	S6	S7	Average
Week 1	5	5	5	4	3	4	5	4.4
Week 2	6	4	5	5	3	5	6	4.9
Week 3	5	6	6	6	5	6	6	5.7
Week 4	3	6	7	7	6	7	7	6.1

Table 1 shows that the average number of figures plotted increases each week as it reaches an average of 6.1 from 4.4 by week 4 (average number of figures plotted is highest on week 4). As can be seen in table 1, the majority of toddlers were able to plot all the figures (7 figures) correctly by week 4. Hence, the Alternate Hypothesis 1 is retained and the Null Hypothesis 1 is rejected because there is significant improvement in memory of toddlers over 4 weeks.

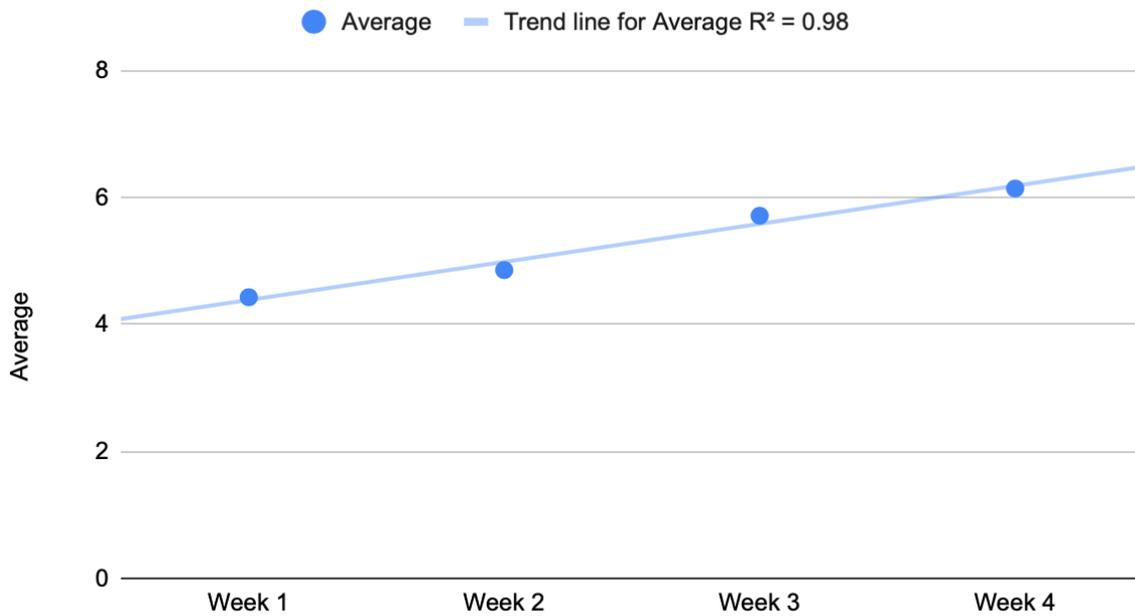


Figure 5: Average number of figures plotted by all toddlers in each week

Figure 5 shows that the trend line progresses upwards i.e. the average number of figures plotted increases each week (average number of figures plotted is highest on week 4). Hence, the upwards transgression allows the Alternate Hypothesis 1 to be retained and the Null Hypothesis 1 to be rejected.

Table 2: Number of attempts taken by all toddlers to finish the activity and their averages

	S1	S2	S3	S4	S5	S6	S7	Average
Week 1	3	1	3	3	3	3	3	3
Week 2	2	2	2	5	3	2	2	2.6
Week 3	2	2	1	3	2	2	1	2
Week 4	1	3	1	2	4	3	2	2.3

Table 2 shows that the average number of attempts taken by all toddlers to finish the activity are less in Week 4 than in Week 1. There is a significant decrease in the scores of student 1 and student 2 as they both started off with having 3 attempts in week 1 and then only took 1 attempt in week 4. While, even students 4 and 7 improved as their number of attempts decreased by 1 by week 4. On the other hand, student 6 neither improved or worsened. Simultaneously, students 2 and 5 worsened. In conclusion, as an average, the number of attempts decreased which allows to retain the Alternative Hypothesis 2 and reject the Null Hypothesis 2. Hence, the memory of toddlers improved over a span of 4 weeks.

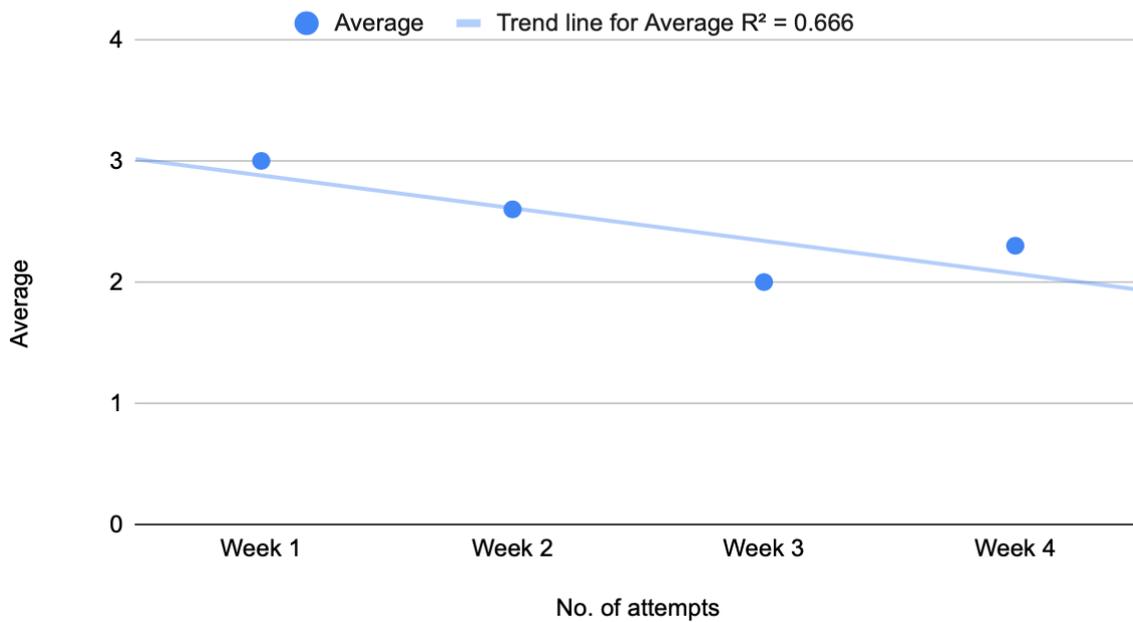


Figure 6: Average number of attempts taken by all toddlers to finish the activity

Figure 6 shows that the trend line progresses downwards i.e. the average number of attempts taken by all toddlers to finish the activity are less in Week 4 than in Week 1. As can be seen in Figure 6, the average number of attempts dropped significantly in week 3 but they increased slightly again in week 4 as the difficulty of the activities increased. However, if we compare the average attempts taken between weeks 1 and 4, the week 4 attempts were much lower, allowing to retain the Alternative Hypothesis 2 and rejecting the Null Hypothesis 2. Hence, the memory of toddlers improved over a span of 4 weeks.

Table 3: Time taken by all toddlers to finish the activity and their averages (in seconds)

	S1	S2	S3	S4	S5	S6	S7	Average
Week 1	180	24	180	360	180	120	300	192
Week 2	136	165	180	420	160	150	270	211.6
Week 3	140	149	120	300	180	130	260	182.7
Week 4	130	170	120	240	175	160	250	177.9

Table 3 shows that the average time taken by all toddlers to finish the activity is less in Week 4 than in Week 1. As for students 1, 3, 4 and 7 ; their average time taken dropped dramatically while student 5 showed minimal improvement. On the other hand, the performance of student 6 worsened dramatically by week 4 while student 2 's performance dropped incredibly. Thus on average, the time taken of most students improved by week 4, which is why the Alternative Hypothesis 3 is accepted and the Null Hypothesis 3 is rejected.

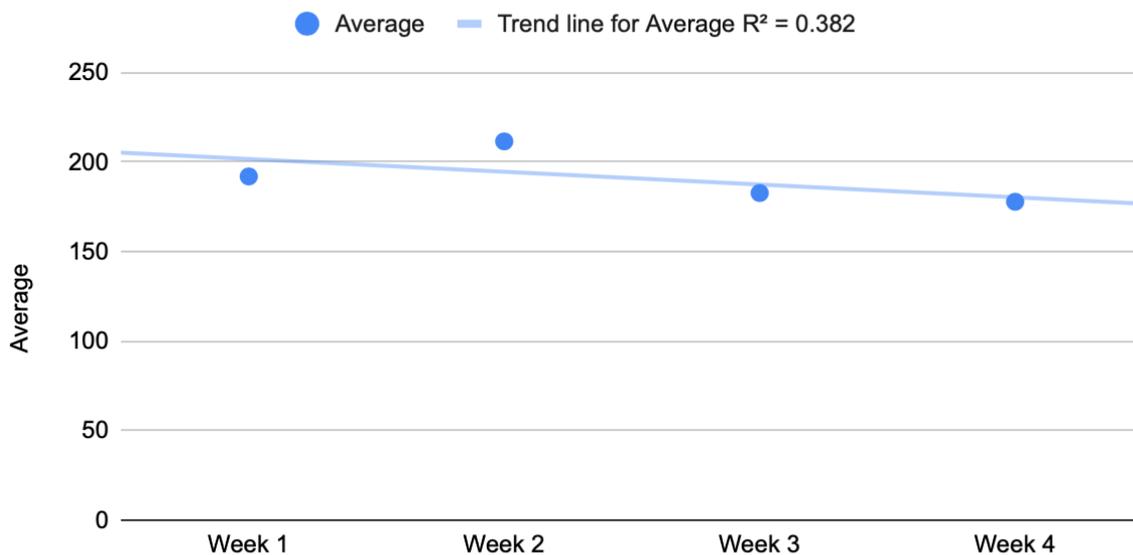


Figure 7: Average time taken by all toddlers to finish the activity

Figure 7 shows that the trend line progresses downwards (from 200s towards 150s) i.e. the average time taken by all toddlers to finish the activity is less in Week 4 than in Week 1. The average time taken for toddlers increased in week 2 while it dropped in week 3 until it continued to drop in week 4. Hence the Alternative Hypothesis 3 is retained and the Null Hypothesis 3 is rejected.

4. Discussion

The first set of results (Figure 1 and Table 1) portray how as each week passes, the average number of figures plotted increases despite an increase in the difficulty level of the tangrams, which indicates that the toddlers are able to recall what they did in the earlier week / s. In week 1, the information is encoded in the memory of toddlers and this memory is used by the toddlers in the forthcoming weeks to perform better in the activities (NCERT, 2019). This evidences the concept of memory retention in toddlers and the idea that repetition of the same activity leads to an improvement in spatial, visual-motor, optic and perceptual skills because of their ability to learn from past mistakes made and improve their performance. Thus, the number of times the activity has been repeated is directly proportional to the average number of figures plotted as the number of times the activity has been repeated increases, so does the average number of figures plotted.

The second set of results (Figure 2 and Table 2) shows that the average number of attempts taken by all toddlers to finish the activity decreases over time, again due to their ability to relate their past experience to the present activity they had been given. Here, the toddlers used episodic memory to remember the past mistakes and associate them with the present, in

order to prevent making those mistakes, which caused them to make less mistakes with each passing week and which is why the average number of attempts kept reducing, on average. Moreover, they also used automatic consciousness to be aware of themselves in the subjective time and then relate those experiences with similar situations in the future. Thus, the number of times the activity has been repeated is inversely proportional to the average number of attempts taken by all toddlers to finish the activity as the number of times the activity has been repeated increases, the average number of attempts taken by all toddlers to finish the activity decreases.

The last set of results (Figure 3 and Table 3) displays a decrease in the average time taken by all toddlers to finish the activity over the span of 4 weeks, emphasising on an increase in the ability of toddlers to concentrate during the activity. Their attention seems to have increased over the four weeks as they are able to finish the activity faster, despite an increase in difficulty because the toddlers used their foresight for logical reasoning and remembrance of context. Foresight also helped them to anticipate future encounters and perform better with each passing week. Thus, the number of times the activity has been repeated is inversely proportional to the average time taken by all toddlers to complete the activity as the number of times the activity has been repeated increases, the average time taken by all toddlers to complete the activity decreases.

The tangram activity, thus, proved to be an effective tool that should be explored, in helping toddlers with learning disabilities, memory retention problems and lack of required attention span.

5. Conclusion

The paper aimed at implementing a self-made curriculum model, consisting of a set of activities and tools to facilitate the growth of toddlers and make a difference in the current educational system in a private preschool.

The independent variables for this study included the memory and attention span of toddlers while the dependent variable is the age for one whole group of toddlers.

Therefore, This research paper proves how structured assignments help improve the learning ability of a toddler and impact their memory retention, attention span and ability to focus on a specific task. Thus, educational institutions can use this paper to structure activities like the ones used in this research study and target improvements in the toddlers' performance.

6. Limitations

There were some limitations of the study : one being that the sample size of toddlers for the study was very small, hence the data cannot be generalised for all toddlers. There was also

the influence of other variables such as the noise which may have distracted the toddlers during the activity. The entire experiment was time consuming as it ranged over a span of 4 weeks where each week, it took about 15-20 minutes to explain the activity to the toddler and then conduct it.

7. Implications

This research paper stands as an important document to understand how structured assignments improve the learning ability of toddlers. Thereby, this research could be translated into quantitative analysis by helping children with learning disabilities like ADHD, visual perceptual and visual motor deficit, caused due to an inability to retain information, recall experiences or sustain focus throughout a given task. This research paper can also be used by preschools to build on their curriculum in order to help those with learning disabilities or in general improve the cognitive skills of toddlers. Researchers can also explore how different economic backgrounds affect learning abilities using the same kinds of research methods.

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