# Development of Brain Based Intervention Model for Learning Acceleration of Children at Early Elementary Level

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***ABSTRACT****--The study aimed to develop a brain based intervention model for the learning acceleration of children at early elementary level. A counter balance experimental design was adopted for the study. Total 180 6th graders were selected from 3 different schools, N=60 from each school, taking all elementary school students of Province Punjab as the population of the study. The schools were randomly selected from three areas; urban, suburban and rural areas. In each school, 60 students were distributed in two equal groups of 30 each. The experimental group in each school was taught using three types of activities (cooperative Learning, Practical Simulation, and Problem solving separately) and the control group of thirty students were taught with conventional method. After three months, all experimental groups were given alternative treatments. Another session of three months was taken with the three type of activities alternatively. Cumulatively each experimental group was taught with each strategy but with different sequence. All sessions were pre and post tested including three control groups. The activities were developed from the twelve chapters of General science book of grade 6. Total period of experiment was nine months consisting of three phases of three months. The study found positive affect of cooperative learning, practical simulation and problem solving on students' academic achievement. The study has implications for the use of brain based acceleration strategies to enhance early elementary students learning.*

***Keywords--*** *Brain-based intervention, Learning acceleration, Cooperative learning, Practical Simulation, Problem Solving.*

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# I. INTRODUCTION

Teaching and learning is not a simple process; it is a system of interaction between the learning environment, learner and teacher. There are many factors involved in teaching and learning process which indirectly or directly relate to the learner.

Brain-Based learning is a learning theory based on the structure and function of brain. Its approaches emphasise how the brain learns

The cognitivists focus on the process of acquiring knowledge and how the knowledge can be explained by understanding the nature of brain(Kolon, 2008)(Van de Vrande, 2009). The progress of neuroscience also helps researchers to understand the learning in new and different ways.The classrooms based on brain-based instructions affect students' learning positively (Cain, 1991). The emphasis is on what each student in the classroom learns rather then what the teachers teach (Erlauer, 2003).

(Gozuyesil, 2014) Addressed that brain-based learning has a positiveeffect on students' academic performance. (Duman, 2010) concluded that using a variety of techniques and approaches reflects learner's experiences as compared to traditional instructions. Researchers have also observed a positive impact of brain-based instructions(Malik, 2012). A current study by Tafti (2017) found that brain-based learning had a good impact on students' retention and learning than other strategiesbecause they engage students' senses maximum, make them energetic and stimulate higher order thinking skills. The blend of social, emotional and cognitive stimulus revitalizes their brain and learning gets accelerated (Yasar, 2017).

***Objective of the study***

The objectives of the study are:

1) To develop a brain based intervention model including problem solving, cooperative learning and practical simulations for learning acceleration of general science subject for grade sixth.

2) To measure the effect of cooperative learning on the achievement of early elementary students in the subject of science.

3) To find out the effect of practical simulation on achievement of students in science in 6th grade.

4) To measure the effect of problem solving method of learning on achievement of students in science at grade 6.

5) To modify the brain-based intervention model in the light of findings of the experimental study.

# II. REVIEW OF RELATED LITERATURE

The literature review works as bridge the gap between existing study and previous studies. It may also help the researcher to be clear and help to formulate objectives and development of tool for the study. The researcher reviewed the related literature to know about aspects, nature, history and theoretical background of the study.

Brain based method focus to engage a student in subject practically. It is focus on learning through experience and students learn effectively if they learn through practical experiences. A child cannot sit passively in brain based program. He learns actively. Teacher asses the students by their demonstration, art work and portfolio rather than assessing them by their homework and test scores (Varghese, 2016).

The brain based learning supports the stress free learning environment which includes emotional engagement and physical exercises for relaxation. Stressful environment discourage learning, suppressed creativity and leads towards low memory retention. So, the learning environment should be free from stress and students learn in a limit time period and feel free(Subadi, 2013).

Brain based learning helps to create stress free learning environment to make the learning process effective and interesting. If learning environment is stress free and fresh, student may explore new things and learning can be long lasting (Siercks, 2012).

The current study used three brain-based learning strategies:

1. Cooperative learning
2. Practical simulation
3. Problem-solving

***Cooperative learning***

The cooperative learning is a structured instructional approach which facilitates and arranges classroom activities according to the social learning experiences of an individual. The individual learning is competitive by nature but in cooperative learning students work collaboratively in groups to complete their task and accomplish their academic goals (Johnson & Johnson, 1998).

Formal cooperative learning can be successful for any course, level or topic. Jigsaw, think pair share, inside-outside circle and reciprocal teaching are the types of activities usually students perform in cooperative learning (Hedeen, 2003).

The students of different capabilities work together in a friendly environment and acquire mastery in the assigned topic. Cooperative learning allows friendly competition, learners have the freedom to interact with each other, and they are responsible for the task that they have to prepare (Hsiung, 2012).

The implementation of cooperative learning in classrooms is challenging because it consumes time, requires some control and makes students busy but the slow learners and less confident students cannot learn by cooperative learning (Slavin, 2003). The role of the instructorin cooperative learning is as an active instructor, that is why, some teachers are afraid to adopt it, but this method increases student's communication skills and academic achievement if implemented correctly (Prince, 2006).

***Problem-solving***

Problem-solving skills are known as a major quality parameter of an individual who lives in modern society. Students are also future citizens andproblem-solving skills enable them to meet the challenges effectively. Therefore, the development of learner's problem-solving skill is need of today (Abd-El-Khalick, 2000).

Problem-solving is the core of scientific investigation. In science learning, students recognise the problem, investigate the scenario and search the solution by following the guidelines of problem-based learning (Meador, 2003).

The application of problem-solving is considered a new perspective in science learning. The use of problem-solving skills in science learning encourages learners to learn logically (Kirtikar, 2013).

Problem-solving skill makes learning meaningful instead of providing only information and facts. The teacher should provide autonomy and freedom to students and facilitate them to ensure pleasure and joy in science learning (Tandogan, 2007).

The problem solving model for learning of science at elementary level consisted as introduction, observation, identification of problem, collection of data, data organisation, analysis of data/ generalisation, and conclusion(Gozuyesil, 2014).

***Practical Simulations***

Practical simulation is considered a constructive learning strategy. It is also known as a student-centred approach and a form of experiential learning (Deng, 2012).In this strategy, the teacher puts the student in a situation to achieve desirable goals and parameters of the scenario controlled by the teacher. Simulations can be used in the form of activity, game and role play. The commitment and creativity of students decide the success of simulation (Lean, 2006).

The application of simulations in classroom causes deep engagement and critical thinking because students practice an activity rather than listening and seeing. The techniques of practical simulations are more realistic than other teaching methods, but assessment with this method is complex than that in other teaching methods. It also requires time and resources; some simulations require more than one hour (Alonzi, 2000).Students gain knowledge while adopting the situation. If there is a component of competition in learning with simulation, the goal of students will not be towing but to acquire knowledge (Sauvé, 2010).

The studentunderstands the relationship among variables of the model while building the model. They learn rules and regulations in role-playing. So, the practical simulations engage students in deep learning (Lean, 2006).Teacher makes sure that student interacts with other classmates, understand and adopt the situation and actively engages in activity with her own thoughts (Porter, 2004).

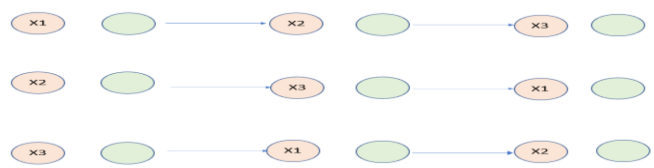
The effectiveness of practical simulations requires the preparation of instructor (explanation and preparation of lesson with clear goals), active participation of students (each student participates actively and do not depend on their classmates) and discussion (teachers discuss the reflection of students what they have learned from simulation) after completion of activity (Mérel, 2009).

Traditional method of teaching is teacher centered approach and its focus on memorization and route learning. Teacher expects that student learn because teacher tell them to learn. Students learn through recitation and memorization in traditional method and their problem solving, critical thinking and decision making skills do not developed (Kirtikar, 2013).

## III. METHODOLOGY

The present research was quantitative by nature and experimental by type. The research held a quasi-experimental design, a counter balanced experimental and control group design with six groups (three control and three experimental intact groups). The counterbalance design is used to control intervening variables and to see the effect of order of the treatment where more than one experimental groups receive different treatments at different times but each group face the same set of stimulus (Birnbaum, 1999).The experimental groups were intervened by using cooperative learning, practical simulation and problem-based learning alternatively as compared to control groups who were taught by traditional methods.

Counter balance experimental design




Where X1, X2 and X3 show three alternative treatments.

***Population of the study***

Population of the study was all students of early elementary level (Grade-6) at province of Punjab including, all rural, urban and suburban areas.

***Sampling technique***

The researcher selected three Public Schools randomly, one school from rural area, one from urban area and one from suburban area of Lahore District. After selecting schools, the researcher selected students of grade 6th studying General Science subject; thirty students for experimental group and thirty students for control group from each school. The students of both experimental and control groups were intact (already studying in different sections). The total sample was 180 6th graders.

**Table 3.2.1**: Sample distribution

| **Schools** | **Control Group** | **Experimental Group** | **Total Sample** |
|---|---|---|---|
| Urban public School | 30 | 30 | 60 |
| Rural public School | 30 | 30 | 60 |
| Suburban public School | 30 | 30 | 60 |
| Total Sample | 90 | 90 | 180 |

***Instrument of the study***

The researchers developed three modules (cooperative learning, practical simulation and problem solving method) using content of twelve chaptersof general science book of Punjab Curriculum and Text Book board for grade 6. The students were taught in three public schools (rural public, urban public and sub urban public schools) using cooperative learning module and activities, problem solving techniques and practical simulation. The treatment accrued in three phases.Threemultiple choice objective typeconcept-based tests was used to assess the subject achievement of students. Students were pretested and post tested before and after of each phase (treatment). These tests were developed from the syllabus of general science text book Grade six.

The three achievement tests contained the content of four, eight and twelve chapters respectively for each phase. If the tests are considered as A, B and C the test administration order was as below:

A-----XI------A,B-----XII-------B,C-----XIII-----C
While XI, XII and XII are treatment periods.

# IV. ANALYSIS

The scores of control group and experimental group of each pair of one phase were compared by applying independent sample t-test to observe the significant difference between their gain score. Independent sample t-test is described as, "Independent sample t-test is used for a research design that has a separate sample for each treatment condition (or for each population), an independent-measure research design or a between-subjects design" (Gravetter &Wallnau's, p. 310).

Analysis of variance was applied to determine the significant difference among schools (rural public, urban public and suburban public) and different treatments. According to (Gravetter and Wallnau's, 1979), "Analysis of variance (ANOVA) is a hypothesis-testing procedure that is used to evaluate mean difference between two or more treatments (or groups)".

**Table 4.1:** Comparison of gain score of experimental and control group, Phase1at Rural Public School Independent sample t-test

| | | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|---|
| Phase 1 Rural | Equal variances assumed | .005 | .946 | 9.596 | 58 | .000 |
| | Equal variances not assumed | | | 9.596 | 57.966 | .000 |

The table shows a "significance difference in the gain score of phase 1at rural public school of control group and experimental group; t (58) =9.596, p=.000< .05. The computed p-value is less then alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of practical simulation on students' academic achievement" The statistical difference shows that students of experimental group who were taught with the practical simulation at phase 1 have gained more scores than that of control group who were taught with traditional method. So, it is concluded that practical simulation has significance effect on students' academic achievement.

**Table 4.2:** Comparison of gain score of experimental and control group in Phase 2 at Rural Public School Independent sample t-test

| | | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|---|
| Phase 2 Rural | Equal variances assumed | 2.785 | .101 | 7.397 | 58 | .000 |
| | Equal variances not assumed | | | 7.397 | 56.200 | .000 |

The table shows a "significant difference in the gain score of phase 2 at rural public school of control group and experimental group; t (58) =7.397, p=.000, the computed p-value is less then alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of cooperative learning on students' academic achievement" The statistical difference shows that students of experimental group who were taught with the cooperative learning at phase 2 have greater gain score than the participants of control group who were taught with traditional teaching method. Therefore, it is concluded that cooperative learning has significant effect on students' academic achievement.

**Table 4.3:** Comparison of gain score of experimental and control group in Phase 3 at Rural Public School Independent sample t-test

| | | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|---|
| Phase 3 Rural | Equal variances assumed | .136 | .713 | 17.147 | 58 | .000 |
| | Equal variances not assumed | | | 17.147 | 57.986 | .000 |

The table shows a "significance difference in the gain score of phase 3 rural public school of control group and experimental group conditions; t (58) =17.147, p=.000"the computed p-value is less than alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of problem solving method on students'

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academic achievement" The statistical difference shows that students of experimental group who were taught with the method of problem solving at phase 3 have gained more scores than the participantsof control group who were taught with traditional method. The results also support that students who are taught by problem solving technique have achieved higher scores than the students of control group who were taught with traditional teaching method. So, it is concluded that problem solving method have significance effect on students' academic achievement.

**Table 4.4:** Comparison of gain score of experimental and control group in Phase 1 at suburban Public School Independent sample t-test

| | | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|---|
| Phase 1 suburban public school | Equal variances assumed | .258 | .613 | 8.777 | 58 | .000 |
| | Equal variances not assumed | | | 8.777 | 57.987 | .000 |

The table shows a "significance difference in the gain score of phase 1 suburban public school of control group and experimental group conditions; t (58) =17.147, p=.000"the computed p-value is less then alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of cooperative learning on students' academic achievement" The statistical difference shows that students of experimental group who were taught with the cooperative learning at phase 1 in suburban public school are gain more scores than the students of control group who were taught with traditional teaching method. The results also support that students who are taught by practical simulation were achieve higher scores than the students of control group who were taught with traditional teaching method. So, it is concluded that problem solving method have significance effect on students' academic achievement.

**Table 4.5:** Comparison of gain score of experimental and control group in Phase 2 at suburban Public School Independent sample t-test

| | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|

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|---|---|---|---|---|---|---|
| Phase 2 suburban public school | Equal variances assumed | 6.051 | .017 | 7.058 | 58 | .000 |
| | Equal variances not assumed | | | 7.058 | 53.153 | .000 |

The table shows a "significance difference in the gain score of phase 2 suburban public school of control group and experimental group conditions; t (58) =7.058, p=.000" the computed p-value is less than alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of problem solving method on students' academic achievement" The statistical difference shows that students of experimental group who were taught with the cooperative learning at phase 2 in suburban public school have achieved higher gain score than the students of control group who were taught with traditional teaching method. The results also support that students who are taught by problem solving method achieved higher scores and learned better than the students of control group who were taught with traditional teaching method. So, it is concluded that cooperative learning method have significance effect on students' academic achievement.

**Table 4.6:** Comparison of gain score of experimental and control group in Phase 3 at suburban Public School Independent sample t-test

| | | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|---|
| Phase 3 suburban public school | Equal variances assumed | 17.517 | .000 | 11.258 | 58 | .000 |
| | Equal variances not assumed | | | 11.258 | 45.353 | .000 |

The table shows a "significance difference in the gain score of phase 3 suburban public school of control group and experimental group conditions; t (58) =11.258, p=.000" the p-value is less then alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of practical simulation on students' academic achievement" The statistical difference shows that students of experimental group who were taught with the practical simulation at phase 3 in suburban public school have gained more scores than the students of control group who were taught with traditional teaching method. The results also support that students who are taught with problem solving method have achieved higher scores than the students of control group who were taught with traditional teaching method. So, it is concluded that problem solving method have significance effect on students' academic achievement.

**Table 4.7:** Comparison of gain score of experimental and control group in Phase 1 at urban Public School Independent sample t-test

| | | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|---|
| Phase 1 urban public school | Equal variances assumed | 5.745 | .020 | 15.868 | 58 | .000 |
| | Equal variances not assumed | | | 15.868 | 50.845 | .000 |

The table shows a "significance difference in the gain score of phase 1 urban public school of control group and experimental group conditions; t (58) =15.868, p=.000" where the computed p-value is less then alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of practical simulation on students' academic achievement" The statistical difference shows that students of experimental group who were taught with the practical simulation at phase 1 in suburban public school gained more scores than the students of control group who were taught with traditional method. The results also support that students who are taught with practical simulation have achieved higher scores and learned better than the students of control group who were taught with traditional teaching method. So, it is concluded that practical simulation has significance effect on students' academic achievement.

**Table 4.8:** Comparison of gain score of experimental and control group in Phase 2at urban Public School Independent sample t-test

| | | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|---|
| Phase 2 urban public school | Equal variances assumed | 3.601 | .063 | 15.149 | 58 | .000 |
| | Equal variances not | | | 15.149 | 52.780 | .000 |

| | |
|---|---|
| | assumed |

The table shows a "significance difference in the gain score of phase 2 urban public school of control group and experimental group conditions; t (58) =15.149, p=.000" the computed p-value is less then alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of cooperative learning on students' academic achievement" The statistical difference shows that students of experimental group who were taught with the cooperative learning at phase 2 in urban public school acquired more scores than the students of control group who were taught with traditional teaching method. The results also support that students who are taught by cooperative learning achieved higher scores than the students of control group who were taught with traditional teaching method. So, it is concluded that cooperative learning has significance effect on students' academic achievement.

**Table 4.9:** Comparison of gain score of experimental and control group in Phase 3 at urban Public School Independent sample t-test

| | | **Levene's test for Equality of variances F** | **Sig.** | **t** | **t-test for Equality of means df** | **Sig. (2 tailed)** |
|---|---|---|---|---|---|---|
| Phase 3 urban public school | Equal variances assumed | 4.100 | .047 | 15.081 | 58 | .000 |
| | Equal variances not assumed | | | 15.081 | 43.792 | .000 |

The table shows a "significance difference in the gain score of phase 3 urban public school of control group and experimental group conditions; t (58) =15.081, p=.000" the computed p-value is less then alpha 0.05. It rejects the null hypothesis that, "there is no significance effect of problem solving on students' academic achievement" The statistical difference shows that students of experimental group who were taught with the problem solving method at phase 3 in urban public school have gained more scores than the students of control group who were taught with traditional method. The results also support that students who are taught by problem method gained higher scores and learned better than the students of control group who were taught with traditional teaching method. So, it is concluded that problem solving have significance effect on students' academic achievementsolving

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**Table 4.10:** A comparison of experimental groups taught with practical simulation in rural public school, cooperative learning in suburban public school and problem solving in urban public school during phase I

**ANOVA**

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 13.400 | 2 | 6.700 | .614 | .544 |
| Within Groups | 949.500 | 87 | 10.914 | | |
| Total | 962.900 | 89 | | | |

A one way ANOVA was applied for the analysis of data at alpha value p=0.05. The table above depicts that there was insignificant difference of treatments on student's achievement in science subject at phase 1(practical simulation in rural public school, cooperative learning in suburban public school and problem solving in urban public school) at p>0.05 level for the three types of treatment, [F (2, 87) = .614, p = .544]. Being the F Ratio insignificant, the null hypothesis, "There is no significant difference in students' scores in practical simulation in rural public school, cooperative learning in suburban public school and problem solving in urban public school at phase 1 in rural public school" is accepted and it is concluded that there is no significant difference between treatments at phase 1. Students were used to learn with traditional teaching methods and the experimental treatments were new for them. That's why they enjoyed learning with cooperative learning, practical simulation and problem solving.

**Table 4.11:** A comparison of experimental groups taught with cooperative learning in rural public school, problem solving in suburban public school and practical simulation in urban public school during phase 2

**ANOVA**

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 317.422 | 2 | 158.711 | 9.371 | .000 |
| Within Groups | 1473.467 | 87 | 16.936 | | |
| Total | 1790.889 | 89 | | | |

A one way ANOVA was applied for the analysis of data at alpha value p=0.05. The table above depicts that there was significant difference in gain scores of student's achievements in science subject at phase 2, cooperative learning in rural public school, problem solving in suburban public school and practical simulation in urban public school with [F (2, 87) = 9.371, p = .000]. Being the F-Ratio significant and the null hypothesis, "There is no significant difference in students' scores taught with cooperative learning in rural public school, problem solving in suburban public school and practical simulation in urban public school at phase 2 in rural public school" is rejected and it is concluded that there is significant difference between treatments at phase 2 in rural, suburban and urban public schools.

**Table 4.12:** A comparison of experimental groups taught with problem solving in rural public school, practical simulation in suburban public school and cooperative learning in urban public school during phase 3

**ANOVA**

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 89.867 | 2 | 44.933 | 4.020 | .021 |
| Within Groups | 972.533 | 87 | 11.179 | | |
| Total | 1062.400 | 89 | | | |

A one way ANOVA was applied for the analysis of data at alpha value p=0.05. The table above reveals that there was significant difference of treatments on student's achievement in science subject at phase 3 (problem solving in rural public school, practical simulation in suburban public school and cooperative learning in urban public school) at $p<0.05$ level for the three type of treatments, [F (2, 87) = 9.371, p = .021]. Being the F Ratio significant, the null hypothesis, "There is no significant difference of problem solving in rural public school, practical simulation in suburban public school and cooperative learning in urban public school at phase 3 in rural public school" is rejected and it is concluded that there is significant difference between treatments at phase 3 in rural, suburban and urban public schools.

**Table 4.13:** A comparison of experimental groups of rural public school taught with practical simulation at phase one, cooperative learning at phase two and problem solving at phase three

**ANOVA**

| | Sum of Squares | df | Means Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 227.267 | 2 | 113.633 | 9.703 | .000 |
| Within Groups | 1018.833 | 87 | 11.711 | | |
| Total | 1246.100 | 89 | | | |

A one way ANOVA was applied for the analysis of data at alpha value p=0.05. The table above describes that there was significant difference of sequence of treatments as practical simulation at phase one, cooperative learning at phase two and problem solving at phase three on student's achievement in science subject at rural area public school in phase one, phase two and phase three at $p<0.05$ level for the three type of treatments, [F

(2, 87) = 9.703, p = .000]. Being the F-Ratio is significant and the null hypothesis, "There is no significant effect of sequence of treatments as practical simulation in phase 1, cooperative learning in phase 2 and problem solving in phase 3 at rural public school on student's achievement in science subject in rural public school" is rejected and concluded that there is significant difference between treatments at phase 1, 2 and 3 in rural area public school.

**Table 4.14**: A comparison of experimental groups of suburban public school taught with cooperative learning at phase 1, problem solving at phase 2, practical simulation at phase 3

**ANOVA**

| | **Sum of Squares** | **df** | **Means Square** | **F** | **Sig.** |
|---|---|---|---|---|---|
| Between Groups | 123.822 | 2 | 61.911 | 3.512 | .034 |
| Within Groups | 1533.733 | 87 | 17.629 | | |
| Total | 1657.556 | 89 | | | |

The *ANOVA* table above reveals that there was significant difference of sequence of treatments of cooperative learning at phase one, problem solving at phase two, practical simulation at phase three on student's achievement in science subject at suburban area public school at p<0.05 level for the three type of treatments, [F (2, 87) = 3.512, p = .034]. Being the F-Ratio is significant and the null hypothesis, "There is no significant effect of sequence of treatments as cooperative learning in phase 1, problem solving in phase 2 and practical simulation in phase 3 at suburban public school on student's achievement in science subject in." is rejected and concluded that there is significant difference between treatments at phase 1, 2 and 3 in suburban area public school.

**Table 4.15:** A comparison of experimental groups of urban public school taught with problem solving at phase 1, practical simulation at phase 2, cooperative learning at phase 3

**ANOVA**

| | **Sum of Squares** | **df** | **Means Square** | **F** | **Sig.** |
|---|---|---|---|---|---|
| Between Groups | 107.467 | 2 | 53.733 | 5.546 | .005 |
| Within Groups | 842.933 | 87 | 9.689 | | |
| Total | 950.400 | 89 | | | |

The *ANOVA* table above reveals that there was significant difference of sequence of treatments at urban area (problem solving at phase one, practical simulation at phase two, cooperative learning at phase three) on the achievement of students at p<0.05 level for the three type of treatments, [F (2, 87) = 9.371, p = .021]. Being the F-Ratio is significant, the null hypothesis, “There is no significant effect of sequence of treatments as problem solving in phase 1, practical simulation in phase 2 and cooperative learning in phase 3 at on student’s achievement in science subject in urban public school” is rejected and concluded that there is significant difference between treatments at phase 1, 2 and 3 in urban area public school.

## V. DISCUSSION AND CONCLUSION

Jazariyah (2017)Studied the significance of brain based learning and concluded that the working system and potential of brain is very important at early childhood level, that’s why brain based learning is very important at early childhood level. Learning can be optimized by applying brain based strategies in classroom. Connell (2018) investigated the global aspects of Brain Based learning and recommend that, brain based learning provides connections to teaching and learning, helps teachers to design classroom and school environment for different group of students to achieve learning goals.

At early elementary level, teacher is responsible for students’ learning. However, using a variety of teaching methods can improve students’ learning. The study describes that brain based intervention model accelerates the learningof students at early elementary level as claimed byConnell (2018). Three teaching methods, cooperative learning, problem solving method and practical simulation were applied to develop a brain based intervention model for learning acceleration. Three modules were developed for syllabus of general science grade six. One module was developed with the activities of cooperative learning, the other for practical simulation method and the third module was based on problem solving strategies.

Results show that all of the three types of brain based activities have positive effect on students’ achievement. Research conducted in three phases and in three different public schools (rural, sub urban and urban) depicts that, students of experimental group gained higher scores in posttest than the students of control group at phase one, phase two and phase three in rural public school. It reveals that students at rural school were stimulated by brain based methods and were excited to learn and exhibited higher order thinking skills in response to intervention. In the next three months, the students of experimental group gained better scores than that of control group in all three areas. The present study supported Tafti (2017), Abd-El-Khalick (2000) and Hsiung (2012) who envisaged the improvement in learning through student centered brain based activities. The best sequence of three activities for rural students was, collaborative learning, problem solving and practical simulation, while for urban and sub urban students, students scored higher in the sequence of problem solving, collaborative learning and practical simulation. The difference was observed due to stimulation of problem solving in students of rural area while urban and suburban students were more active during collaborative learning. The existing sequential study has not been conducted before while independently all three types of activities were found effective as compared to traditional method in the previous researches. Therefore, the study suggests following implications for pedagogical practices:

1. Brain based intervention needs to be introduced for all students including rural, urban and sub urban areas to accelerate learning.
2. Students of grade six can have better learning if they are taught with the sequence of (collaborative learning, problem solving and practical simulation) and students of urban and sub urban areas perform better when they are engaged in the sequence of problem solving, collaborative learning and practical simulation.
3. The modules of cooperative learning, practical simulation and problem solving are helpful for teachers to engage students in higher order thinking skills.

## VI. CONCLUSION

The purpose of education is not just to deliver content knowledge but it adds the rational thinking and concept learning among students. Education needs to stimulate lifelong learning and innovation in learning for both teachers and students. The current study found that learning would be highly effective if teachers start using the brain based intervention model in their classroom.

The findings of the study reveal that the application of brain based intervention model, as teaching strategy, strengthens the learning of students and empower them with a variety of activities and teaching methods. It provides opportunities for higher order thinking skills and learning independently. Therefore, the study concluded that the presentation of content is very important in the class. The curriculum should add diverse activities which should promote, movement, diversity, curiosity, learning challenges and consistent engagement of thinking process. It holds the stance that teacher as a facilitator should shift the learning responsibility to students rather putting the content in static, passive and silent classrooms. Every activity that urges students to think helps them to come up with multiple solutions of learning problems and that if existing content of different subjects is designed in an engaging way the students can develop long term concepts which they may utilize in their real life.

## REFERENCE


1. Abd-El-Khalick, F., & Lederman, N. G. . (2000). Improving science teachers' conceptions of nature of science: a critical review of the literature. International journal of science education, 22(7), 665-701.
2. Alonzi, P., Lange, D. R., &Simkins, B. J. (2000). An Innovative Approach in Teaching Futures: A Participatory Futures Trading Simulation. Financial Practice & Education, 10(1), 228-238.
3. Cain, C. (1991). Personal Stories: Identity acquisition and self-understanding in Alcoholics Anonymous. Ethos, 19(2), 210-253.
4. Connell, J. D. (2018). The Global Aspects of Brain-Based Learning: Educational Horizons. Research-based Education: The Global Case, 88(1), 28-39.
5. Deng, H., Stauffer, P. H., Dai, Z., Jiao, Z., &Surdam, R. C. (2012). Simulation of industrial-scale CO2 storage: Multi-scale heterogeneity and its impacts on storage capacity, injectivity and leakage. International Journal of Greenhouse Gas Control, 10, 397-418.
6. Duman, C. H. (2010). Models of depression. In Vitamins & Hormones Academic Press, 82, 1-21.
7. Erlauer, L. (2003). The brain-compatible classroom: Using what we know about learning to improve teaching. ASCD.
8. Gozuyesil, E., &Dikici, A. . (2014). The Effect of Brain Based Learning on Academic Achievement: A Meta-Analytical Study. Educational Sciences: Theory and Practice, 14(2), 642-648.
9. Hedeen, T. (2003). The reverse jigsaw: A process of cooperative learning and discussion. Teaching Sociology, 31(3), 325-332.
10. Hsiung, C. M. (2012). The effectiveness of cooperative learning. Journal of Engineering Education, 101(1), 119-137.
11. Jazariyah. (2017). Signifikansi Brain Based Learning PendidikanAnakUsia Dini. Nadwa | JurnalPendidikan Islam, 11(1).
12. Kirtikar, R. (2013). A Problem-Solving Approach for Science Learning. New Perspectives in Science Education.
13. Kolon, T. F., Clement, M. R., Cartwright, L., Bellah, R., Carr, M. C., Canning, D. A., & Snyder III, H. M. (2008). Transient asynchronous testicular growth in adolescent males with a varicocele. The Journal of urology, 180(3), 1111-1115.
14. Lean, J., Moizer, J., Towler, M., & Abbey, C. . (2006). Simulations and games: Use and barriers in higher education. Active learning in higher education, 7(3), 227-242.
15. Malik, M. A., Hussain, S., Iqbal, Z., & Rauf, M. (2012). Effectiveness of Brain-Based Learning Theory on Secondary Level Students of Urban Areas. Journal of Managerial Sciences,, 6(1).

16. Meador, K. J., Loring, D. W., Hulihan, J. F., Kamin, M., Karim, R., & CAPSS-027 Study Group. (2003). Differential cognitive and behavioral effects of topiramate and valproate. Neurology, 60(9), 1483-1488.
17. Mérel, P. R., Saitone, T. L., & Sexton, R. J. (2009). Cooperatives and Quality-Differentiated Markets: Strengths, Weaknesses, and Modeling Approaches. Journal of Rural Cooperation, 37(2).
18. Porter, T. S., Riley, T. M., &Ruffer, R. L. . (2004). A review of the use of simulations in teaching economics. Social science computer review, 22(4), 426-443.
19. Prince, M. J., & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. Journal of engineering education, 95(2), 123-138.
20. Sauvé, L., Renaud, L., & Kaufman, D. (2010). Games, simulations, and simulation games for learning: definitions and distinctions. In Educational gameplay and simulation environments: Case studies and lessons learne. IGI Global, 1-26.
21. Siercks, A. (2012). Understanding and achieving brain-based instruction in the elementary classroom a qualitative study of strategies used by teachers. Retrieved from http://stars.library.ucf.edu/honorstheses1990-2015/1372
22. Slavin, R. E., Hurley, E. A., & Chamberlain, A. . (2003). Cooperative learning and achievement: Theory and research. Handbook of psycholog, 177-198.
23. Subadi, T., Khotimah, R. P., & Sutarni, S. (2013). A Lesson Study as a Development Model of Professional Teachers. International Journal of Education, 5(2), 101-114.
24. Tafti, M. A., &Kadkhodaie, M. S. . (2017). The Effects of Brain-Based Training on Learning and Retention of Life Skills in Adolescents. International Journal of Behavioral Sciences, 10(3), 140-144.
25. Tandogan, R. O., &Orhan, A. (2007). The Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning. Online Submission, 3(1), 71-81.
26. Van de Vrande, V., De Jong, J. P., Vanhaverbeke, W., & De Rochemont, M. . (2009). Open innovation in SMEs: Trends, motives and management challenge. Technovation, 29(6423-437).
27. Varghese, M. G., & Pandya, S. (2016). A study on the effeciveness of brain-based learning of students od secondary level on their academic achievement in Biology, study habits and stress. International Journal of Humanities and Social Sciences (IJHSS), 5(2), 103-122.
28. Yasar, M. D. (2017). Brain Based Learning in Science Education in Turkey: Descriptive Content and Meta-Analysis of Dissertation. Journal of Education and Practice, 8(9), 161-168.