# *Learning Exponential-Logarithmic Equations through Values-Driven Interventions*

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**Abstract**
Mathematics is, undeniably, a fundamental skill that a learner should acquire and master. Its purposes since the era when man learned to write his annals cannot be overemphasized. The learners should explore independently the intricacies of the subject; hence, constructivist approach. As developed by Jerome Bruner, it is where the learners construct new ideas based upon their current or past undertakings. This study covered the performances of selected 34 College students in learning exponential-logarithmic equations. Revealed here were: pretest and post-test performances have averaged differently; the null hypothesis of no significant difference between the two performances is **rejected**. The null hypothesis stating that the interventions used have equal influence to post-test results is **accepted**; the most predominant behavioral changes are determination, organization of thoughts, self-confidence, and humility; all interventions used are assessed effective. As concluded, a significant difference exists between the two performances and that the interventions have equal influence over the post-test performances.

Keywords: exponential-logarithmic equations, values-driven interventions, constructivism

## Introduction

Mathematics is, undeniably, a fundamental skill that a learner should acquire and master. Its purposes since the era when man learned to write his annals cannot be overemphasized. Its rudiments have been perfected generation by generation until such time when mathematics is difficult to understand. They must create their own constructs or frameworks of understanding based on the established mathematical principles; hence, constructivist approach. By constructivism we mean learning by doing. A learning theory that is developed by Jerome Bruner, its major theme is that learning is an active process in which the learners identify, select and transform data into meaningful information to guide them in their formulation of hypothesis and decision making (Source: http://www.thirteen.org/edonline/concept2class/constructivism/) It is in this light that the researcher had attempted to explain how the learners acquire understanding and mastery of exponential-logarithmic equations.

## Conceptual Framework

The central theory adopted for this study is the importance of independent cognition, or independent learning. Aptly stated, and the researcher quotes, "*Jerome Bruner's constructivist theory is a general framework for instruction based upon the study of cognition*." Originally, Bruner focused on the mathematical and scientific studies which served as foundation of higher learning for young children.

At the confines of a constructivist, his concentration is the learner; very minimal to him or herself. Contradictory to common notion towards constructivism, the importance of teachers is not neglected. Their roles are just modified. (Source: http://www.thirteen.org/edonline/concept2class/constructivism/)

Whitehead (1929) as cited by Slaterry (2013) pronounced that "students are alive, and the purpose of education is to stimulate and guide their self-development." This leads to the universal recognition of the vitality of addressing the nature of the learners. Kersey & Masterson (2013) added that there is a need for positive guidance with our young children today. They had elaborated too the essence of having a creative teachers available for help, coaching, and facilitating.

In the constructivist model, learners are encouraged to work for their own learning, conceptualizing, and processing. In harmony with what the JRU Faculty Manual declares, a teacher is expected to guide students in a wholesome environment and in the adoption of habits that would improve their character and personality, which is the very core of constructivism.

In its entirety, the researcher had made used of different values-driven interventions whereat the participants had engaged themselves actively. These included socialized blended recital, student-led discussion, board work / demonstration, and math video / film showing. Adoption of these approaches had subscribed to the ideas of Zulueta (2006), who emphasized that learning must be interactive. He believes that it is only when the individual reacts to the stimulus in the environment that learning is likely to occur.

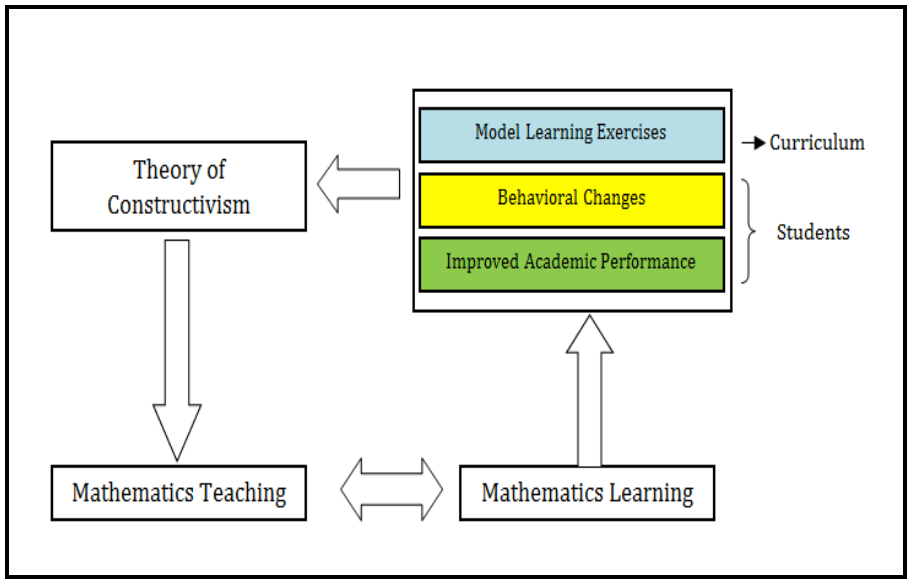


Figure 1: The Conceptual Framework

Figure 1 shows the conceptual framework of the study. As the learners are exposed to their own learning environment, they could explore the lessons on hand, determine what is essential from peripheral, and crystallize what are the precise preconceptions. These will lead to their improved academic performance and behavioral changes. While these are for students to experience, it is also expected that the curriculum would be further enriched through modelling learning exercises.

**Significance of the Study**

Bearing in mind the relevance of student-centered approach of teaching nowadays, this present research would be beneficial to the following:

School administrators. They will be able to formulate classroom policy in institutionalizing administrative support to independent learning environment.

Teacher-facilitators. They will be able to effectively gauge their students and provide academic support in order to make the learners understand mathematical concepts and acquire necessary competencies through learner-centered approach.

Learners. They will be provided with optimum collaboration for individualized instruction and independent exploration giving them opportunity to unlock their own learning difficulties and misconceptions.

**Scope and Limitations**

This evaluative study covered the performances of the participants in acquiring understanding and skills involving exponential-logarithmic equations, an Advanced Algebra lesson. The researcher did not attempt to compare and contrast performances of the participants according to their strategies/approaches employed rather focused on the overall pretest and post test results only. This limitation the researcher had positioned outset could prevent the direct comparison of the interventions used by the

participants. Instead, he reduced to the comparative analysis of their overall improvement marks. While it is true that the researcher also gave consideration to the participants' perceptions, these had been corroborated by their post-test performances.

**Definition of Terms**

The following terms were operationally defined by the present researcher.

**Behavioral Changes**. This term refers to the manifested behavioral change of the participants from pre-intervention to post-intervention when learning the logarithmic-exponential equations.

**Constructivism.** As a learning theory, this refers to the process / approach employed in the present undertaking whereby the participants were allowed to explore their own potentials in acquiring pre-determined mathematical competencies of understanding and applying logarithmic-exponential equations.

**Values-driven interventions.** These interventions were determined by the researcher in which the participants could employ independent learning. These were specifically limited to blended recital, student-led discussion, board work/demonstration, and math video / film viewing.

**Hypothesis**

The following are the null hypotheses that the researcher had tested at 0.05 alpha level of confidence:

| | |
|---|---|
| **Null Hypothesis 1** | There is no significant difference between the performances of the participants during the pretest and post-test administration. |
| **Null Hypothesis 2** | The independent variable INTERVENTIONS USED has equal influence upon the dependent variable (Y) POST-TEST RESULTS<br>*(Statistically stated: $b_1 - b_2 = 0 \ldots b_n - b_{n+1} = 0$)* |

**Statement of the Problem**

Stemmed logically from the premises set earlier pertaining to independent learning and research objectives, he sought the answers for the following problems:

1. What were the performances of the participants during pretest and post-test?
2. Is there a significant difference on the performances of the participants during the pre-test and post-test?
3. What values were predominant among the participants in learning mathematics through programmed interventions?
4. How effective integrating values were in learning math subject content after the intervention period?

**Research Design Used**

The researcher employed mixed experimental-descriptive design of research. As such, the researcher ascertained that there were planned interferences in the natural order of learning events among his participants. This prompted him since he wished to obtain information concerning the current status of the phenomena (mathematics teaching) and to describe "what exists," which in this research pertains mathematics learning with respect to variables or conditions in a situation. Essentially, the overall research design is that of an action research. Navarro & Santos (2013) explained that action research is an inquiry process conducted by any stakeholder in the teaching-learning environment to address a felt need or address daily problems.

**Population, Sample and Sampling Scheme**

For School Year 2014-2015, the researcher handled eight (8) mathematics classes. Four (4) of these are Advanced College Algebra and the remaining four (4) classes are all Elementary Statistics. Considering that Elementary Statistics are already conducted through Course Redesign Program (CRP), these classes were no longer included in the selection of the sample; thus, only the Advanced College Algebra classes remained. The researcher resorted to fishbowl lottery sampling which gave me the 102G class as research samples.

**Data Gathering Procedure**

The data gathering protocol that the researcher had observed entails the following – initialization, evaluation, and post-evaluation. In a flowchart below, it summarizes the entire procedure observed by the researcher:

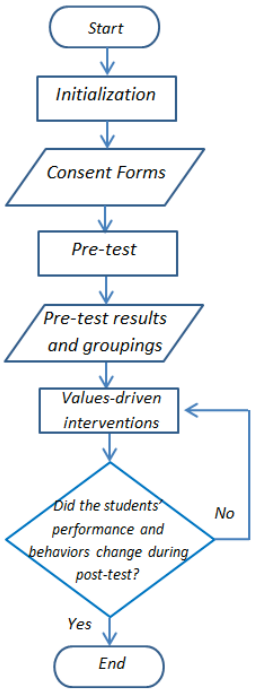


Figure 2. The Flowchart on Data Generation and Processing

During the initialization, he had informed the class (102G) that they were randomly selected as research participants. During the first week of January when classes were resumed, the researcher had emphasized to the participants that their involvement in this research is voluntary, non-discriminatory, and non-bearing either to their periodic or overall mathematics g.p.a.; thus, consent forms were distributed and retrieved before the evaluation phase. When properly filled up consent forms were received, the researcher proceeded in administering the pretest to the 48 participants. He grouped the participants into four comprising 12 members each. Each group was assigned with a specific values-driven intervention –blended recital, student-led discussion, board work / demonstration, viewing math videos/films.

The four groups had utilized the assigned intervention strategies in acquiring knowledge and understanding of exponential-logarithmic equations. This is the researcher's evaluation phase. In here, they were given one and a half (1 ½) weeks, January 19-27, in teaching-learning the said mathematical concepts. The researcher sometimes allowed the participants to argue among themselves as to the accuracy of their own processes, solutions, and answers. After the intervention period, he administered the post-test and again recorded their corresponding stores. It must be noted here that during post-test administration, only 34 participants were available. Some of them did not come for the post-test while one (1) was no longer allowed by her guardian to participate.

On his post-evaluation, the researcher endeavoured to solicit qualitative feedbacks from the participants using a separate research instrument. This, when returned and assessed, amplifies the available statistics derived from tests analysis.

**The Research Instruments**

There were two research instruments that the researcher had used namely Pretest-Post-Test on Exponential-Logarithmic Equations developed and copyrighted by Dr. Abdelkader Dendane, a UAE Professor, and a Post-Test Evaluation Sheet that the researcher had purposively created to gather substantial feedbacks from the participants. Dr. Dendane instantly and gladly granted permission to use his material provided that it (the pretest-post-test material) will only serve educational research purpose as communicated.

The pre-test –post test had included properties of exponential and logarithmic equations. The competency ultimately tested is finding all the permissible solutions to five (5) exponential and five (5) logarithmic equations.

To bolster data gathering, the researcher developed a Post-Test Evaluation Sheet where the participants provided more specific details vis-à-vis to the interventions they employed and their perceptions on its effectivity on promoting values.

**Statistical Treatment of Data**

The researcher had used both the descriptive and inferential statistics to complement and supplement all the findings in this study. Descriptive statistics that hed had employed were frequency counts, percentage, means, weighted means, and standard deviations. As regards to the inferential statistics, separate-variances t-Test for the

difference, ANOVA (F-Test), and simple linear regression were utilized in order to propose later on further studies to ascertain generalizability of the present research.

**Results and Discussions**

The data were taken from the class registry and record during the administration of the pre-test and post-test. The statistics that follow were generated by PHSta2v29.

Table No. 1

**Pretest and Post-Test Performances of the Participants Clustered According to Intervention Used**

| Intervention used | No. of Examinees | Pre-test Mean Score | Post-Test Mean Score | Var |
|---|---|---|---|---|
| Blended recital | 8 | 2.30 | 7.38 | 5.13 |
| Student-led discussion | 10 | 2.30 | 6.30 | 4.00 |
| Board work/ Demonstration | 8 | 2.00 | 7.13 | 5.13 |
| Math video / film viewing | 8 | 2.50 | 7.63 | 5.13 |
| | **AVERAGE** | **2.28** | **7.11** | **4.85** |

Var = variance

It can be gleaned from the table above that there were notable changes on the performances of the participants when they took the post-test. Initially in the pretest, the participants had attained only an average of 2.28 points. When they took the post-test, their performances had leaped to and hit a very high average of 7.11 points. Evaluating from within, among the four interventions used, student-led discussion posted the lowest positive variance of 4.00 points, while the blended recital, board work/demonstration, and math video/film viewing posted bit higher positive variances of 5.13 points each.

Gleaning further, the average positive variance of 4.85 suggests that the four values-driven interventions, when properly and timely executed, could improve low mathematics performances.

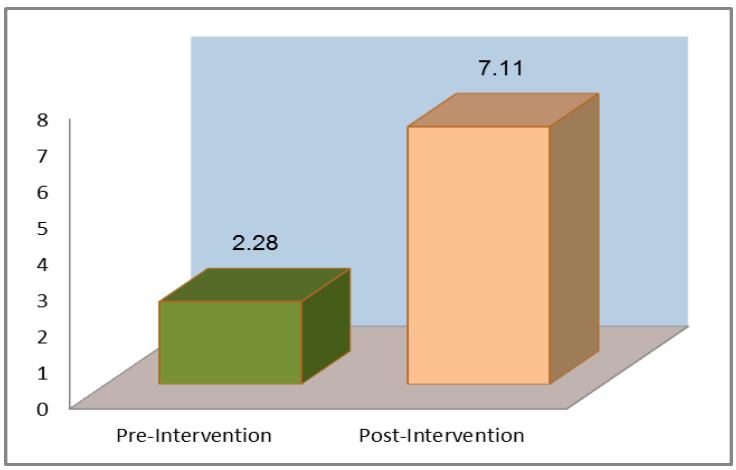


Figure 3. Average Test Performances during Pre-Intervention and Post-Intervention

Figure 3 shows the comparison of two test averages attained during the pre-intervention and post-intervention. Glaringly noticeable is the big gap or difference between the two tests administered purposively.

Meanwhile, Table No. 2 below exhibits the participants' frequency distribution of the improvement marks based on the values-driven interventions that they had employed.

Table No. 2
**Frequency Distribution of Participants' Improvement Marks according to the Interventions Used**

| Interventions used | Inc (f) | % | Dec (f) | % | Unch (f) | % |
|---|---|---|---|---|---|---|
| Blended recital | 7 | 87.50 | 0 | 0.00 | 1 | 12.50 |
| Student-led discussion | 9 | 90.00 | 1 | 10.00 | 0 | 0.00 |
| Board work/ Demonstration | 7 | 87.50 | 1 | 12.50 | 0 | 0.00 |
| Math video / film viewing | 7 | 87.50 | 1 | 12.50 | 0 | 0.00 |
| **Total and Average** | **30** | **88.13** | **3** | **8.75** | **1** | **3.13** |

Inc – Increased Dec – Decreased Unch – Unchanged

As reflected in the table above, there were 30 participants or 88.13% whose performances have increased while there were 3 participants or 8.75% whose performances have decreased. Only one (1) participant or 3.13% has an unchanged performance. Interestingly, that sole participant came from blended recital group only. Analyzing it further, the results posited that student-led discussion, board work/demonstration, and math video/film viewing as learning interventions had slightly decreased the performances of those who had employed them.

Table No. 3
**Separate-Variances t Test for the Difference between Pre-test and Post-Test**

| Results | Means | t-computed | Critical value | Decision | Remarks |
|---|---|---|---|---|---|
| Pre-test | 2.28 | -45.9438 | ±2.0195 | Reject Ho | Significant |
| Post-Test | 7.11 | | | | |
| **Two-tailed test; α = 0.05** | | | | | |

Table 3 shows the test of significant difference between the pretest and post-test performances of the participants. It can be seen from the table that the mean performance during pretest is 2.28 while during post-test is 7.11. Based on the computations made, the t-statistic absolute value of –45.9438, which is lower than the absolute t-critical value of –2.0195; thus, the null hypothesis which states that there is no significant difference between the pretest and post-test performances of the participants is **rejected**. Therefore, a significant difference exists between the two performances of the participants.

While there is a significant difference that exists between the participants' pretest and post-test performances, the ANOVA (F-Test) results for interventions used and the post-test performances provide another interesting result as explained in the succeeding texts.

Table 4
**ANOVA Matrix for Intervention Use and Post-Test Results**

| | df | SS | MS | F | Sig. F |
|---|---|---|---|---|---|
| Between groups | 1 | 0.0016 | 0.0016 | 0.0148 | 0.9039 |
| Within groups | 32 | 3.5278 | 0.1102 | | |
| Total | 33 | 3.5294 | | | |

df – degrees of freedom MS – mean square SS – Sum of squares Sig – Significant

As shown in Table 4, the computed F-value is 0.0148 is lower than the critical F-Value of 0.9039; thus, the null hypothesis which says that the INTERVENTION USED (Blended recital, student-led discussion, board work/demonstration, and math video/film viewing), as a set, have equal influence to Post-test results is **accepted**. This means that the four (4) intervention methods have the same influence over the performance of the participants during their post-test.

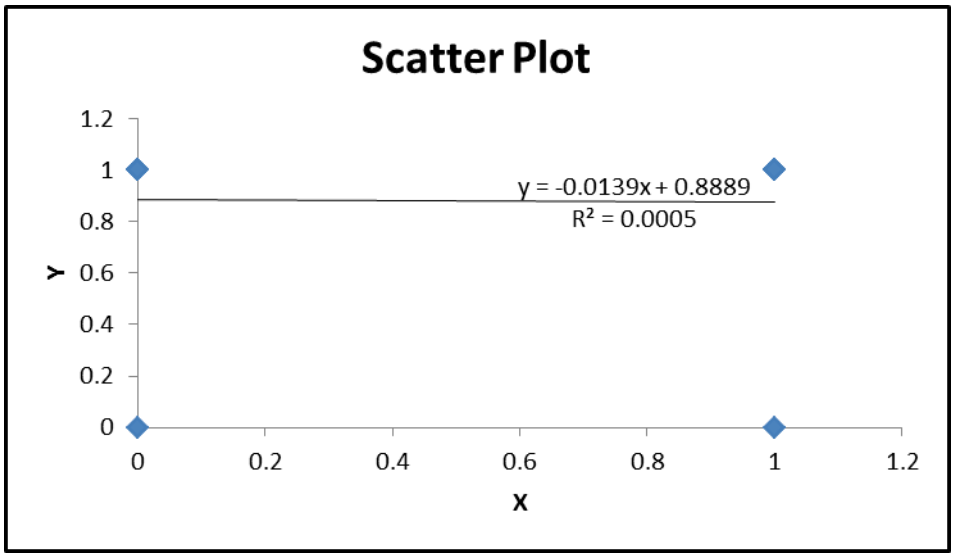


Figure 4. **Scatter plot and the Regression Equation**

Figure no. 4 shows the scatter plot for Interventions Used and Post-test Results data. It shows the regression equation y = –0.0139x + 0.8889. Meaning, for any Pre-test (x) score, say 8, the post-test (y) score of the student would be 0.7777 higher.

Table No. 5
**Predominant Behavioral Changes as Ranked by the Participants in Blended Recital**

| Predominant Behavioral Changes | Participants' Ranking | |
|---|---|---|
| | Raw | Translated |
| Attentiveness. *I became alert during random calls.* | 2.50 | 2 |
| Determination. *I became eager to participate, answer, and share.* | 2.00 | 1 |
| Patience. *I became patient to wait for my turn to be called.* | 3.63 | 4.5 |
| Readiness. *I became readily available for help when nobody wants to answer.* | 3.63 | 4.5 |
| Responsiveness. *I became focus on the learning content.* | 3.25 | 3 |

Table No. 5 exhibits the rankings made by the participants who have the blended recital discussion as learning intervention on the predominant behavioral changes they experienced. Based on the table, Determination ranks first with a raw rank of 2.00 which was followed by Attentiveness with a raw rank of 2.50. Responsiveness is ranked third with a raw rank of 3.25. Tailing at the end are Patience and Readiness with the same raw ranks of 3.63. Accordingly, a constructivist teacher provides tools such as problem-solving and inquiry-based learning activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment. This is observed too during the blended recital.

Table No. 6
**Predominant Behavioral Changes as Ranked by the Participants in Student-led Discussion**

| Predominant Behavioral Changes | Participants' Ranking | |
|---|---|---|
| | Raw | Translated |
| Attending to details. *I became sensitive and particular to words, symbols, and sounds during discussion.* | 2.30 | 2 |
| Clearness / organization of thoughts. *I became organized when discussing with my group mates.* | 2.20 | 1 |
| Enthusiasm to share. *I became animated and passionate during my discussion time.* | 3.10 | 3 |
| Keenness. *I became perceptive on others' shortcomings in learning mathematics.* | 3.70 | 4.5 |
| Precision. *I became meticulous on the procedures involved when doing mathematical tasks.* | 3.70 | 4.5 |

Table No. 6 exhibits the rankings made by the participants who have the student-led discussion as learning intervention on the predominant behavioral changes they experienced. Based on the table, Clearness/organization of thoughts ranks first with a raw rank of 2.20 which was followed by Attending to details with a raw rank of 2.30. Enthusiasm to share is ranked third with a raw rank of 3.10. Tailing at the end are Keenness and Precision with the same raw ranks of 3.70. As expected among the

learners, they have become organized when discussing with their own group members. This is evident especially when the leader responsibly managed their work. In a constructivist environment, though there is minimal supervision of the teacher, a leader among the learners could surface during the process. Their emergence must be supported. It is when a leader is born among the learners, an optimization of the potential of an individual.

Table No. 7
**Predominant Behavioral Changes as Ranked by the Participants in Board work / Demonstration**

| Predominant Behavioral Changes | Participants' Ranking | |
|---|---|---|
| | Raw | Translated |
| Articulacy. *I became expressive during board work / demonstration of the mathematics content.* | 3.38 | 3.5 |
| Compliance. *I became conforming to the requirements of the task.* | 3.38 | 3.5 |
| Cooperation. *I became supportive with my colleagues while demonstrating the process of solving mathematics problems.* | 2.50 | 2 |
| Neatness of work. *I became aware of the necessity to work with efficiency especially with numbers.* | 4.00 | 5 |
| Self-confidence. *I became confident / buoyant while it was my time to demonstrate on the board.* | 1.75 | 1 |

Table No. 7 exhibits the rankings made by the participants who have the board work / demonstration as learning intervention on the predominant behavioral changes they experienced. Based on the table, Self-confidence ranks first with a raw rank of 1.75 which was followed by Cooperation with a raw rank of 2.50. Articulacy and Compliance are ranked third with the same raw ranks of 3.38. Tailing at the end is Neatness of work with a raw rank of 4.00. Perhaps the primary reason of such low ranking of neatness is the practice the participants have been accustomed to. Erasures and trials are allowed in mathematics as we attempt to answer or prove mathematical equations.

In here, Whitehead (1929) gets affirmation. Students are truly alive and must be encouraged to work for their own learning, conceptualizing, and processing. In the board work or demonstration, participants have acknowledged the significance of the concept of self-worth apropos learning by doing. This may be the underlying reason why the participants have ranked self-confidence the highest.

Table No. 8
**Predominant Behavioral Changes as Ranked by the Participants in Math video/film viewing**

| Predominant Behavioral Changes | Participants' Ranking | |
|---|---|---|
| | Raw | Translated |
| Creativity. *I became creative in approaching mathematical problems, thus helping me to solve correctly.* | 3.38 | 4 |
| Exactitude. *I became careful when complex mathematical problems are at hand.* | 2.75 | 2 |
| Humility. *I became unpretentious knowing that there are people who deal mathematics with difficulty.* | 2.00 | 1 |
| Promptness. *I put emphasis on the essentiality of learning mathematics.* | 3.63 | 5 |
| Creativity. *I became creative in approaching mathematical problems, thus helping me to solve correctly.* | 3.38 | 4 |

Table No. 8 exhibits the rankings made by the participants who have the math video / film viewing as learning intervention on the predominant behavioral changes they experienced. Based on the table, Humility ranks first with a raw rank of 2.00 which was followed by Exactitude with a raw rank of 2.75. Vigilance is ranked third with a raw rank of 3.25, followed by Creativity with a raw rank of 3.38 and tailing at the end is Promptness with a raw rank of 3.63.

Bruner is right when he said that in the constructivist milieu, learners should be given ample opportunities to explore by themselves the learning environment they have. Upon doing, they are moved, changed, transformed. These are the primary impacts of viewing Math – related films. Most of the videos that the participants have watched have promoted special consideration to people of different learning backgrounds. Most of the participants have watched ABAKADA INA (Philippines), A BEAUTIFUL MIND (U.S.A.), and CITY HUNTER (S. Korea) that shows struggles of, and compassion to people who are either mathematically gifted or challenged.

Across all interventions employed, the most predominant behavioral changes are determination, clearness / organization of thoughts, self-confidence, and humility substantiated by their high raw ranks made by the participants.

Table No. 9
**Distribution of Participants' Perception on the Effectivity of the Interventions Used**

| Perceptual Response | Frequency (f) | Percentage (%) |
|---|---|---|
| Effective | 34 | 100.0 |
| Not Effective | 0 | 0.00 |
| **TOTAL** | **34** | **100.0** |

Table No. 9 exhibits the frequency and percentage distributions of the participants on their perceptions on the effectivity of the interventions used. All of the 34 participants

claimed that the interventions the specifically used during the acquisition of exponential-logarithmic equations are effective.

Interspersing these perceptions on their post-test performances, their aggregate belief is evidently true. Their perceptions are supported and validated by very high improvement marks of 4.85 points from a low average of 2.28 points to 7.11 points. This positive leap is enormous considering that the participants were just given a rationed time allotment of two classroom meetings.

At that point, Kersey & Masterson (2013) had emphasized the impact of positive guidance with the learners no matter how short the contact is. Creative teachers do give meaningful experience to the children and influence how the learners perform. Concerning this assessment of the participants, they acknowledge the operative influence of the values-driven interventions where they had engaged themselves worthily and actively.

**Conclusions**

Based on the foregoing findings that were revealed in this study, the researcher formulates the following inferences:

1. The participants have yielded higher test performances during the post-intervention phase.
2. A significant difference exists between the pre-intervention and post-intervention performances and that the interventions (blended recital, student-led discussion, demonstration, and have equal influence over the post-test performances.
3. In each values-driven intervention, a predominant behavioral change surfaces.
4. The participants claimed that the post-intervention measures explored and employed by them were effective in learning exponential-logarithmic equations.

**Recommendations**

Congruent to the findings revealed and conclusions formulated, the researcher hereby recommends the following:

1. Extend the values-driven interventions to other classes. This is to support or negate the positive results that the interventions have caused to the performances of the participants.
2. Expose the students to different teaching strategies/approaches and learning styles.
3. Explore student pre-conceptions from where to build firmer foundation of new mathematical learning.

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**Internet resources**

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**Other references**

JRU Faculty Manual (College Division)

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