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GRAPHIC ORGANIZER: A LEARNING TOOL IN TEACHING PHYSICAL SCIENCE

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Abstract

The integration of the effective study techniques could still be a relevant education research topic if we are to consider the changing demand for skills brought about by technological advancements. Thus, Graphic Organizer as a teaching tool was developed and implemented to promote conceptual understanding in the solution processes of algorithmic related topics in Physical Science. Specifically, the study determined the level of academic achievement of the participants in the pretest and posttest assessment of a quasi-experimental research design. Further, this study also determined which group (control or experimental) performed better after applying the intervention. Results showed that the control and experimental groups pretest scores do not meet expected proficiency level, however, there was a significant improvement in their posttests scores described respectively as satisfactory and very satisfactory. It was found out further that participants from experimental group achieved significantly better than the participants from the control group. As observed, the participants have confidently and actively

indulged themselves in graphic organizer guided activities resulting to a deeper understanding of concepts, retention, and mastery of contents.

Keywords

Graphic Organizer, Physical Science, Learning Tool, Newton's Law, Stoichiometry

1. Introduction

Stoichiometry and Newton's Laws of Motion in Chemistry and Physics concepts, respectively, are major topics of physical science. Both are mathematically related which become one of the sources of worry among many high school students as mentioned categorically by Bridges, (2015) and Dhurumraj, (2013). There have been methodologies adapted in teaching the aforementioned mathematically related topics, for instance, dimensional and vector component analysis. However, an obstacle to students in understanding the concepts and connecting it to the solving process remains evident as shown in the low academic performance (Tigere, 2014).

Lack of learning motivation and poor teaching methods are factors considered in the study of Bucayong (2019). Degrano (2017) also emphasizes that scientifically aided instruction enhanced the level of student's academic achievements than the traditional methods of teaching science. Accordingly, the possible means that guarantee successful learning is when the teacher tried and introduced another method to limit the learning difficulty. This is in consonance with the aim of 21st century education which is the integration of new study techniques for a meaningful learning. An example is the Graphic Organizer as teaching tool according to the study of Swoosh (2013).

Alderete and Bennete (2012) posited that instead of just the traditional way, a Graphic Organizers emerged to facilitate and improve learning outcomes. This method addresses a wide range of learners by way of categorizing information and identifying connections between ideas, hence considered as an effective instructional tool.

However, Le (2013) in his research findings articulated that Graphic Organizers can only help alleviate the learners' example pattern mentality but do not likely enhance conceptual understanding and skills in solving algorithmic problems. In addition, the study concluded that increase in academic achievement is not guaranteed by the use of Graphic Organizers.

In line with the numerous findings of researchers on the effectiveness of Graphic Organizer as a learning tool, which is in contrary to the argument of Le, the researcher prompted to pursue a similar study. Graphic Organizer was used as a learning tool in teaching Physical

Science specifically; understanding concepts and solving algorithmic problems of Stoichiometry and Newton's Laws.

1.1 Review of Related Literature

1.1.1 Graphic Organizer

Basically, a graphic organizer is an instructional tool or aid (ILTER, 2016) in improving the capability of the students in recognizing word meaning and developed positive achievement emotions (enjoyment, hope and pride) more than just the contextual process. In addition, the effect of graphic organizer (Sarabi and Beheshti, 2012) is sufficient for the improvement of students' comprehension, academic performance and motivation in learning. Nor and Jin (2012) stressed that graphic organizer as visual instructional aid embarks into the varied strata of learners' excellence and academic achievements. They explicitly claimed that there is accentuated augmentation of comprehension and more learning engagement for students while participating in a graphic organizer guided activities.

Drapeau (2016) and Sian, et al (2016) findings on the effect of Graphic Organizer as learning tool revealed that Graphic Organizers are powerful tools in promoting student academic achievements. Findings connote further, that Graphic Organizers help the learners' abilities to engage in critical and creative thinking. The exercises of mind long known to be essential to academic achievements.

Moreover, Alderite (2012) research evaluation on graphic organizers have shown proof that it increases comprehension and retention for visual learners and can be used with all students ranging from gifted and talented, as well those with mild cognitive disabilities. The research highlighted supports for the utilization of graphic organizer as a contributory factor in improving performance in classroom and achievement test scores if they used effectively and become part of classroom instruction.

1.1.2 Solving Mathematically Related Physical Science Problems

Solving problem has been widely investigated by educational researchers in an effort to help learners improve their problem solving skills. The nature of difficulty for the students in understanding the concepts of physical science subject as elaborated in the study of Sokrat, et al (2014) was in terms of inadequate basic knowledge of relating physical science topics to mathematical solving process.

A study by Upahi and Olonundare (2012) revealed most common difficulties of students. These were the difficulties to relate known variables and recalling information from memory for

critical reasoning through the problem. Le (2013) and Bridges (2015), research findings showed that problem solving difficulty is due to teachers' lack of skills to teach science mathematical related concepts. At the onset, teachers were suggested to adapt own delivery style of instruction which fits their own kind of learners (Bucayong, 2018).

Jonasen (2014), posited that since the physical science problem is an abstract concept, the students must not resort to algorithms with a little understanding of the concepts. He explained that the key to adequately solve the problem is through visual representation. As suggested, visual instructional tools must come in for externalizing learners' internal representations leading to greater conceptual understanding.

Another study by Tigere, (2014), was showing low academic performance results of grade 12 Physical Science learners due to poor algorithmic and conceptual solving abilities in chemistry and physics problems. The study elaborated a demotivated behavior of students towards algorithmic concepts which resulted in poor performance. He then concluded, that Physical Science teachers should focus on developing strategies that could motivate the learners to learn more and find ways to make solving physical science problems enjoyable and enticing. This is in line with the study of Orbeta & Decano (2019) which verified that learner attributes like interest and motivation could undeniably fuelled students to strive hard for academic success.

The foregoing ideas, concepts and findings emphasized the similarities and differences to the present study. In context, some insights reflect that the use of graphic organizers is an effective tool in learning and in enhancing capabilities of students in understanding abstract concepts. The studies also point toward that Graphic Organizers equip learners for integrative reconciliation, effective presentation, promotion of active reception learning, encouragement to adopt critical approach and application to the solution of problems. The findings are in relevant support to the present study in its quest to further investigate the value of graphic organizer in improving the academic achievement of students in solving algorithmic related concepts in physical science subject.

Literature supports that graphic organizers are valuable instructional tool. Though on the other hand, Le reiterated that frequently, students are not taking advantage of this tool and the tool did not likely enhance the skills of learners which apparently did not positively affect academic achievements. Hence, a gap emerges needing further investigation which establishes connection to the present study.

1.2 Theoretical Framework

One of the most recognized and discussed theory of education is Piaget Cognitive Theory (1896-1890) through which this study is anchored. Piaget, a renowned researcher in developmental psychology believed that a person progressed through four stages. One of which is the formal operational stage, described by a person's logical use of symbols related to an abstract concept (Mintzes, 2012), resulting in a more generalizable and powerful cognitive abilities. In like manner, the theory explains the implication of graphic organizers to the academic achievements of students. In the process, students acquire, assimilate and accommodate information to arrive at new ideas resulting in cognitive ability development.

The underlying concepts of cognitive theory involve how students think and gain knowledge. It involves examining learning, memory, problem solving skills, and intelligence. Employing graphic organizers to aid students' cognitive development engaged in academic activities fosters and facilitates logical thinking through visually assisting students in assimilating and accommodating newly acquired information as described by Piaget.

1.3 Research Paradigm

Figure 1 presents the research paradigm of the study which shows the flow of the research. The rectangular box on the left part is the Pre-test which was administered by the researcher to the participants to measure the performances with regard to their previous knowledge in specified physical science topics. After the pre- test was given to all the participants, they were assigned to two groups, the experimental and control. As shown in the central rectangular boxes. The experimental group was taught utilizing graphic organizers as learning tools whereas the control group was given lectures through the traditional way **(**without the graphic organizers as learning tool). After going through the lessons, both groups were given post-test as viewed in the rightmost box of the research paradigm of the study. This should be the achievement scores of the learners in Physical Science, in particular, Stoichiometry and Newton's Laws of motion topics.

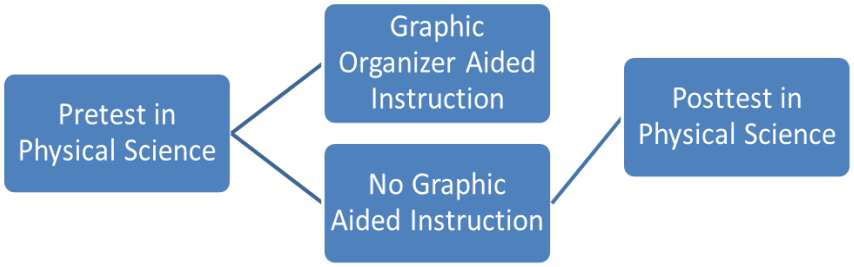

Figure 1: *Research Paradigm*

1.4 Statement of the Problem

This study aimed to determine the effect of Graphic Organizer as the learning tool in teaching Physical Science: Understanding concepts and solving algorithmic problems of Stoichiometry and Newton's Laws of Motion. Specifically, this study sought to answer the following questions:

1. What is the level of participants' academic achievements in Physical Science in the pre-test and post-test?
   1.1 traditional instruction (no graphic organizer); and
   1.2 Graphic organizer aided instruction.
2. Is there a significant difference of the participants' pre-test and post-test scores in Physical Science?
3. Is Graphic Organizer aided instruction effective compared to the traditional way in Teaching Physical Science?

2. Methods

2.1 Research Design

The researcher made use of the quasi-experimental design. This design was deemed appropriate since it determined and explained the data gathered from the participants' test scores (Academic achievement) as affected by the use of Graphic Organizers as learning tool in teaching Physical Science.

2.2 Locale and Subjects of the Study

The study was conducted to the Grade 11 Senior High School students, particularly on the two heterogeneous sections of both academic tracks namely; HUMSS and GAS. The HUMSS students constituted the experimental group and those of GAS were the control group. Table 1 shows the distribution of participants in this study.

Table 1: *Distribution of Respondents*

Year and Section	N	n
Grade 11 - HUMSS	20	20
Grade 11 - GAS	20	20
Total	40	40

The focus of the study was on the effect of Graphic Organizers as learning tool or instructional aid in the academic achievement of learners in Physical Science: Understanding the concepts and solving algorithmic problems of Stoichiometry and Newton's Laws of Motion. The study conducted covers the contents "how chemical changes take place" and "why we believe that the laws of physics are universal".

2.3 Research Instrument

The instrument used in collecting data was a researcher – made 50 items multiple choice test. Specifically, covering the topics; balancing chemical equation, mole concepts, limiting reactant and percent yield of Stoichiometry (chemical Changes) and the Newton's Laws of Motion which items are guided by the content and competencies. These competencies were stipulated in the curriculum guide of the Core subject- Physical Science of the Senior High School under K-12.

Validity. A draft of the researcher-made instrument was presented to the adviser for suggestions and recommendations. The content validation was done by the expert in Chemistry and Physics Graduate School teachers by thoroughly checking it against TOS.

Reliability. Pilot testing (test and re-test) was done to determine clarity and reliability of the test instrument through the non-participants. The scores were treated using Pearson r. The result showed a reliable *ρ-value.*

2.4 Ethics and Data Gathering Procedure

Proper research protocol was observed by the researcher in the conduct of the study. After the validation the reliability test was conducted and upon approval from the principal the achievement test (pre-test) was administered to assess their prior knowledge and understanding about the topics and concepts in Physical Science that the students should acquire. The experimental group was exposed to the Graphic Organizers aided teaching-learning tool in understanding the concepts via computer aided presentation. A Graphic organizer guided solving problem activities were presented as well as board work and demonstration activities. The control group on the other hand, was exposed to traditional teaching; the "chalk-talk" method and a power point presentation of facts. Solving problems were through sole board work by label factor method and demonstration activities without the procedural steps via graphic organizer or so called Graphic Organizer guided activities.

After all the topics have been covered following the time schedule a post-test was administered to the two groups. The post-test was to evaluate the academic achievements of the two groups in Physical Science under specified topics which were facilitated through different strategies of learning instructions. Scores from pre-test and post-test were tabulated and was treated to analyze the data.

2.5 Data Analysis

The following statistical tools were employed in analyzing the data of the study:

- *Mean and Standard Deviation:* These were used to describe the participants' level of academic achievement in the pre-test and post-test scores of both the experimental and control groups**.**
- *t-test for Independent Sample:* This was used to measure the differences of improvement on the pre-test and post-test scores of experimental and control groups.

3. Results and Discussions

3.1 Participants' Level of Achievement in the Pretest and Post Test

Presented in Table 2 is the level of achievement in the pretest and posttest of the participants.

Table 2: *Participants' Level of Achievement in Physical Science*

Group	Test	Mean	SD	Transmutation	Description
Experimental	Pretest	12.55	3.32	73	Did not meet Expectation
	Post Test	29.40	6.29	86	Very Satisfactory
Control	Pretest	12.60	3.09	73	Did not meet Expectation
	Post Test	21.70	5.13	80	Satisfactory

As can be gleaned in table 2 the pretest mean scores of the participants for both experimental and control groups are 12.55 and 12.60 which in transmutation are both 73 and described as *"Do not Meet Expectation"*. These results indicate that the participants from both groups exhibited evidence of minimal and insignificant level of knowledge in Physical Science; Stoichiometry and Newton's Laws of Motion in particular. These results further imply that the two groups are comparable as far as their initial knowledge in selected topics of Physical Science is considered prior to instruction.

The standard deviation suggests that the scores of the participants differ from each other at 3.32 for experimental group and 3.09 for control group. These mean that there are those whose scores are below or above the mean score. This could be due to their background of Chemistry and Physics Concepts when they were in Junior Grades. However, the two groups do not vary greatly as indicated in pre-test scores.

In the same table (Table 2), results showed that after the instruction the experimental group obtained a transmuted grade of 86 qualitatively described as *Very Satisfactory* while the control group garnered a transmuted grade of 80 which qualitatively described as *Satisfactory.*

It can be observed that there are significant increases of scores from both experimental group and control group. This means that both groups learned from the instruction given to them. However, the increase of mean score in the experimental group is comparatively greater compared with that of the control group. Apparently, it means that students exposed to Graphic Organizer aided instruction and Graphic Organizer Guided Activities gained more skill and understand well the algorithmic concepts. These findings agreed with the study conducted by Hafid, et al (2014) that Graphic Organizer is a tool which helps students better understands Physics and Chemistry ideas. Furthermore, the results supported the findings of Byun (2014) that

Graphic Organizer improved the learning motivation, comprehension, and idea organization leading to mastery of content and concepts which in effect increase academic performance. Hence, the control group must be exposed to Graphic Organizer aided instruction and Graphic Organizer guided activities rather than just merely traditional or usual practice instruction and lesson activities.

3.2 Difference in the Participants' Pre-Test and Post-Test Scores in Physical Science

Table 3 displays the significant improvement of the participants' post-tests in Physical Science.

Table 3: *T-test for dependent of Scores in Physical Science*

Group	**t**	**df**	**ρ-value**	**Decision**	**Interpretation**
Experimental	-14.95	19	.0000*	Reject H_o	Significant
Control	-10.42	19	.0000*	Reject H_o	Significant

*** ρ < .05 = significant**

Table 3 reveals the significant improvement of participants' posttests in Physical Science. Results obtained showed that the ρ-values both for control group and experimental group are less than 0.05 hence; there is significant difference between pretest scores and posttest scores which led to the rejection of the null hypothesis. These indicate that both groups gained learning from the two methods of instruction given to them.

Considering the t-values at 19 degrees of freedom (Experimental group: t=14.95, Control group: t=10.42), the participants of experimental group have shown remarkable improvement in their posttest scores. Thus imply, that Graphic Organizer as a tool of instruction in teaching Physical Science is reasonably effective to increase academic performance of learners which is in agreement to the study of Alderete (2012) and Bennete (2012) claiming that Graphic Organizers facilitate and improve learning outcomes.

3.3 Effectiveness of Graphic Organizer Aided Instruction Compared to the Traditional Way of Teaching Physical Science

Depicted in Table 4 is the academic achievement of the two groups exposed to Traditional/usual method of instruction (control group) and Graphic Organizer aided instruction with guided activities (experimental group).

Table 4: *T-Test for Independent of Scores in Physical Science*

Tests	**t**	**df**	**ρ-value**	**Decision**	**Interpretation**
Pretest	.049	38	.9	Do not reject H_o	Not significant
Post Test	-4.24	38	.0001*	Reject H_o	Significant

* $\rho < .05$ = significant

Table above reveals the ρ-values of the pretest scores and posttest scores between control group and experimental group. The pretest depicts a ρ-value of 0.9 which is greater than .05. This implies a non-significant difference which led to the acceptance of null hypothesis. It can be interpreted that both groups have comparable knowledge in Physical Science prior to instruction.

Further, the ρ-value of posttest which is .0001 is much lesser than .05 which indicates a highly significant difference between control group and experimental group's post-test scores. The result then showed that the Graphic Organizer aided instruction with Graphic Organizer guided activities is more effective than the traditional way of teaching Physical Science. It was observed that the participants of the experimental group were more motivated and enticed to actively do the guided activities than in the control group. This may be the reason why they easily mastered the concepts and topic contents. True enough as attested by Tigere (2014), that solving algorithmic problems in Physical Science needs motivating activities. These graphic organizers' aided instruction and activities have organized the connection of concepts and solving steps that may enabled the learners find it easier to solve mathematical related problems in Physical Science. As a result, academic performance becomes highly significant. But this does not mean that the participants of control group which were exposed to traditional or usual way of instruction were not learning enough. Maybe the way that the activities in traditional method were presented did not bridge the gap they need in connecting the concepts to the solving process.

4. Conclusions

Graphic Organizer as learning tool in teaching Physical Science has essentially improved the capability of learners in understanding algorithmic concepts and motivated them to solve problems through guided activities. Significant level of understanding on the conceptual facts using the visual presentation during the discussion was observed through graphic organizer technique. The organizer also guided the students on how to attack mathematically related

concepts (facts connection to solving process) resulting to a positive attitude towards solving problems as shown in their improved quantitative analysis.

Teaching Physical Science, specifically the chemistry and physics concepts tackled in this study, became more effective with the use of visual presentation through Graphic Organizer as learning tool than just the traditional method. In consequence, the academic achievements of learners in experimental group were significantly better.

5. Recommendations

In the light of the findings, conclusions and significance of the study, the following recommendations are given:

i. Teachers teaching Physical Science are encouraged to adapt and apply Graphic Organizer aided instruction especially to mathematically related topics in order to organized conceptual facts and visually relate those with solving processes. Since, learners improved well when they are engaged in graphic organizer guided activities, teachers may also design their own graphic organizer guided activities suited for their learners.

ii. As observed, Graphic organizer may have developed positive attitude towards learning, hence, there was improved academic achievements of learners. It is recommended that school administrators should support for the maximum use of Graphic Organizer as learning tool in the teaching-leaning process by facilitating seminar-workshops.

iii. The students are encouraged to participate actively in any graphic organizer guided activities and construct their own styles of graphic to visually present and organize ideas for a deeper mastery of the given topics.

iv. More intensive researches are encouraged to explore greater advantages and usage of Graphic Organizer as learning tool in varied fields. Explicitly, construct guided activities which are more effective for a specific field to address learners' academic performance issues.

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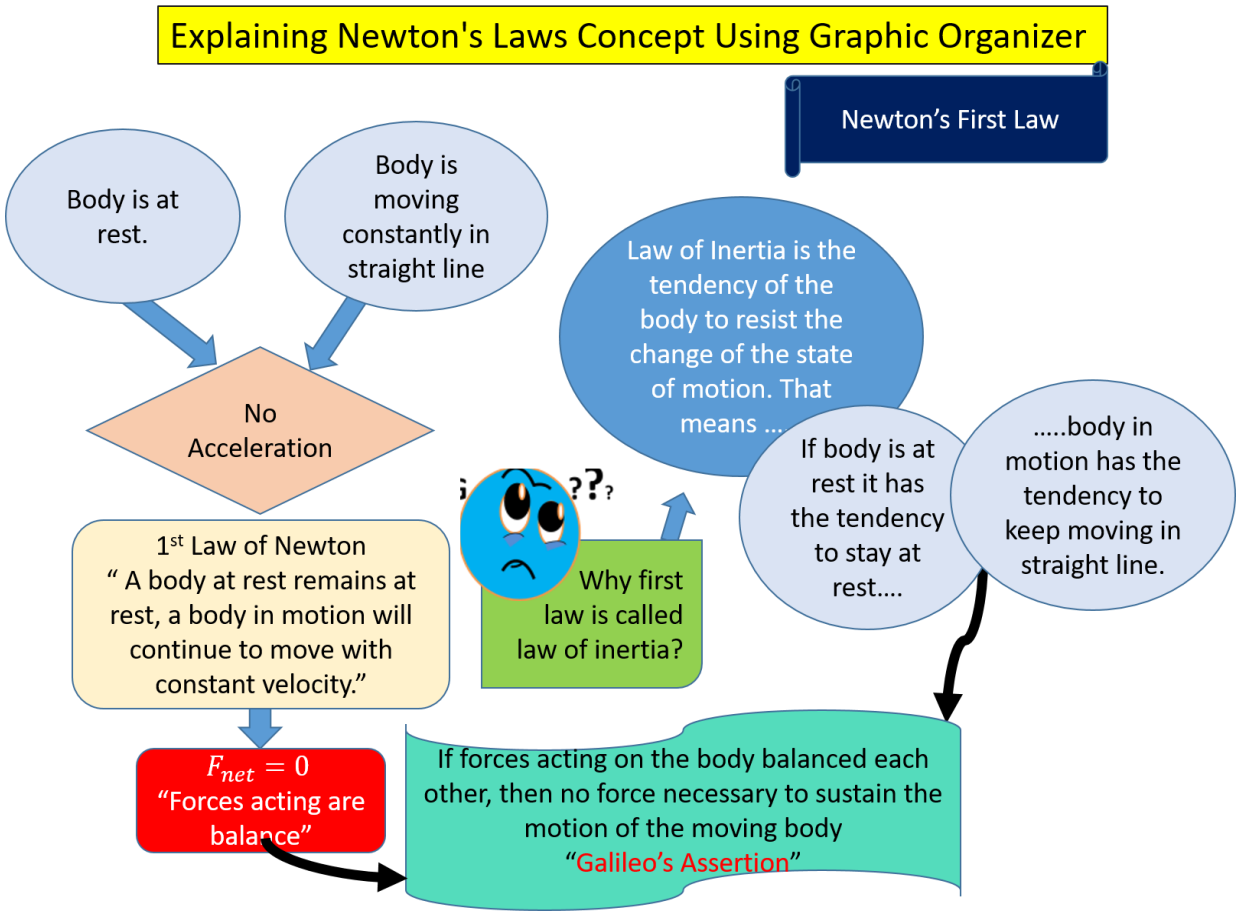
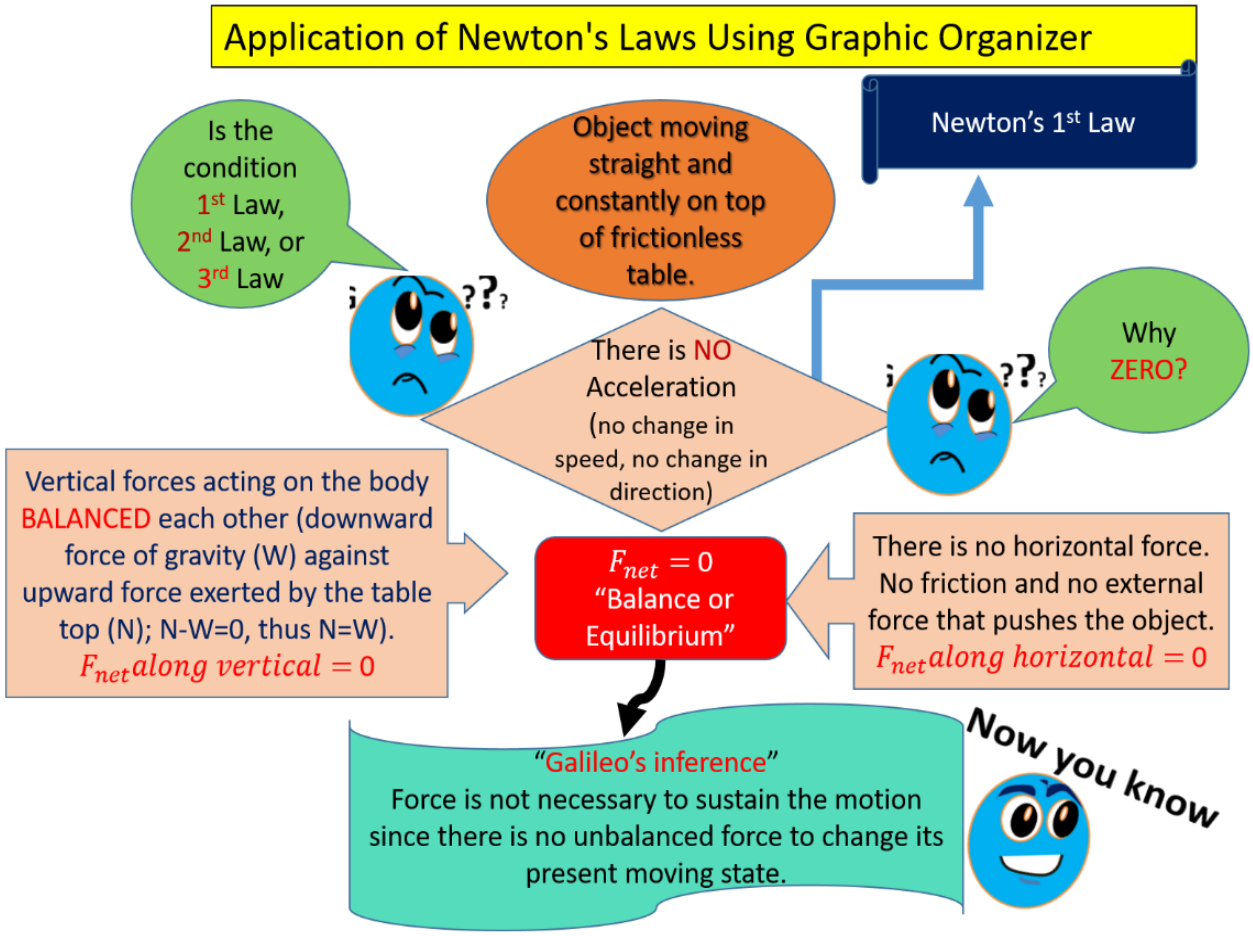
APPENDIX

Sample Graphic Organizer in Newton's 1st Law




Application of Newton's Laws Using Graphic Organizer
Newton's 1st Law
Is the condition 1st Law, 2nd Law, or 3rd Law
Object moving straight and constantly on top of frictionless table.
There is NO Acceleration (no change in speed, no change in direction)
Why ZERO?
Vertical forces acting on the body BALANCED each other (downward force of gravity (W) against upward force exerted by the table top (N); N-W=0, thus N=W).
$F_{net}along\ vertical = 0$
$F_{net} = 0$ "Balance or Equilibrium"
There is no horizontal force. No friction and no external force that pushes the object.
$F_{net}along\ horizontal = 0$
"Galileo's inference"
Force is not necessary to sustain the motion since there is no unbalanced force to change its present moving state.
Now you know