Merging Graphic Organizer in 7Es Model to Enhance Online Learning

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Research Article

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Abstract

The startling shift in the teaching and learning approach due to the COVID-19 pandemic also redirected the researcher's focus on effective pedagogy. Thus, this study merged the Know, Wonder, and Learn (KWL) graphic organizer and 7Es models to develop a learning material for online classes. The model's cognitive origin and constructivist implications inspired material development. This learning intervention material was implemented online and tested using a pretest-posttest design. Statistical results proved this intervention's effectiveness by improving the students' conceptual understanding of force and motion concepts, $t = 3.53$, $p = 0.001$. Further investigation was conducted to determine the variances of performance among students. Results showed that the learning intervention, aside from positively affecting the student's learning gains, implies a more significant impact on the initially low-performing students.

Rationale/introduction

Although blended learning has already started in many schools, the unforeseen epidemic still affects most teachers stuck with the old way of teaching (Dhawan, 2020). The COVID-19 pandemic opens research opportunities on pedagogical approaches which are assumed to be effective in online learning. This startling shift left teachers with no option except to embrace the online teaching-learning platform overnight. Moreover, academic units are still struggling to find a solution to this challenging situation.

The uncertainty of returning to the old face-to-face classroom learning prompted this present study to merge Graphics Organizer Technique (GOT) in Seven-Cycle Learning Strategies (7E) to be delivered using online platforms.

Research studies have proven the validity of using the 7Es cycle in the students' cognitive achievement (Jasim, Khattab, and Ashour, 2019) and learning retention (Abdullahi et al., 2021; Villacrusis & Beloy, 2021). The said learning cycles were followed in creating "what I KNOW," "what I WANT to know," and "what I LEARNED" or KWL template in the development of Graphic Organizer materials. This teaching and learning tool integrates texts and visuals to show concepts' relationships and connections (Athuraliya, 2021).

However, the onset of the pandemic gave the additional challenge in delivering the said developed GOT in 7E online. To address the said problem, the researcher opted to create 7E GOT in PowerPoint and video presentations uploaded in google classroom and using a licensed Moodle learning app for the implementation and assessment stage of the study.

Review Of Literature

Research shows that the educational system is adjusting and coping with the demands of online learning brought about by the COVID-19 pandemic. Online learning is a learning experience using devices connected to the internet in a synchronous or asynchronous environment. Accordingly, the learner does not have to be in school to learn and interact with the teacher or other students (Singh & Thurman, 2019). This situation forced academic institutions to make urgent scenario planning to cope with the sudden shift of this learning mode (Rieley, 2020). One way of coping with up is the development of instructional materials and investigating different instructional learning techniques that can be delivered online.

Graphic Organizer Technique (GOT)

Throughout the years, educators and psychologists have produced a variety of ideas and contemporary perspectives, such as Schema Theory and Expertise Theory. These influenced the graphic organizer method of knowledge representation (Sandoval, 2020). A graphic organizer is a teaching and learning tool to organize information and ideas for easy understanding and internalization. It involves the integration of organized text and visuals to show relationships and connections between concepts (Athuraliya, 2021).

A study by Vasquez (2018) shows that graphic organizers set a clear learning goal in which the students can understand the text and assess their improvement. It also helps learners engage in critical and creative thinking (Tandog & Bucayong, 2019). These mind exercises have long been known to be essential for academic achievements. Integrating such techniques made Education in the 21st century learning more enjoyable (Swoosh, 2013).

Sandoval (2020) said that Graphic organizers serve as mental representations of acquired and read knowledge. He added that students who used concept map graphic organizers represent knowledge via semantic connections, whereas students who utilized graphic disciplinary organizers organized information according to crucial theories.

The Graphic organizer used in this study is the KWL (Athuraliya, 2021) in visual presentations. The presentation started with students' prior knowledge or experience to capture what they already knew. The prior knowledge stage was followed by a series of visuals and art of questioning to ignite their curiosity to learn. Then, the lesson ended by answering questions asked along the process.

7Es Model

Studies have been conducted on constructivist instruction and reported the effectiveness of the 7E model on student learning (Adak et al., 2017). This model follows an inquiry approach in a learning cycle. The inquiry method allows the learners to investigate the scientific knowledge using science process skills and to acquire self-learning information based on constructivist theory (Jati & Slamet, 2017)

Formerly, these learning cycles consisted of only three steps; surveying, introducing a keyword or building concept, and applying the concept. These three steps were then adapted, and with the inclusion of the "learning presentation" stage, it became the 4E model. Later, it was improved to the 5E learning approach when a "prior knowledge" check was deemed necessary. Lastly, examining prior knowledge and applying knowledge steps finalized the 7E learning model (Eisenkraft, 2003). This new model emphasizes knowledge transfer by following a proper sequence; "elicit" stage before "engage" and "extend" stage after "evaluate" (Bybee, 2014)

Utilization of this 7 Es learning cycle enables the students to construct their ideas through familiarization and then its application as an authentic experience (Turgut, et al., 2016).

Merging GOT in 7Es for Online Learning

Physics has always been regarded as a difficult subject. Unfortunately, this common notion resulted in the student's lack of interest in Physics classes and courses. Therefore, it is a challenge for every Physics teacher to provide a learning environment that wards this misconception off.

Although a lot of studies, including physics subjects, have already attested that Graphics Organizer and the 7 Es learning cycle model increase the conceptual understanding and address the misconceptions as well (Athuraliya, 2021; Naade, et al., 2018; Adak, 2017; Turgut, et.al, 2017; Abdullahi et al., 2021; Villacrusis & Beloy, 2021), but the merging of these pedagogical instructions to be implemented online is novel. Based on literature reviews, the researcher did not find any similar studies.

In this study, the merging of these two teaching and learning models was inspired by their cognitive origins and constructivist implications. Graphic Organizers find their origin in the cognitive theories of learning (Alshatti, Watters, & Kidman, 2011). Cognitive theorists presumed that learners best learn in an organized and predictable process. Moreover, constructivists' backgrounds in the cognitive and developmental theorists believe in the learner's ability to construct new knowledge from their existing and prior knowledge (Elliott, Kratochwill, Littlefield Cook, & Travers, 2000).

Similarly, the 7 Es model has its root in the constructivist approach. Every step in the said model emphasizes the importance of the learner's prior knowledge (Balım, Türkoğuz, Aydın, & Evrekli, 2008). Balim et al. concluded their study by stating that lesson presentations should be organized appropriately to eliminate misconceptions that influence the construction of new knowledge. This idea has a similar bearing on the KWL Graphic Organizer. Specifically, utilizing the Graphic Organizer Technique (GOT) as a visual tool to brainstorm and organize information is essential in formulating inquiry-based learning cycles. This technique and process helped students study subjects regarded as complex or subject matter that requires an analytical approach, according to Tandog (2019). Thus, the researcher was prompted to pursue merging Graphic Organizer materials in a 7Es learning model.

Graphic Organizers can now be created with the help of mobile applications, computer software, and websites. However, implementing GOT in 7 Es material faced challenging problems due to the Covid-19 pandemic. In addition, most students prefer conventional learning over virtual classes for several reasons (Sarkar, et al., 2021). Namely, the problem in accessing synchronous classes, the type of device used (mobile versus laptop), and the homeplace's location (urban/rural). As a result, students are forced to continue online classes, having left with no choice but to advance their studies.

Hence in this study, the researcher created GOT 7Es in PowerPoint and uploaded videos to google classrooms. The pretest and posttest were implemented using Moodle app asynchronous but with a time limiter. This implementation method for intervention and the assessment of conceptual understanding addresses problems such as difficulty in synchronous learning, connectivity issues, and the type of devices used for online learning.

Objectives

This study envisioned developing teaching and learning material that can be effectively used for online learning. Specifically, the study aims to:

1. Develop graphic organizer material in Force and Motion topics.
2. Merge graphic organizer technique and 7Es learning model (GOT in 7Es).
3. Implement the GOT in 7Es via online learning.
4. Determine the effectiveness of the developed learning material in the students' conceptual understanding of Force and Motion topics.
5. Determine how the intervention affects the learning performances among students.

Procedure/methodology

The study employed a pretest, posttest quasi-experimental design. The study sample comprises 74 college students from two Mechanics and Heat classes. The said classes were purposively chosen based on their prior knowledge comparability.

Validation of Instrument

The instrument used to measure conceptual understanding is the adapted Force and Motion Conceptual Evaluation Original (FMCE v98) (Thornton, R. and Sokoloff, D., 1998). FMCE v98 is a multiple-choice test composed of 47 questions to assess mechanics content knowledge. Specifically, the original version consists of three clusters: Newton's 1st and 2nd Laws (including acceleration), Newton's 3rd law, and the velocity concept. This instrument has been used for many types of research with College and High School level respondents. The instrument received a gold validation level based on the following standard: formulation of questions was student thinking research-based, passed the expert reviews, appropriate statistical analysis employed, conducted to multiple research groups and with peer-reviewed publication (Madsen, A. McKagan, S., Sayre, E., 2021).

However, respondents for the development and testing of FMCE were non-Filipino students. Cultural differences, educational standards, and other relevant factors may be considered to adapt the instrument. Thus, FMCE was then pilot tested on 121 students of Central Mindanao University who have already taken Mechanics topic in their physics subject. Data were then subjected to statistical analysis to determine their reliability. Results showed that Cronbach's alpha for the pilot tested FMCE is only 0.405. This statistical output prompted the researcher to conduct item analysis to determine which items needed revisions or were automatically discarded. Only four (4) items must be eliminated because of the corresponding negative discriminating factor, and 12 items need modifications. However, the researcher opted to eliminate all 16 items (discard and revise) because the remaining 31 items could still represent the clustering of topics according to the study of Smith and Wittman (2007). Accordingly, the original test questions were grouped into clusters based on a physicist's view of the content area without regard to why students chose incorrect answers. The new clustering allows categorization focusing on the latter. This categorization and the corresponding number of items retained are the following; Force Sled (4 items), Reversing Direction (5 items), Force Graphs (4 items), Acceleration Graphs (4 items), 3rd Law of Newton (6 items), Velocity Graphs (4 items), and Energy (4 items). Performing the statistical analysis after the 16 items were deleted has raised Cronbach's alpha from 0.405 to 0.529. This result does not guarantee an internal consistency of the items. However, the following justifications may suffice to reconsider this adapted instrument tested in the local setting. First, the increase of alpha is partially dependent upon the number of test items in the scale, and in this study, the modified FMCE items were reduced, yet the alpha was increased by 0.124. Second, the remaining items sufficiently balanced the needed clustering of topics (Smith and Wittman 2007). Third, the new normal setup of our educational system may also be a contributing factor. Fourth, the focus of the study is the development and testing of the intervention, not standardizing an instrument for local research. Thus, the researcher opted to use the modified FMCE instrument for the conceptual assessment of this study

Development of Learning Intervention

The merging of the Graphic Organizer and 7Es learning cycle was based on their cognitive origins and constructivist implications. Specifically, the KWL method in Graphics Organizer has similar implications in the 7Es stages. Thus, the researcher followed the 7Es stages in developing learning materials on force and motion topics. Each category of the FMCE comprises one complete cycle of this model. For example, only the 3rd law of Newton's topic was taken from the engaging stage up to extend stage. The KWL part was embedded in the stages by providing a series of visuals and art of questioning to assess the prior and acquired knowledge which is fundamental in a constructivist approach. The said approach is a common ground for both models.

Implementation of the Learning Intervention

The sample of this study consists of a control group with 31students and an experimental group with 43 students; both were taking mechanics topic. These students had a comparable background in force and motion topics in physics.

Initially, learning materials were converted into PowerPoint and video presentations, then uploaded to Google Classroom. The developed learning material was presented online to the experimental group of respondents in an asynchronous approach. The students were requested to sign the non-disclosure agreement to ensure no breach of the learning materials intended solely for the experimental group. The control group continued to be under a typical online class due to the Covid19 pandemic.

Before implementing the learning intervention, control and experimental groups were given the modified FMCE instrument to assess their prior knowledge. This was done through the Moodle app to ensure that students took the exam within the prescribed schedule and prevented from taking it beyond its allotted time. After the learning intervention was given to the experimental group, the posttest followed with all respondents using the same instrument and mode of assessment.

Results & Discussions

The Intervention Material - Graphics Organizer in 7Es

Figure 1 shows an example of the "Explain" stage in the 7Es learning model presented in Graphics Organizer, specifically the "what I WANT to know" part in KWL. Following the constructivist approach, the visual presentation of lessons was properly organized to eliminate possible misconceptions which may lead to the faulty construction of new knowledge.

Another excerpt of the intervention material is given in Fig. 2, specifically, the Extend Stage for 7Es. The graphics KWL part was embedded in this stage by providing a series of visuals and art of questioning to assess the prior and acquired knowledge as presented in the previous stages of the 7Es model. The art of questioning is fundamental in the constructivism approach.

Testing the effectiveness of Graphic Organizer in 7Es

To test the intervention material's effectiveness, modified FMCE was administered pretest and posttest for experimental and control groups. The control group comprised 31 students, the experimental group with 43 students, and a total number of 74 students. The descriptive statistics are shown in Table 1. Both groups got zero minimum scores out of 31 possible perfect scores in the pretest. Comparable scores are also evident in the minimum values for both groups, but a considerable value of change in the maximum posttest score for the experimental group. Although the experimental group has the greatest mean (10.87), it also incurred the most significant variance of 4.43 against 1.97 in the control group. The nearly doubled variance during the posttest in the experimental group was caused by the more extensive spread of scores about its mean. This result can be verified by comparing the differences between both groups' minimum and maximum posttest scores.

Table 1
Descriptive statistics of the respondents

	Groups	Mean	SD	Min.	Max.	N
Pretest	Control	5.74	2.22	0	10	31
	Experimental	6.33	2.74	0	12	43
Posttest	Control	7.74	1.97	4	12	31
	Experimental	10.87	4.43	3	24	43

With the given descriptive statistics in Table 1, the researcher opted to check the assumption for covariant. Levene's equality test was conducted to test if the posttest variable was equal across groups. The result is significant ($F = 16.6$, $p < 0.05$), which indicates that the assumption of homogeneity of variances has been violated. However, since cell sizes are not far enough (31, 43) to cause a big problem, the result may not be affected using the robust ANCOVA analysis, according to Leech et al. (2005).

ANOVA analysis was also conducted using the groups as the independent variable and pretest as the dependent variable. The analysis assessed whether pretests were not statistically different between control and experimental groups. The result is shown in Table 2. The obtained value of $p = 0.324$ is not significantly different ($F = 0.99$, $p > 0.05$, $df = 1$), which means the pretests for both groups were comparable.

Table 2
Test of between-subject effects with pretest as the dependent variable.

Source	df	F	p-value	Interpretation
Groups	1	0.99	0.324	Not significant

Another checking for the assumption of covariant was the Homogeneity of Regression test. With posttest as the dependent variable and pretest as the covariate, the result is shown in Table 3. The p-value of 0.442 was obtained ($F = 0.59$, $p > 0.05$, $df = 1$), which means that the difference is not statistically significant. The result implies that the covariate and factor do not interact, or there was no interaction between the pretest and the groups. The data meet the homogeneity of the regression condition.

Table 3
Test of between-subject effects with pretest as a covariate.

Source	df	F	p-value	Interpretation
Groups*Pretest	1	0.59	0.442	Not significant

After confirming all necessary assumptions for covariant, ANCOVA was conducted. The said analysis is used to assess whether a significant difference will be observed between control and experimental groups after controlling the effects of the pretest scores. Table 4 shows the means and standard deviations for both groups on posttest scores before (unadjusted) and after (adjusted) controlling pretest scores. The adjusted mean values have changed compared to those found in the descriptive statistics (unadjusted), as shown in the data.

Table 4
Adjusted and unadjusted means of groups and variability for posttest using pretest as a covariate.

	N	Unadjusted		Adjusted	
		Mean	**SD**	**Mean**	**SE**
Control	31	7.74	1.96	7.85	0.61
Experimental	43	11.21	4.22	11.13	0.52

The result for the covariance analysis is given in Table 5, indicating that after controlling pretest scores, there is a statistically significant difference between adjusted means. Specifically, there is a significant difference between the groups, $F(1, 72) = 16.55$, $p < 0.05$).

Table 5
Analysis of covariance for posttest using pretest as a covariate.

	df	F	p-value	Interpretation
Pretest	1	4.52	0.037	Not significant
Groups	1	16.85	0.000	Significant
Error	72			

However, the analysis of variance only implied a significant difference in the overall behavior between groups. Therefore, to further investigate the significant differences within and across groups, an independent t-test was conducted. The result is shown in Table 6. Consistent with the ANOVA analysis in Table 3, the pretests between groups were not significantly different, $t = 0.92$, $p = 0.362$, which means that none between the two groups performed better in the pretest. However, posttests revealed more excellent evidence of a significant difference between groups, as shown in $t = 4.72$ and $p < 0.05$ values. In addition, computing the differences in their absolute gains, the t-test result showed that the experimental group is significantly higher than the control group, $t = 3.53$, $p = 0.001$.

The result agrees with the results of previous studies (Athuraliya, 2021; Naade, Alamina & Okwelle, 2018; Adak, 2017; Turgut, U., A. Colak, and R. Salar, 2017; Abdullahi et al., 2021; Villacrusis & Beloy, 2021; Oginni, O. I., 2021), which attest the positive impact on the learning outcomes using graphic organizers in visual presentations and also the 7Es model.

Table 6
Independent t-test comparing experimental and control groups in various tests.

Test Scores	F-value	t-value	df	p-value	Interpretation
Pretests	2.55	0.92	71.18	0.362	Not significant
Posttests	17.8	4.72	63.06	0.000	Significant
Gain	5.6	3.53	68.96	0.001	Significant

Statistical analysis revealed that graphic organizer in 7Es as a teaching and learning intervention significantly affects the students' conceptual understanding. A graphical presentation is given in Fig. 3 illustrating the pre-post scores between control and experimental groups for a clearer picture.

The left end of the line labeled as one (1) represents the scores in the pretest, while the right end labeled two (2) represents the corresponding scores in the posttest. The bold weighty red lines denote the average formed by respective groups. The steeper the line implies a more significant difference in their pre-post assessments. A positive slope indicates a student's learning gain; a negative value denotes otherwise. Almost everybody in the experimental group has a positive slope, as shown in the lines, including the average red bold line. The figure shows that the experimental group has the most significant line slope on average, which means that students in the experimental group perform better in their posttest.

To investigate further if the students who scored highly in the pretest would very likely score higher in the posttest, the scatter plot is shown in Fig. 4. The "Control Low" consisted of the control group of students who had obtained pretest scores below the means. Otherwise, they belong to the "control high" classification. The same grouping applies to the experimental students to group them accordingly.

Comparing gains between high and low within groups, as shown in Fig. 2, students who got lower in pretests achieved the more significant gains. Same for the experimental students, wherein the highest gainer is the low pretest performing group. An independent t-test was conducted to compare gains between high and low within groups to determine if the differences were significant. The result is shown in Table 7. There is a statistically significant difference between gains of the low and high students in the experimental group, $t = 2.78$, $p = 0.009$. Whereas no significant difference in gains between low and high pretest performing students in the control group, $t = 1.34$, $p = 0.193$.

Table 7
Independent t-test of Gains between "Low Pretest" vs. "High Pretest" within groups.

	t-value	p-value	Interpretation
Experimental	2.78	0.009	significant
Control	1.34	0.193	not significant

The t-test result in Table 7 implies that the teaching and learning material greatly affects the initially low-performing students. This claim can be refuted by reasoning that gains may be lower for the high-performing group due to their initially high scores in the pretest. However, the former claim can be verified by comparing the result with the control group. Since statistical analysis reveals that the new-normal online learning approach did not significantly affect low and high pretest-performing students, the intervention material made the difference as claimed.

Conclusion(S)

The study has developed learning intervention material that can help improve students' conceptual understanding and be implemented on an online platform. The merging of the Graphic organizer in the 7Es model as a learning intervention was inspired by the model's cognitive origins and implications.

The developed material was implemented and tested on the students via online classes. Statistical test results proved a positive impact on the students' conceptual understanding. Furthermore, an assessment was also conducted on the effects of this learning intervention on the students' performance within and across groups. The result shows that this intervention did not only help improve the students' conceptual understanding but also implies a more significant impact on the initially low-performing students.

Recommendation(S)

The study implies a positive effect of learning intervention on the students' conceptual understanding even in online learning. The researcher recommends that the merging of graphics in the 7Es approach be adapted to other topics in physics and maybe in other subjects.

In addition, further investigation may be conducted to assess the correlation effect of the said approach between initially low performing students vs. high performing students during the pretest.

Declarations

Ethical Statement:

This article does not contain any studies with animals performed by the author. All procedures performed in studies involving human participants followed the ethical standards of the institutional research committee.

Consent Statement:

Consent was obtained from all individual participants included in this study.

Disclosure of Potential Conflict of interest

No conflicts of interest are directly or indirectly related to this work.

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Figures

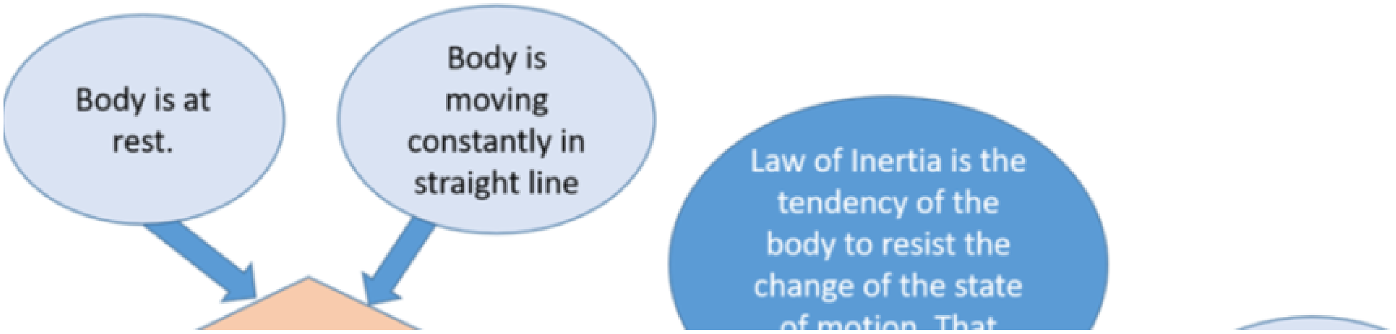

Figure 1

Sample "Explain Stage" of the Intervention Material

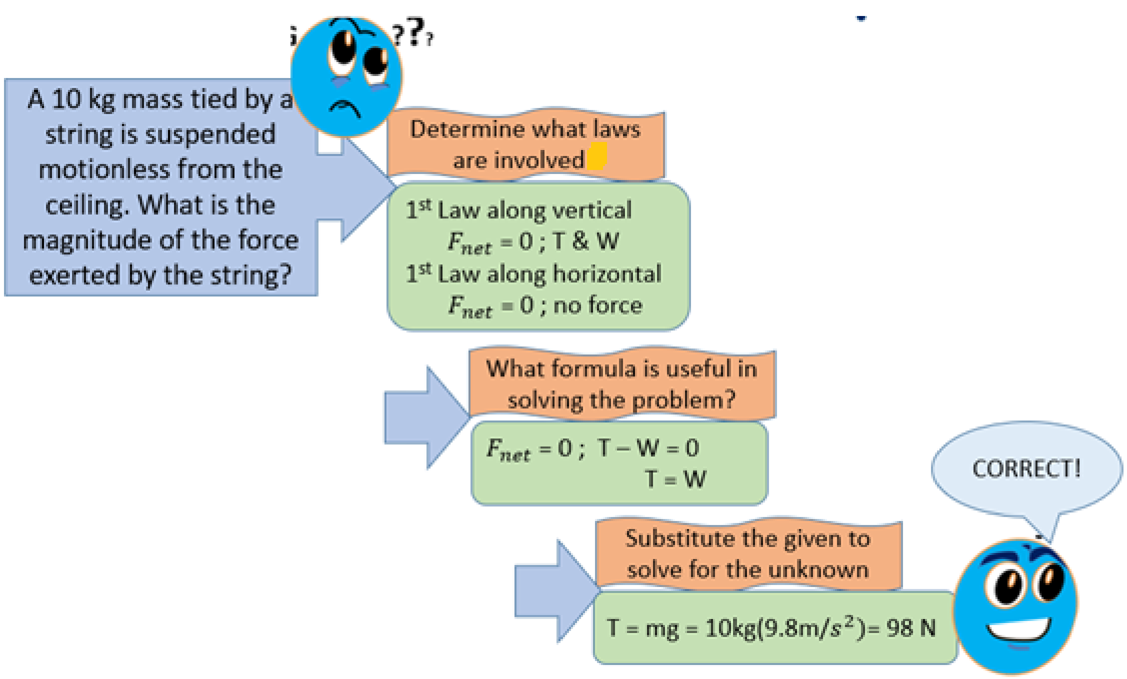

Figure 2

Sample "Extend Stage" of the Intervention Material

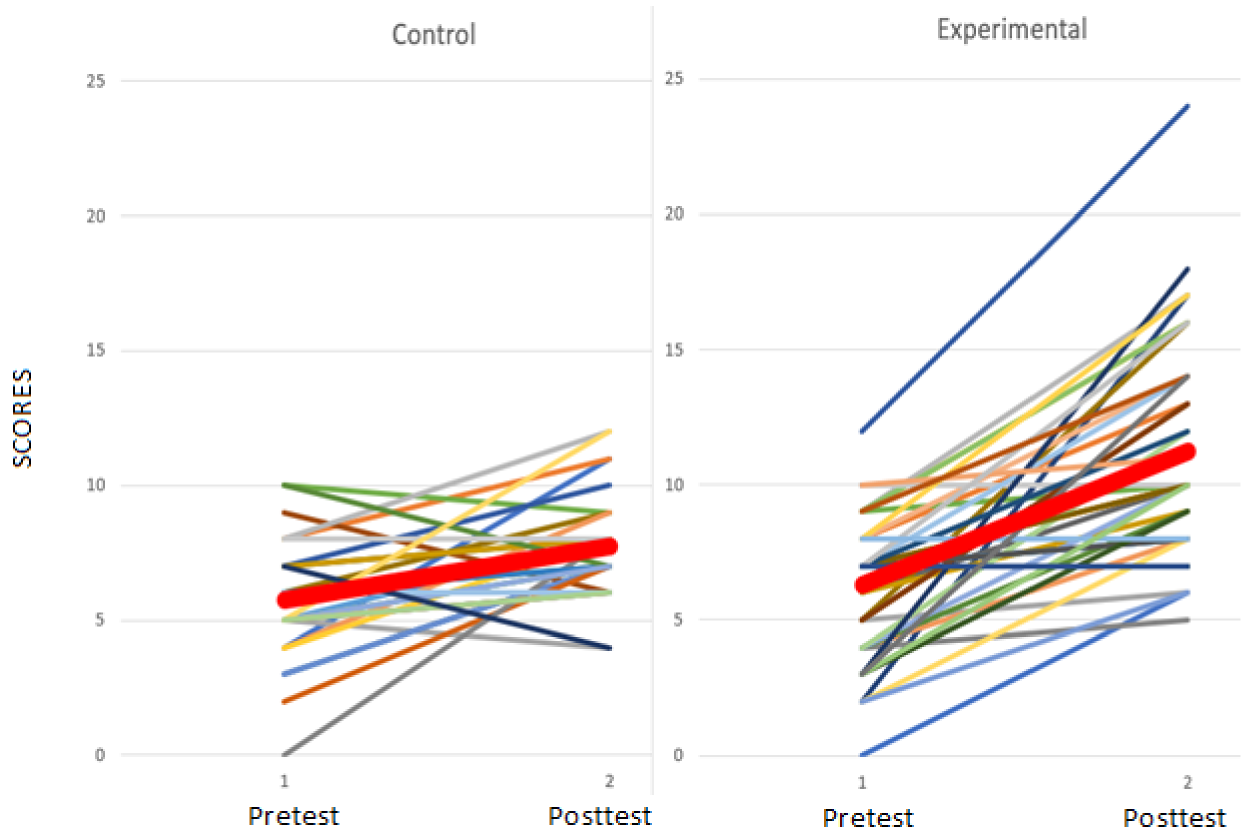

Figure 3

Lines representing the student's pretest (starting 1) and posttest (ending 2) between groups.

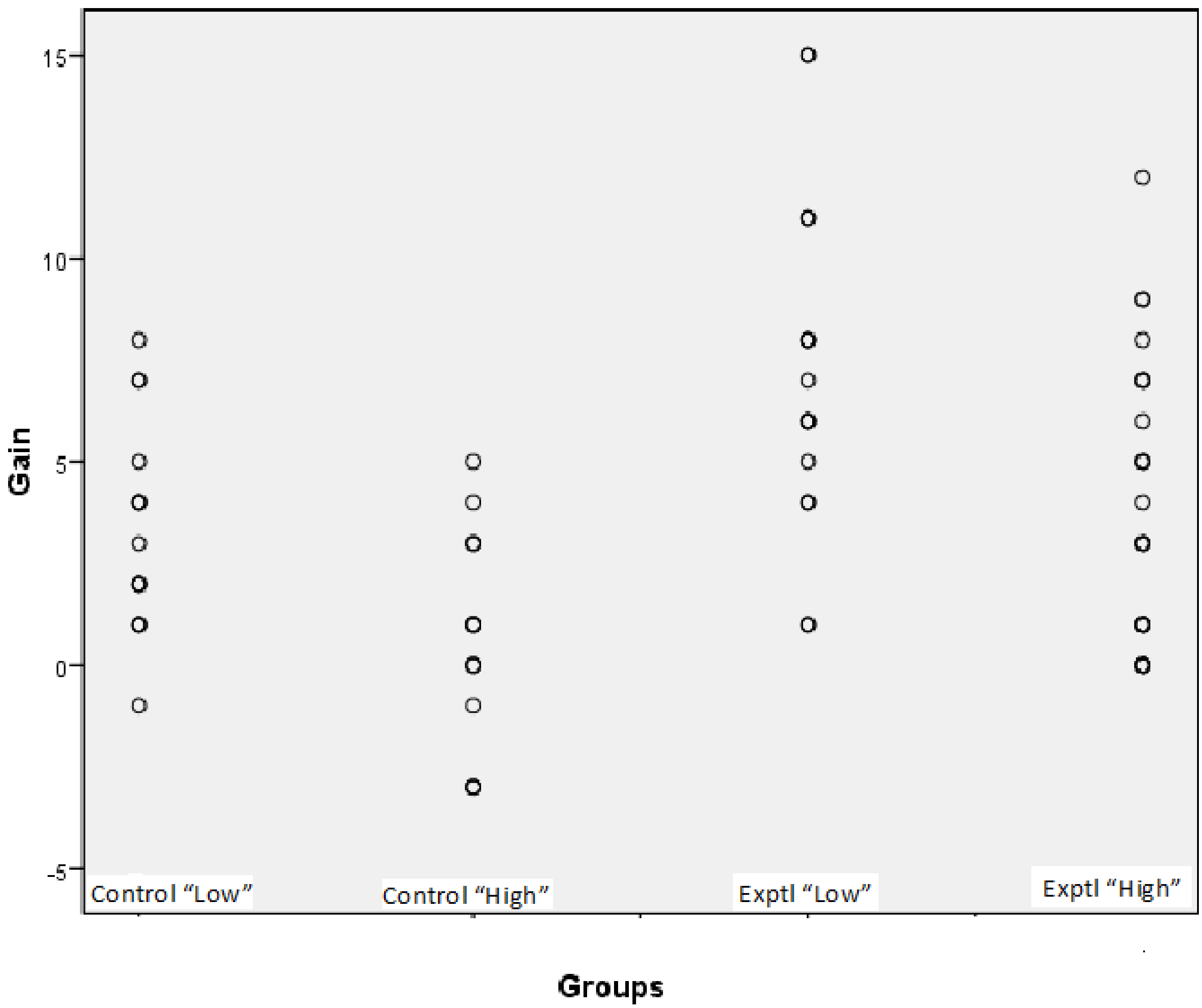

Figure 4

Gain vs. Groups of control (low, high) and experimental (low, high)