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THE RELATIVE EFFECTS OF AUSUBELIAN AND GAGNEAN SEQUENCE OF PHYSICS INSTRUCTION ON STUDENT PERFORMANCE

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ABSTRACT

This study aims at assessing the relative effects of Ausubelian and Gagnean sequences on student performance in the teaching/learning of 'pressure'. Performance was assessed in terms of student's ability to comprehend as well as apply the concept taught.

120 out of 160 JSS 3 students in four intact classes were randomly selected from a school in Ibadan municipality of Oyo State and used for the study. Two experimental and two corresponding control groups, each having 30 subjects, were used. Assignment of the intact classes to experimental and control groups was done randomly. While the two experimental groups were taught the concept of pressure based on Ausubelian sequence, the control groups were exposed to Gagnean sequence. A period of two weeks was used for the treatment.

The result obtained showed no significant difference between the experimental and control groups with regards to the two dependent variables considered. This was interpreted to mean that hierarchical structuring of learning materials is more crucial than the direction of hierarchy itself. Based on this finding, some recommendations were made.

INTRODUCTION

Science has, almost indisputably, been accepted now as a human enterprise and thus subject to human frailties. This recent view is contrary to the ''ancient'' ones where scientific laws, theories and generalization were regarded as incontrovertible and absolute. As a human enterprise, therefore, the sequence of presentation has a tendency of influencing the degree to which scientific knowledge could be acquired, comprehended and applied.

This study was therefore concerned with the investigation of the relative influences of methodology of teaching the concept of pressure on student ability to comprehend as well as apply the concept.

Ausubel's Learning Theory:

Ausubel has primarily been concerned with meaningful verbal learning. Meaningful learning is said to occur only when the new material to be learnt is incorporated into a learner's cognitive structure by an available appropriate subsumer or an advanced organizer, in the absence of appropriate subsumer (Ausubel, 1960; and Asusubel and Robbinson, 1973). Moreover, Ausubel emphasizes that the cognitive structure is hierarchically organized and that learning materials should be structured such that a more inclusive concept subsumes a less inclusive one. In other words, learning should proceed from the most inclusive concepts to the least inclusive ones.

Gagne's Learning Theory:

This theory is rooted in task analysis of concept to be learnt. According to Frazer and Maskill (1979), the key question to be asked always in Gagne's task analysis is ''what must the learner be able to do in order to achieve what is required, given only simple instruction''? The same question could be asked for each of the pre-requisite skills until eventually a level of task is arrived at which can be taken as already present in the learner's repertoire of knowledge.

One fundamental similarity between Ausubelian and Gagnean sequences is that in both, hierarchical structure of learning material is emphasized. However, while the former sequence recommends learning to start from the more inclusive to a less inclusive concept, Gagnean sequence suggests the reverse.

Empirically, highly structured learning materials have been found better acquired and comprehended than the poorly or traditionally structured ones (Trindade, 1972; Browne and Anderson, 1974; and Anderson and Lee, 1975). Some Ausubelian researchers have acknowledged relative superiority of Ausubelian sequence over traditional, especially in problem - solving in science (Shavelson, 1972; Novak, 1977; and Ausubel and Novak, 1978). Other researchers have not found any difference, especially in cognitive achievement (Moreira, 1978; Abraham and Renner, 1983). In all these researches, the traditional approach referred to was similar to Gagnean approach used in this study.

Most of the previous studies in this respect have been in areas of science other than physics. Moreover no indigenous study has probably been carried out to unveil the relative impacts of Ausubelian and Gagnean sequences with respect to understanding, comprehension and application of physics concepts in Nigeria schools.

Research Questions

The study aims at answering the following questions:

1. will there be any difference between students taught with Ausubelian sequence and those taught with Gagnean sequence in the ability to comprehend the concept of pressure?
2. Are students taught with Ausubelian sequence different from those taught with Gagnean sequence in the ability to apply the concept of pressure?

Based on the above research questions, the following null hypothesis were tested.

Hypothesis 1 ($H_0$1)

There will be no significant difference between students taught with Ausubelian sequence and those taught with Gagnean sequence with respect to ability to comprehend the concept taught.

Hypothesis 2 ($H_0$2)

There will be no significant difference in terms of ability to apply the concept of pressure, between students taught using Ausubelian sequence and those taught with Gagnean sequence.

Sample and Research Design

All subjects were drawn from a single school in Ibadan municipality of Oyo State. Subjects were expected to have no knowledge of the concept of pressure and the school was expected to have a poorly equipped physics laboratory. Out of the 160 JSS 3 students in the four sections of the class, 120 were randomly selected, 30 from each section. The random sampling was done by using a table of random numbers. Subjects so chosen were not aware of their being chosen for the study. The four sections of the class were

randomly assigned to experimental and control groups. There were therefore two experimental (E_1 and E_2) and two control (C_1 and C_2) groups.

The study was carried out with a solomon - 4 design, structurally shown as follows:

$O_1\ X_1\ O_2\ (E_1)$
$O_3\ X_2\ O_4\ (C_1)$
$X_1\ O_5\ (E_2)$
$X_1\ O_6\ (C_2)$

where E_1 and E_2 are first and second experimental groups; while C_1 and C_2 are first and second control groups. O_1 and O_3 are pretests; while O_2, O_4, O_5 and O_6 are post tests. X_1 and X_2 are treatments based on Ausubelian and Gagnean sequences respectively.

Procedure

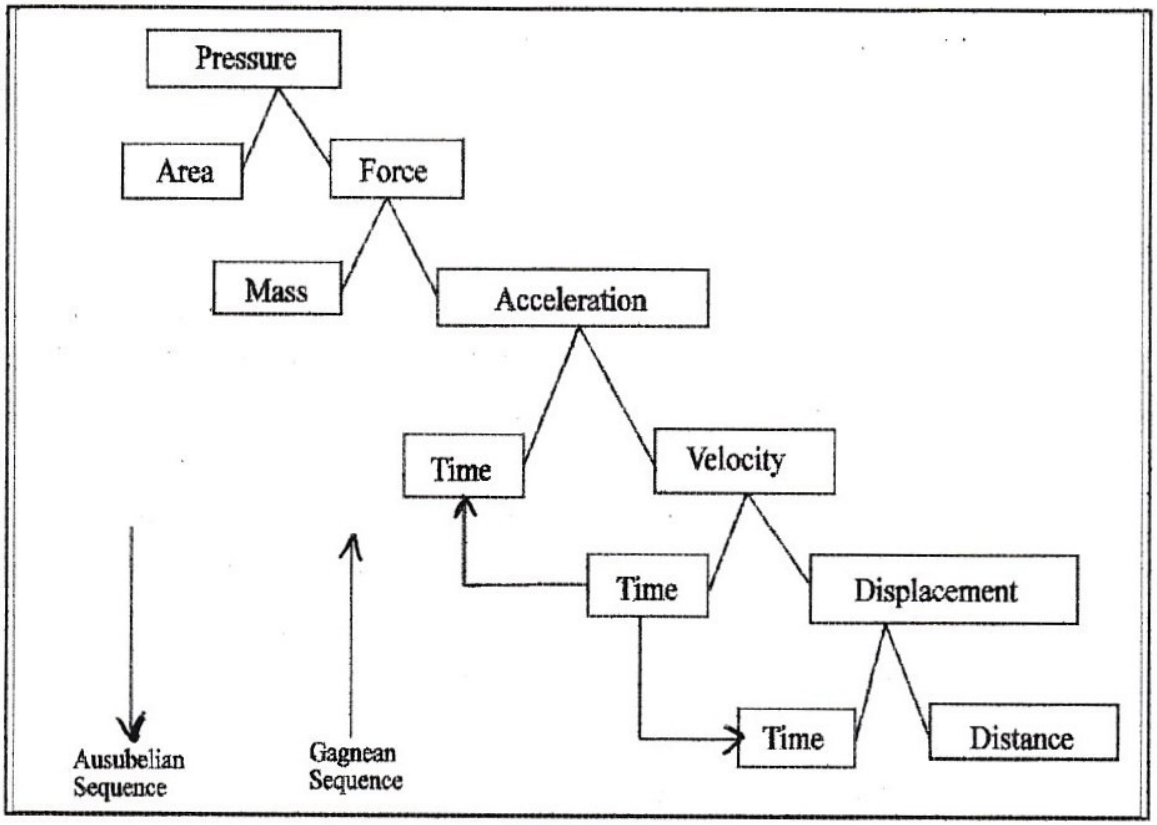
Pretest (KACT and TOA) were given only to the first experimental (E_1) and first control (C_1) groups. The rationale for not pretesting the second experimental and control (E_2 and C_2) groups was to possibly neutralize the pretest effects on the groups. The groups were pretested a day before the treatment was given. A day after the pretest, treatment based on Ausubelian sequence was given to the two experimental groups (E_1 and E_2) while the control groups (C_1 and C_2) were treated based on Gagnean sequence. To ensure consistency in teacher's variables, the researcher gave treatment in all the groups. Distinct lesson notes were used in each treatment day.

The interval between the end of treatment in one group and the commencement in another group was usually not more than an hour. This gap was necessary for teacher's preparation. Attempts were also made to minimize experimental contamination by having lessons with both experimental and control groups on each day of treatment. On the whole, the treatment lasted for two weeks. Two days after the treatment, post tests were given to all the groups (E_1, E_2, C_1 and C_2) on the same day.

The figure below shows the hierarchical arrangement of sub-concepts of pressure, viz, force, acceleration, velocity, displacement and distance in two distinct orders. The first order (shown with a downward arrow) shows an Ausubelian sequence. In this sequence, arrangement is such that a more inclusive concept comes before a less inclusive one. In each case, the concept

above subsumes the one immediately below it.

Ausubelian and Gagnean Sequences of the Concept of Pressure: A Schematic Representation



The second order (shown with an upward arrow) shows a Gagnean sequence, where concepts are arranged from less inclusive to more inclusive ones. As shown in the Figure, for example, the concept ''distance'' is less inclusive and serves as a pre-requisite concept for learning the concept of ''displacement''. Displacement in turn is a pre-requisite concept for learning the concept of ''velocity'', and so on. This order was strictly followed in the course of the treatment. To ensure this, lesson notes were prepared separately based on the two sequences. The behavioral objectives were, however, the same.

Moreover, teaching aids such as a ticker-tape timer, force board and pointed objects were used. The main focus of treatment was on pressure in

solid although mention was made of existence of pressure in fluids.

Knowledge and Comprehension Test (KACT)

This was a researcher constructed 25 - item test comprising questions on pressure (5); force (5); acceleration (4); velocity (4); displacement/mass (4); and time/area (3). The test aimed at measuring the effects of the two sequences of instruction on students cognitive ability, especially as revealed in knowledge and comprehension. The test was face - validated and the split-half reliability coefficient of 0.80 was obtained.

Test on Application (TOA)

TOA was designed to test students' ability at the application level in Bloom's Taxonomy of educational objectives (cognitive domain). It covered the effect of stiletto heels on slippery surfaces; penetrating effects of needles and other pointed objects; case of descending a hill compared to ascending; friction on moving vehicles; and numerical problems. TOA, like KACT, was face-validated by a panel of judges. A reliability coefficient of 0.65 was obtained using a split - half method. Full tests of both KACT and TOA have been described elsewhere (Onwioduokit, 1986).

Analysis and Discussion of Results

The data obtained in the study were analyzed using t - test difference of means. Analyses were carried out to test whether or not there existed significant differences between experimental and control groups with respect to:

1. Knowledge and comprehension of the concept of pressure;
2. Application of the concept.

Table 1: T-test showing difference between experimental and control groups for pre knowledge and comprehension.

Groups	N	Sum of X	$\bar{X}$	S^2	t	P < .05
E_1	30	232	7.75	5.81		
C_1	30	211	7.03	2.16	1.35	ns

ns = not significant

Since the calculated t-value was found less than the critical value of 2.66, the notion that there exists no significant difference between the experimental and control groups, with respect to their pre knowledge and comprehension of the concept of pressure, was accepted. The lack of significant difference may have been due to the fact that subjects were drawn from a school in which mechanics was yet to be taught to them. Another reason could have been that mixed grouping method was used by the school authority in assigning students to all sections of all classes in the school. On the whole, the lack of significant difference between the experimental and control groups confirmed the comparability of the groups.

A similar result was obtained in respect of the subjects' pre ability to apply the concept of pressure, as shown in Table 2 below:

Table 2: T-test showing difference between experimental and control groups for pre application ability:

Groups	N	Sum of X	$\bar{X}$	S^2	t	P < .05
E_1	30	230	7.67	5.16		
C_1	30	213	7.10	5.89	0.94	ns

ns = not significant

The lack of significant difference between the experimental and control groups in this case may have emanated from the fact that the difference in the pre knowledge and comprehension was insignificant at .05 alpha level. It is only when a concept is acquired and comprehended that is could be applied.

Table 3: T-test showing difference between experimental and control groups for post knowledge and comprehension.

Groups	N	Sum of X	$\bar{X}$	S^2	t	P < .05
E_1	30	295	9.83	11.56		
C_1	30	248	9.47	5.57	0.48	ns
E_2	30	351	11.70	5.95		
C_2	30	304	10.13	4.45	0.97	ns

ns = not significant

As shown in Table 3 above, the calculated values of t for both groups with an without pretest, were found much less than the critical values. Hypothesis 1 (H_0 1) was therefore retained, meaning that there exists no significant difference between experimental and control groups in comprehension ability. Since the experimental and control groups were taught using Ausubelian and Gagnean sequences respectively, the result shows that the two sequences are equally effective in enhancing understanding and comprehension of physics concepts. This result generally agrees with those obtained by Moreira (1978); Wise and Okey (1983); and Yore (1986). The lack of significant difference could be attributed to the fact that the two sequences were highly hierarchical. It is perhaps this hierarchy that enhanced subjects' knowledge and comprehension of the concept taught rather than the direction of hierarchical trend. Moreover, the result shown in Table 3 further showed a lack of significant influence of pretests on post tests since a similar result is obtained with and without pretests.

Table 4: T-test showing difference between experimental and control groups for post application of the concept.

Groups	N	Sum of X	$\bar{X}$	S^2	t	P < .05
E_1	30	307	10.23	7.95	0.83	ns
C_1	30	290	9.67	5.62		
E_2	30	298	9.93	9.86		
C_2	30	292	9.73	5.66	0.28	ns

ns = not significant

Table 4 above shows that the calculated t-values for both groups with and without pretest were much less than the critical value of 2.00. Hypothesis 2 (H_0 2) was consequently retained. It was therefore deduced that the experimental and control groups were not significantly different in their ability to apply the knowledge of the concept taught. Based on the result obtained, it was concluded that as Ausubelian sequence was as effective as Gagnean sequence in enhancing students' ability to apply physics concepts.

The lack of significant difference may have resulted from the fact that knowledge and comprehension levels of the experimental and control groups were not significantly difference. There is probably a significant correlation between comprehension and application of physics concepts. Moreover, as mentioned earlier, the trend of hierarchy, that is, whether from more inclusive to less inclusive concept or vice versa, does not seem to be as impactful as the hierarchical structure of the concept itself. These findings are in consonant with those of Moreira (1978) and Abraham and Renner (1983).

CONCLUSION AND RECOMMENDATION

The study had as its focus the investigation of the relative comprehension and application of the concept of pressure in schools. The results obtained showed no significant difference between the two sequences for all the dependent variables considered. This was attributed to a probable

overwhelming influence of the hierarchical structure of the sequences rather than the direction of hierarchical trend.

In view of the study outcome, it is recommended that learning materials be well and highly structured in school physics curriculum. Text book writers and publishers should endeavour to arrange the materials orderly to enhance comprehension and subsequent application. Areas of further research recommended are:

1. investigation of the relative effects of Ausubelian and Gagnean sequences on students of different reasoning abilities and cognitive styles.
2. relative influences of the two sequences on the retentive ability of students.

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