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Classroom Interaction Patterns and Students' Learning Outcomes in Physics

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Abstract: The purpose of the study was to observe and code the interaction patterns during physics lessons and to relate the identified patterns to students post-instructional attitude towards physics and achievement in low and high academic tasks. The sample consisted of 516 SS1 students and 15 physics teachers drawn from 15 selected secondary schools in Calabar Education Zone of Cross River State, Nigeria. Each teacher/classroom was observed for 4 lesson periods spaced over a period of 8 week and the interaction patterns coded using the Science Interaction Categories. Two other instruments were used to collect data on students attitude and achievement in physics. The results of data analysis indicated, inter alia, that a significantly positive relationship exists between interaction pattern and students' post-instructional attitude and low academic task achievement.

Key words: Classroom interaction, attitude towards physics, learning outcomes in physics, Nigeria

INTRODUCTION

The dynamics of teaching is a crucial factor in how much students learn (Grouws, 1981). Though students' performance may not be a simple direct consequence of the teachers' teaching act, the latter has a lot to do with classroom learning. Teachers establish the pattern of general conduct during a lesson, while on their part students establish certain types of behaviour to coincide with this pattern. Consequently the students participate to varying degrees in different classes and react differently to different teachers. This combined instructional pattern and student participation lead to a specific classroom environment characterized by specific interaction patterns. The instructional theory of 'social emotional climate' hypothesizes that this environment has a direct effect on both student attitudes and achievement (Hager, 1974). The validity of this hypothesis has been the subject of verification by many researchers, using various verbal classification systems to assess and describe the classroom climate.

For instance, Mckinney *et al.* (1975) investigated the relationship between classroom behaviour and academic achievement using multiple regression procedures in which the frequencies of twelve behaviours were used to predict the achievement of 90 sec graders from 5 classes in 3 public schools. They obtained multiple correlations of 63 and 51 for fall and spring data, respectively. In a similar study, McDonald (1976) reports that teaching performance accounted for a third to half of the variance in pupil spring scores when their fall scores were partialled out and about half of the variance in mean-change scores in maths but only about 10% of the variance in reading.

In Nigeria, the few interaction studies (Ajayelami, 1983; Akuezuilo, 1987; Domike, 2002; Emah, 1998; Iyewarum, 1983; Mani, 1986; Okafor, 1993; Okebukela, 1985; Okebukola and Ogunniyi, 1984; Ogunkola, 1999; Udeani, 1992) have indicated that some relationship exists between classroom interaction pattern and students' achievement. Okebukola (1986) reports that classroom participation had the greatest independent contribution (22%) to the variance in achievement scores while Udeani (1992) reports that classroom interaction accounted for about 74 and 71% of the variation in students cognitive achievement and process skill acquisition, respectively. Also Okafor (1993) found a positive relationship between classroom interaction behaviour and students' level of achievement. Incidentally, these few studies on interaction patterns in Nigerian classrooms were mostly in Biology classrooms. Not much has been done in the subject-matter of physics.

Though there are generic teaching skills (Martin, 1963), McDonald's (1976) report to the effect that patterns of effective and ineffective teaching performance differ by subjects, is suggestive of the fact that what obtains in Biology classrooms may not be exactly so in physics classrooms. Again, academic achievement is likely to be dependent on the structure of the tasks required. The achievement of students in academic tasks which require them to understand and reproduce information encountered during instruction (low academic tasks) and those that require them to apply the information and draw inferences (high academic tasks) may likely differ. Thus, the intention in the present study was to observe, code and analyze the interaction patterns in physics lessons and to relate the identified patterns to students' post-instructional attitude towards physics and achievement in low and high academic tasks.

MATERIALS AND METHODS

Sample: The sample consisted of 516 Senior Secondary one (SS1) physics students (239 boys and 277 girls) and 15 physics teachers drawn from 15 selected secondary schools in Calabar Education Zone of Cross River State, Nigeria. The schools were constituted by the purposive sampling technique. Only those schools which taught the focal units of physics on which the achievement test for the study was set, during the second term when the study was conducted, were selected. In schools with more than one stream of SS1 physics classrooms, a stream was randomly drawn for the study.

Instruments: Three instruments were used to collect data for the study, viz, Students Physics Attitude Scale (SPAS), Physics Achievement Test (PAT) and Science Interaction Categories (SIC). SPAS is a twenty six-item researcher-designed, Likert-type questionnaire consisting of students possible opinions and feelings towards physics as a subject, its importance to their daily lives, their interest or otherwise in the subject, etc. It was used to generate data on students' attitude towards physics. The internal consistency of the items and the coefficient of stability of the instrument were found to be 0.84 and 0.79, respectively. PAT which was used to collect data on students achievement in low and high academic tasks in physics, is a thirty-item, multiple-choice objective test on 5 topics in the SS1 physics curriculum commonly taught during the second term in the schools used for the study, namely, speed, velocity/rectilinear acceleration; work, energy and power; electric charges, description and property of fields and gravitation field. The reliability of the instrument was determined by estimating the internal consistency of the items and the coefficient of stability of the students' responses, which were respectively found to be 0.72 and 0.81.

SIC was used to code and analyze interaction behaviuours during physics lessons in the selected schools. It is an adaptation of Flander's (1970) observation system designed to code teacher and student behaviours during science lessons. It was modified to include an additional behaviour category (pupil-pupil interaction) and subcategories of teacher behaviour. Thus, the SIC used in the study consists of 9 categories of teacher behaviour with 2 subcategories in each of teacher reward, criticism and question and 7 categories of student behaviours (Kalu, 1997). After a two-week, in-school training session by the researcher and an assistant on how to use SIC in coding classroom interaction behaviours during physics lessons the inter-observer reliability was established to be 0.94.

Data collection procedure: Measurement of classroom interaction pattern necessitates the collection and analysis of ecological data. Thus, to obtain data on interaction patterns, the instructional process in each of the 15 selected physics classrooms were observed and the interaction patterns coded using SIC. Each classroom was observed for four lesson periods spaced over a period of 8 weeks, starting from the 3rd week of the second term when lessons on the focal topics were taught in the schools. Only interaction during physics lessons were observed and coded. The observed events were coded every 5 sec. At the end of the 8 week observational period, PAT and SPAS were administered to the students.

RESULTS

The data generated with the instruments were analyzed using Pearson Product Moment Correlation technique. Before that, the frequency of occurrence of each behaviour category of SIC for the 4 sets of observational data for each teacher/classroom group were combined, tabulated and converted into a composite matrix of interaction behaviour categories by teachers. The matrix consisted of the occurrence of each behaviour category expressed as a percentage of the total frequency of all the behaviour categories. This helped to compute the Indirect/Direct (I/D) ratio which served as an index of the interaction pattern per classroom group. The results of data analyses are shown in Table 1.

As shown in the Table 1, the 3 student learning outcomes correlated positively with classroom interaction pattern and the only relationship which is not significant at the 0.5 probability level is that between interaction pattern and students' achievement in high academic tasks. Since the analysis was performed with the value of the I/D ratio as representative of classroom interaction pattern, the obtained result can be interpreted to imply that the more teachers used indirect teaching, the more students developed positive attitudes towards physics and achieved higher in low academic tasks. In other words, students development of positive attitude towards physics and achievement in low academic tasks significantly increased with teachers' indirect influence of classroom activities.

Table 1: Pearson Product-moment correlations between interaction patterns and students' learning outcomes in Physics (N = 15)

Variables	ΣX(ΣY)	$ΣX^2$ ($ΣY^2$)	ΣXY	r
Classroom interaction pattern	3.94	1.159		
Post-instructional attitude	1262.77	106417.44	332.74	0.28*
Low task achievement	503.24	18614.96	141.01	0.60*
High task achievement	380.48	10057.41	100.14	0.03

* $p<0.05$

DISCUSSION

The significant positive relationship between interaction pattern and students achievement in low academic tasks implies that, on the average, students tended to perform well in academic tasks that require only memory and comprehension in classrooms where the teacher adopts more of indirect teaching. In a sense this is unexpected. Direct teaching emphasizes control of students and their compliance. It is a situation where the teacher gives out the facts, does not use much (if at all) of students' ideas and students are not encouraged to think deeply about the facts. Consequently, students become passive recipients of facts and knowledge given by the teacher. Under such situations, during examinations students can only memorize and regurgitate what they were taught in class and nothing more.

It is noteworthy that one of the objectives of secondary education in Nigeria as enshrined in the National Policy on Education (Federal Republic of Nigeria, 2004) is the inculcation of the attitude of reflective thinking in the students. The essence is to enable the students to participate actively in the solution of societal problems both at the individual and group levels and hence become functional members of the Nigerian Society. To do this students are expected to apply the knowledge acquired in school in the solution of problems. Such application of school knowledge require a thorough analysis and synthesis of the problem in order to identify its various ramifications. Unfortunately, however, as the results have indicated predominantly-indirect instruction is not conclusively hospitable to the development and use of students' higher mental processes and hence the achievement of the earlier mentioned objective of secondary education. It is certainly not of much advantage to produce youths with inert, factual, inapplicable knowledge. This points significance to the need to train and encourage teachers to be more indirect in their teaching.

Nevertheless, the correspondence between interaction pattern and students' learning outcomes is not one-to-one as the above explanation may tend to imply. It will not be perfectly correct to recommend that teachers who want their students to perform highly in low academic tasks should use more of indirect instruction. Obviously, teachers' direct or indirect approach in teaching is not the primary causal factor of students' learning outcomes. This assertion may become clearer if one considers the apparent contradiction between the finding in another part of the present study, that a positive but non significant relationship exists between teachers' attitude towards inquiry instructional strategy (i.e., disposition towards indirect teaching) and students' post-instructional attitude (Kalu, 1997) as well as the present finding that interaction pattern (predominantly direct influence) bears a significantly positive relation with students post-instructional attitude and achievement. This apparent contradiction can be resolved if one thinks of interaction pattern as having indirect effects on students' learning outcomes. That is, if one considers interaction pattern and students' learning outcomes to be mediated by other components of the classroom milieu, teacher and student characteristics.

CONCLUSION

The results of canonical analysis (not shown) lend credence to this view point. Apart from interaction pattern, teacher and student characteristics had meaningful loadings on the low task achievement and general academic achievement factors. In other words, low academic task achievement and general academic achievement of students in physics can be accounted for by these teacher and student characteristics in addition to classroom interaction pattern, not only the latter.

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