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Development and Validation of Students' Social Interaction Scale in Practical Physics Class in Oyo State

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Abstract: The focus of this study was to develop and validate a scale that can be used by teachers to ascertain the type of interaction of students with their peers in practical physics class. The scale was administered to a sample of senior secondary school physics students (SS 2) in twenty local government areas in Oyo state. The samples for this study were selected using multi stage random sampling method and 1000 students were selected. Four research questions posed guided the study and were answered using factor analysis method. To purify the data, factor loading of <0.3 were discarded and items with >0.40 loading on two or more factors were also removed. The scale possessed reasonably high internal consistency and adequate construct validity. A principal component analysis was used to extract eight-factor solution which reflected what students considered before engaging themselves in social interaction with their peers. Confirmatory factor analysis was performed with maximum likelihood and χ^2 analyses. The eight factors extracted include student's physical attractiveness, student's scholastic achievements, student's athletic ability, student's socio-economics status, student's gender, student's residence, student's religious persuasion.

Key words: Development, validation, students' social interaction scale, practical physics, attractiveness, Nigeria

INTRODUCTION

The recognition of the laboratory by scientist as a forum for experimentation is not new. Cavendish, the Curie, Fleming, Bohr and many others made scientific discoveries of epochal significance during laboratories activities. Many breakthroughs in science and technology are traceable to laboratory work. There is a general consensus among science educators that the laboratory plays a central role in the process of seeking new knowledge and deeper understanding of nature. According to Sumner (1988), centuries of purely deductive reasoning from the days of the Greeks have not produced the same utilitarian results as a few decades in this century of experimental activities.

In Nigeria, the tardiness in developing a scientific and technological base after many years of science teaching has been demonstrated by both historical and contemporary accounts. Historically, the British under whose governance Nigeria saw colonial subjugation provided half-hearted education in science to the people of Nigeria (Abdullahi, 1982; Oguniyi, 1977). The curricular offered in the schools were not geared towards the production of eminent, Nobel prize-winning and world acclaimed scientists (Ogunyemi, 1972).

This need perhaps informed the contemporary moves to improve the image of science and technology in Nigeria. The indicators of these improved images are however yet to be seen. Many reasons have been proffered most of which point to the manner in which science is taught to the Nigerian students. These reasons range from the non-consideration of the cosmology and to the mode of thought of the children as they relate to science concept formation (Bejah, 1982; Bajah, 1977). The laboratory is a place where the students are provided with such opportunities and the way and manner in which scientist research are learned. The laboratory has also been defined by Oguniyi (1977) as that school building or block designed for carrying out experiment, it is also place where scientific generalizations are validated or falsified. It can be considered as an important instructional component in school teaching.

This study hinges on the Vygostsky theory of social interaction. The major theme of Vygotsky's theoretical framework is that social interaction plays a fundamental role in the development of cognition. Vygotsky (1978) states: Every function in the child's cultural development appears twice: first on the social level and later on the individual level; first between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention to logical memory and to the formation of concepts. All the higher functions originate as actual relationships between individuals. Howe and Mercer (2007) asserts that social interaction

and collaborative activity among children in class can provide valuable, complementary and distinctive opportunities for learning and conceptual development. This challenges the traditional view that talk and social interaction among children are irrelevant, if not disruptive to learning. Talk and social interaction among children play a key role in children's social development and learning. Social development influences patterns of interaction which in turn affect learning, the development of ways of thinking and social development itself.

Survey of relevant literature indicated that four interaction typologies were commonly described. These are student-material, teacher-material, student-student and teacher-students' interactions. Research evidence shows that a student performance is greatly influence by their mode of relationship with peers (Johnson and Johnson, 1983). It is on the basis of this that contemporary researchers now find it profitable to investigate student-student social interaction or socialization dimension of learning environment. It has been that of the four types of interaction, only student-student interaction has attracted little research attention in Nigeria. There is need therefore, to address this important area of research as the growing body of literature has evidenced the importance of peer socialization to learning. Fortunately, one of the most prolific and enduring traditions in the study of students social interaction has been that based on the Sociometrics method. The Sociometrics method was soon widely adopted as a convenient way of exploring student's peer interaction. It has been in evidence consistently since then, adapted to tackle various different research questions. In its basic form the Sociometrics method involves asking all member of a social group to nominate with whom other members of the group they would most like to carry out a task, go to a social event or simply be friends. This provides the researcher with a network of choices between members of the group. Hallinan (1981), reviewing the body of Sociometrics research on pupils, identified three different lines of research within it first, studies of factor correlating with popularity or Sociometrics status, seconds studies of determinants of individual friendship choices and third, studies of how contextual variables affect the structure of interaction within a group.

Popularity studies identify characteristics of students which determine whether or not they will find it easy or difficult to make friends. Researchers used such Sociometrics data to rank group of students on the basis of the number of nominations they received from their fellows and a measure of peer acceptance was produced. Later studies also asked students whom they dislike among their peers (Moore and Updegraff, 1964) and categories of students grouped by sociometric status were produced. Thus, Peery (1979) discriminated between popular students (in receipt of many nominations, predominantly positive) amiable students' (few nominations, predominantly positive), isolated students (few nominations, predominantly negative) and rejected students (many nominations but predominantly negative). The main aim of this line of research was to identify distinctive characteristic in popular students in the hope that knowledge of the bases of popularity would help teacher devise ways of helping unpopular student become better accepted. A number of characteristics of popular children have consistently been identified in this way. Hallinan (1981) listed in her review of the research as correlates of social interaction: physical attractiveness, high intelligence, academic achievement athletic ability and high social class. Even the possession of a common Christian name has been associated with popularity.

It has becomes apparent however that much of this research produced little that could help friendless students establish better social interactions. Most of the characteristics identified were either very broad or general or were unalterable and the correlations between them and sociometric status were in any case, often weak. An easy way to boost the sociometric status of isolated and rejected children was not found.

The only line of research which produced a substantial body of intervention work has been based on social learning theory (Bandura, 1977). Evidence that students of poor sociometric status tend to display less confidence in general social skills than their more popular age mates (Gottman *et al*., 1976) was interpreted as indicating that isolated or rejected children were suffering the consequences of inadequate learning of social skills in their upbringing. It was therefore concluded that programmes of social-skill training which would teach these children basic social skills would enable them to transform their social status and become popular. A variety of training techniques (O'Connor, 1972) produced only short-term gains that were not replicated by later studies (Pullantz and Gottman, 1981).

More intensive coaching techniques yielded more promise on average (Gottman *et al*., 1976) but still some replication studies failed to get results (Hymel and Asher, 1977). Some of the skills which were being taught in these studies were for example the skills of introducing oneself to new friends maintaining a conversation with a partner, gaining entry to a group, developing co-operative play.

One individual characteristic which has been shown to have a very strong influence in student's social

interaction is gender (Tuma and Halliman, 1979). Students tend largely to choose peers of their own sex. Tuma and Halliman (1979) further report a positive relationship between similarity of students level of academic achievement and stability of peer choice. Eder and Hallinan (1978) found that girls tend to form smaller and more exclusive clique whereas boys tend to develop a more open type of group structure. The types of interactions students have is likely to affect their performance in the practical class where they of necessity need the cooperation of one another especially where practical materials are not enough. Since interaction is important therefore, this study developed and validated a scale for measuring students interaction in a physics practical class. In order to guide the study, four research questions were asked:

- What are the characteristics of the students' social interaction scale?
- What factors are indicative of a positive student's social interaction in practical class?
- What is the concurrent and construct validity of the students' evaluation of their peer Social Interaction Scale (SSIS)?
- How tenable is the new factor model?

MATERIALS AND METHODS

The population of this study consisted of all the senior secondary school physics students (SS 2) in Oyo State. The schools were sampled and multistage random sampling technique was used to select 1000 students. The sampling was done on the basis of local government areas. In order to have wide spread representation in the sample, samples were drawn from each of the three senatorial districts. Sampling of local government areas, from the senatorial districts is shown in the Table 1.

Table 1: Sample of Local Government Areas (LGAs) number of schools available and number of school selected from each Senatorial Districts (SD)

Senatorial district	Local govt. selected	Number of school available	Number of school selected
Oyo Central	Akinyele	19	2
	Egbeda	12	2
	Lagelu	18	1
	Surulere	13	2
	Oyo East	8	1
Oyo North	Ogbomoso North	8	2
	Ogbomoso South	11	2
Oyo South	Ibadan North	22	2
	Ibadan South West	23	2
	Ibarapa East	7	2
	Orire	8	2

Twelve local government areas were used from the available thirty-three local government areas in Oyo state. Samples were selected across school location (urban, rural) and school types (public and private). The instrument developed in this study is a rating scale and it has been developed for senior secondary school physics students (SS2) to rate (their physic classes) their friendship choices.

Development of students' social interaction scale: Ten students in five schools were asked to write down possible factors for friendship choices that could make them form cooperative group during practical physics classes. The items were collated and streamlined items with the same meaning. The surviving items are referred to as crude instrument. The crude instrument was given to experts in the field of educational evaluation to give it both face and content validity. Many items were deleted probably for reason of inadequacy and few were restructured to give a total of 50 items. The instrument was administered on 1000 Senior Secondary School pupils students in Oyo state.

RESULTS

Research question 1: What are the characteristics (i.e., mean, Standard Deviation, total item correlation) of the students' social interaction scale?

The Table 2 shows the characteristics of the instrument. Both description and reliability analyses were performed on the items. Items with item total correlation <0.3 were dropped in order to increase the homogeneity of the items. This is consistent with the procedure recommended by Nunnally and Bernstein (1994). After Nnually and Bernstein advice has been taken note of the 50 items were reduced to 48 items as shown in Table 2.

Research question 2

What factors are indicative of a positive peer social interaction in a practical class? In order to asses the structure of students social interaction scale in practised physics class all the 48 items were factor analysed with orthogonal (Varimax) rotation the initial factor solution for students social interaction using 2 rotations resulted in 8 factors with Eigen values >1. The 8 factors accounted for 84.5% of the variance. This is shown in Table 2. In order to select items for the finale scale, the pattern of factor loadings was examined. Items with factor loading <0.3 were discarded (Nunnally, 1967) as a guideline for considering the items that should be in the factor analysis, it thus appear that there is no specific method of

Table 2: Characteristic of the crude students evaluation of social interaction scale

My friend	Mean	SD	Scale correlation
Appears neat	4.5172	1.1823	0.6645
Lives in my neighbourhood	4.2186	1.1594	0.6584
Is within my age bracket?	3.8975	1.1387	0.6148
Is from a rich family?	4.3160	1.1174	0.6542
Is good looking?	3.9564	1.0963	0.6011
Visits me at home after school hours	4.1121	1.1678	0.5632
Celebrates his birthday party with me	3.6145	1.2631	0.6481
Is brought to school in expensive cars?	3.1261	1.1571	0.5346
Has good stature	4.0071	1.1622	0.6218
Studies with me at home	4.6321	1.1158	0.6539
Is younger than me?	3.4165	1.1193	0.5346
Wears the best shoes around	3.6410	1.1014	0.6013
Has average height	4.1565	1.0816	0.6424
Goes with me to school every morning	3.1871	1.0878	0.6017
Looks older than his age	3.2988	1.1316	0.6250
Parents works in famous establishments	3.4006	1.0984	0.6100
Is fair in complexions?	4.5618	1.3192	0.5758
Attends parties with me in the neighbourhood	3.8670	1.2761	0.5400
Is the youngest of all the students in the class?	3.9780	1.1274	0.6421
Lives in expensive house	4.1282	1.0016	0.5130
Dresses properly in and outside school	4.0741	1.1864	0.5574
Goes home with me after school hours	3.9876	1.0396	0.5760
Is born same data as I?	3.1254	1.2416	0.5783
Lives in exclusive Government Reserve Area (G.R.A)	4.7610	1.1257	0.6258
Is exceptionally brilliant?	4.0112	1.1318	0.5180
Is good at all sports?	3.1890	1.2416	0.6345
Is of same religion as I?	3.5674	1.0924	0.5584
Likes same gender friend	4.1819	1.2420	0.6238
Comes first position in class examinations	4.5418	1.1814	0.6132
Has well developed physique (body) for sports	3.1514	1.1593	0.5154
Attends prayer meetings with me	4.0056	1.1593	0.5154
Feels opposite sex friendship is caring	3.2849	1.1624	0.6784
Answers teacher's question always almost correctly	4.2160	1.1176	0.6280
Has won prizes for the school at sporting events	3.3340	1.2095	0.5140
Attends same church/mosque with me	4.1024	1.1384	0.6341
Feels boys give girls less opportunity in grouped activity	3.8945	1.1485	-
Contributes positively to group discussion	4.3284	1.1260	0.5991
A member of the school football team	4.0126	1.1439	0.6415
Likes the religion as much as I do	3.1640	1.0898	0.6174
Feel girls are less active in practical class	4.5618	1.1322	0.6244
Is chosen as group leader for? practical work	3.8406	1.1508	0.6476
Is the captain of the school team?	3.3410	1.2100	0.5180
Preaches very much to me	3.4915	1.0418	0.6210
Feels boys are helpful in setting up experimental apparatus	3.8156	1.0645	0.6480
Teaches fellow students during group work	3.1786	1.1007	0.6242
Shares same attitude with me to work	3.9617	1.1481	0.5153
Brings me gift during religious festivals	3.1680	1.1237	0.6235
Feels same gender friends understands ones personal problems	3.2686	1.0794	0.5710
Comes regularly to school	2.0976	1.1007	0.2675
Does not share his personal belongings	1.6757	1.1481	0.2155

purifying the structure of a scale therefore, in this study all the factor loadings that are <0.40 were discarded because many of the items loaded highly on the factors. For further purification of the list, items with factor loading of 0.40 or more in two factors were eliminated from the list. These reduced the total item from 48-47 items with 8 factors having eigen values >1 (Table 3).

There were no double-loading complication for the items. Factor 1 reflected student's physical attractiveness as an essential parameter for acceptance of a peer for social interaction and included 6 items (Appears neat is good looking). Factor 2 reflected the student scholastic achievement and it included 6 items (Is exceptionally brilliant), factor 3 reflected student athletic ability and it has 6 items (Is good at all sports), factor 4 reflected socio economic status of student and it include 5 items (Is from rich family), factor 5 reflected student gender that makes him acceptable his peers. It has 6 items (Likes same gender friend), factor 6 reflected the extent to which students live in same neighborhood. It has 6 item (Lives in my neighbourhood). Factor 7 reflected the extent to which students are within same age bracket. It has 6 items (Younger than 1). Factor 8 reflected student's religious affiliation (Attends prayer meetings with me).

Research question 3: What is the concurrent and construct validity of the students' evaluation of their peers' social interaction scale? The concurrent and construct validity of the Students' Social Interaction Scale (SSIS) is shown in Table 4.

The final set of items derived from factor analysis was tested for their reliability by submitting the item analysis using item-total correlation. We analysed the item for each scale separately. The internal consistencies were:

- Factor 1: 0.9142 (i.e., student's physical attractiveness)
- Factor 2: 0.9131 (i.e., student's scholastic achievement)
- Factor 3: 0.9042 (i.e., a student's athletic ability)
- Factor 4: 0.8854 (i.e., student's socio-economic background)
- Factor 5: 0.8823 (i.e., student's gender)
- Factor 6: 0.8745 (i.e., student's proximity in their neighbourhood)
- Factor 7: 0.8635 (i.e., student's age group)
- Factor 8: 0.8620 (i.e., student's religious affiliation)

Exploring the factors indicated that students will want to choose their friends or partners in a physics practical class based on the physical attractiveness, scholastic achievement, athletic ability, socio-economic background, gender, proximity in the neighbourhood, age and religious affiliation.

Research question 4: How tenable is the new model? This research question is answered using the confirmatory factor analysis approach.

Table 3: Rotated component matrix

Item No.	Variables	1	2	3	4	5	6	7	8
1	Appears neat	0.785	-	-	-	-	-	-	-
5	Is good looking?	0.742	-	-	-	-	-	-	-
9	Has good structure?	0.678	-	-	-	-	-	-	-
13	Has average height?	0.654	-	-	-	-	-	-	-
17	Is fair in complexion?	0.618	-	-	-	-	-	-	-
21	Dress properly in and outside school	0.507	-	-	-	-	-	-	-
25	Is exceptionally brilliant?	-	0.714	-	-	-	-	-	-
29	Comes first position in class examinations	-	0.682	-	-	-	-	-	-
33	Answers teachers question almost always correctly	-	0.654	-	-	-	-	-	-
37	Contributes positively to group discussions	-	0.548	-	-	-	-	-	-
41	Is chosen as group leader?	-	0.526	-	-	-	-	-	-
45	Teaches fellow students	-	0.513	-	-	-	-	-	-
26	Is good at all sports?	-	-	0.675	-	-	-	-	-
30	Has well developed physique?	-	-	0.648	-	-	-	-	-
34	Has won prizes for the school at sporting events?	-	-	0.634	-	-	-	-	-
38	Is a member of the school team?	-	-	0.610	-	-	-	-	-
42	Is the captain of the school?	-	-	0.528	-	-	-	-	-
46	Is the game prefect?	-	-	0.514	-	-	-	-	-
4	Is from rich faily?	-	-	-	0.615	-	-	-	-
8	Is brough to school in expensive car?	-	-	-	0.584	-	-	-	-
12	Wears the best shoes around	-	-	-	0.510	-	-	-	-
16	Parents work in famous establishment	-	-	-	0.484	-	-	-	-
20	Lives in expensive house	-	-	-	0.436	-	-	-	-
28	Likes same gender friend	-	-	-	-	0.645	-	-	-
32	Feels opposite sex friendship is caring	-	-	-	-	0.630	-	-	-
36	Feels boys gives girls less opportunity in grouped activity	-	-	-	-	0.612	-	-	-
40	Feels girls are less active in practical class	-	-	-	-	0.548	-	-	-
44	Feels boys are helpful in setting up experimental apparatus	-	-	-	-	0.539	-	-	-
48	Feels same gender friends can understand ones personal problems	-	-	-	-	0.531	-	-	-
2	Lives in my neighbourhood	-	-	-	-	-	0.654	-	-
6	Visits me at home after school hours	-	-	-	-	-	0.640	-	-
10	Studies with me at home	-	-	-	-	-	0.638	-	-
14	Goes with me to school every morning	-	-	-	-	-	0.604	-	-
18	Attend parties with me in the neighbourhood	-	-	-	-	-	0.568	-	-
22	Comes home with me after school hours	-	-	-	-	-	0.518	-	-
3	Is within my age bracket?	-	-	-	-	-	-	0.648	-
7	Celebrates his birthday party with me	-	-	-	-	-	-	0.637	-
11	Is younger than I?	-	-	-	-	-	-	0.623	-
15	Looks older than his age	-	-	-	-	-	-	0.556	-
19	Is the youngest of all the students?	-	-	-	-	-	-	0.534	-
23	Is born on same date as I?	-	-	-	-	-	-	0.482	-
27	Is same religion as I?	-	-	-	-	-	-	-	0.656
31	Attends prayer meetings with me	-	-	-	-	-	-	-	0.642
35	Attends same church/mosque with me	-	-	-	-	-	-	-	0.638
39	Likes the religious as I do	-	-	-	-	-	-	-	0.540
43	Preaches to me very much	-	-	-	-	-	-	-	0.473
47	Brings me gifts during religious festivals	-	-	-	-	-	-	-	0.456

Table 4: The concurrent and construct validity of Student Social Interaction Scale (SSIS)

	Factor loading for the eight dimension of students social interaction							
Parametrs	Student's physical attractiveness	Student's scholastic achievement	Student's athletic ability	Student's socio-economic background	Student's gender	Student's proximity in residence	Student's age group	Student's religious affiliation
Student's physical attractiveness	0.9142	-	-	-	-	-	-	-
Student's scholastic achievement	0.0101	0.9131	-	-	-	-	-	-
Student's athletic ability	0.0508	0.0705	0.9042	-	-	-	-	-
Student's socio-economic background	0.0624	0.0443	0.0140	0.8854	-	-		
Student's gender	0.0574	0.0015	0.0145	0.0340	0.8823	-	-	-
Student's proximity in residence	0.0583	0.0218	0.0110	0.0410	0.0460	0.8745	-	-
Student's age group	0.0163	0.0845	0.0059	0.0145	0.0340	0.0430	0.0635	-
Student's religious affiliation	0.0261	0.0190	0.0023	0.0210	0.0140	0.0450	0.0432	0.8620

Figures along the diagonal are significant ($p<0.05$). Figures below the diagonal are not significant

Table 5: Goodness of-fit-test

Chi-square	Df	Sig.
1380.639	1109	0.000

Confirmatory factor analysis: In order to verify the factor structure of the Students' Social Interaction Scale in Practical Physics Class obtained from the exploratory factor analysis, a confirmatory factor analysis was conducted. Maximum Likehood solution was used to verify the relationship between the observable variables and latent constructs. The chi-square (χ^2) statistic was significant for this model indicating an inadequate fit of the confirmatory model to the data χ^2 (df = 1109, N = 1000) = 1380.639; $p<0.05 = 0.00$ (Table 5).

From the Students' Social Interaction scale in Practical Physics class, we obtained maximum likelihood solutions by using χ^2 to find the relationship between the eight factors. Hang and Michael pointed out that a statically significant value of χ^2 index indicates that the entries for the proposed model deviate from those obtained. Thus, the hypothesised model should be considered untenable. However, it is important to note here that one of the limitations associated with the use of χ^2 value is its dependency on sample size. A large sample size (like in this study) would be expected to lead to a rejection of a model. Since the discrepancies between the model and the data were accounted for by the large sample size, we cannot conclude here that the hypothesized model is untenable.

DISCUSSION

The relationship between the eight factor show that they are highly significant at $\alpha = 0.05$. The correlation between student's physical attractiveness and students scholastic achievement is 0.6401 indicating that students who appear tidy tend to improve their learning as they attracted to themselves other students with differing learning backgrounds. From such interaction, students who might not be initially sound academically will improve in the course of their social intercourse.

The correlation coefficient of students' socio-economics status and students' gender is 0.5774. This is significant and shows that female students tend to choose their friends from those who posses similar socio-economic background as themselves. Most girls gauge their potential friends by such factors as the type of cars that brings them to school. This agrees with the work of Punantz and Gothman that students from high and middle class family tend to make friends with one another than to choose their friends from low socio-economic background. Besides, boys usually dominate girls in mixed-sex grouped activities. They dominate the physical side (voluntary for demonstration in laboratory, providing leadership). In such context, girls' roles are less central consisting of elicitation contribution from boys. It would be simplistic to categorise this behaviour merely in terms of submission or passivity. This position is supported by the research of Webb (1982) that in grouped activities, boys tend to frustrate the girls from active classroom participation by requiring the girl to take the reading of experimentation while they (boys) grapple with the concept of the work. Students' gender and residence of students' proximity to their peers had a correlation co-efficient of 0.8460. This is quite significant. It points to the fact that students make friends with those who reside close to their home. This is so because after the school hours are over, they still have chance of interacting at home and thereby assisting one another with their school work. Those students whose residents are close to one another tend to form a clique during classroom activities. These results corroborate those of Howe and Mercer (2007) where they found that gender, temperament and the social relations between members of class can affect the ways in which children engage in joint activity as can situational factors like the existence of a competitive or co-operative environment. Therefore, teachers need to take such factors into account when organising collaborative work.

The study also reveals that a correlation exists between each of the factors although, they are not as strong when compared with the reliability of each of the factors (values in the diagonal Table 3). This implies that despite the assumption that the factors should be mutually exclusive, there are some links (although very small) among the factors.

CONCLUSION

The teachers are not aware of any study on students' social interaction in practical physics class in Nigeria because the study on students' interaction is relatively new hence, there is no instrument we can term students social interaction scale. This explains why the focus of this study is on how to develop and validate a scale of students' social interaction in a practical physics class. Some students from 10 secondary school were asked to write down what they considered before choosing their pears for grouped laboratory work and a hundred items were generated. Both face and content validity of the instrument was obtained. This exercised led to generation of an instrument termed semi-good and the items were 48 in number. Cronbach Alpha was used to establish the total item correlation and items with <0.3 item total correlation were dropped in order to increase the

homogeneity of the items. The rest items were subjected to factor analysis which yielded eight distinct factors underlying the students' social interaction these factor are: student's physical attractiveness, student's scholastic achievement, student's athletic ability, student's social-economic status, student's gender, student's proximity of residence to peer, student's age group, student's religion affiliation. The correlation matrix of the eight factors shows that none of the eight factors correlation are up to 1.00 at the 2-tailed significant level and none of the correlation coefficients in the matrix is stronger than the values in the diagonal (the internal consistency of each of the factors) this implies that each of the factor is distinct and we cannot say that any two factors are measuring the same thing. This scale can now be used by teachers to determine the level of social interaction among students in classes in each of the dimension considered.

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