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Development and factorial validation of attitude to physics scale (ATPS)

Ovute, A.O.[1*], B.G. Nworgu[2] and Ovute, L.E.[3]

[1]Department of Science Education, Michael Okpara University of Agriculture, Umudike,Abia State, Nigeria
[2]Sub-Department of Science Education, University of Nigeria, Nsukka, Nigeria
[3]Department of Education Foundation, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
Corresponding author

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A B S T R A C T

This study sought to develop and factorially validate an attitude to physics scale (A.T.P.S). The study was an instrumentation research. An initial pool of 100 attitude items was pruned down to 51 items by experts in physics education and Measurement and Evaluation. The 51 items which was in form of likert-type scale formed the preliminary version of the instrument. The instrument was administered on sample of secondary school students. The scores obtained from the items were inter-correlated. The correlation matrix was then factored using the principal-axes method and the factor loading were obtained. The factors were rotated for interpretation of the factors as well as for comparison with others. The results of the factor analysis show that five factor were found factorially valid to explain attitude to physics, each accounting for approximately 13.6% 9.9%, 8.5%, 11.% and 9.5% respectively of the total variance. In all, twenty-four (24) items were found valid factorially to explain the factors.

Introduction

Attitude, as an affective construct is a very significant parameter in the learning situation. According to Okoye, (11987) "Attitudes are our mental dispositions which determine our next line of response to the stimulus to which these attitudes are directed". Attitudes are generalizable. In other words, attitudes can be spread to other stimuli associate (negative or positive) towards a particular subject, may spread to the subject teacher, other related subjects and even the whole ideal of school learning and education.

Attitude therefore is bound to show a positive relationship with achievement (as has indeed) been reported by AH and Aigbornian (1989); Kemp and Dube (1971); and Jegede (1981). As a potent factor in learning, the proper assessment of attitude becomes a sine qua non in the efforts towards improving performance in school subjects. A corollary to this is that proper assessment of attitude hinges on the

availability of instruments with known and satisfactory psychometric features.

Studies with respect to the assessment of attitude toward science can broadly be categorized into, two. One, those which describe the natural direction of students' attitude toward science (eg Odunsi, 1984, Obioma and Ohuche, 1985; Ali and Aigbomian, 1987). The other categories are those which attempted to develop instruments for measuring attitude (e.g. Okoye, 1985, Fable and Roberts, 1983). The instruments used in the first category of studies, are generally of double psychometric characteristics since no serious attention was paid to their development and validation.

For such studies instrument development is usually incidental. On the other hand, the studies in the second category which developed instruments for measuring attitude towards science attempted also validation of the instruments. However, the validation was not sufficient rigorous to guarantee the adequacy of the psychometric properties of the resultant scales instrument. In these studies, either "face validation" or what the authors claimed were: construct validation" was employed. In other words, these studies did not employ the factor analytic method in validating the said instruments notwithstanding the fact that attitude is a psychological construct. Consequently, the factor-structure of attitude to science in general and physics in particular cannot be said to have been adequately addressed.

Purpose

Following from the foregoing therefore, this study sought to develop and factorially validate i attitude to physics scale (ATPS). Specifically, an attempt was made in this study to

1. Generate items measuring attitude towards physics.
2. Subject the items to factor analysis and thereby select items of satisfactory loading and purity.
3. Identify and describe the factor structure of attitude towards physics as revealed by the ATPS.
4. Determine the reliability of the ATPS.

Reach questions

1. What are the factor loadings of items of attitude to Physics Scale (ATPS)?
2. What is the factor structure of attitude to physics as measured by the ATPS?
3. How internally consistent are the items of the ATPS?

Method

Design

The study is an instrumentation research (ICEE, 1971) designed to develop and factorially validate an instrument for assessing the attitudes of secondary school students towards physics.

Subjects

The subjects were 600 Senior Secondary School Students (SSI) to SSIII), drawn from twelve (12) secondary schools from Enugu state. The subjects were drawn through a muthstage random sampling procedure.

From each of the three educational Zones, four (4) secondary schools were randomly drawn. In each school, fifty (50) students' (20 from SSffl; 20 from SSII, and 10 from SS I) were randomly selected for study.

Development of the ATPS

The instrument developed is the Attitude to-physics scale. From the relevant literature, and experienced physics teachers an initial pool of

100 attitude items was generated. The items, $_m$ comprised of favourable and unfavourable (or positive and negative) statements about physics.

The items were then subjected to screening by a panel of five (5) experts in physics Education and Measurement and Evaluation. The experts were requested to rate the items *in* terms of their appropriateness and also to point out items that were replicated. Through this process, the initial pool of 100 items was pruned down to 51 items.

The surviving 51 items at this stage formed the preliminary version of the instrument which was in the form of likert-type scale. There were 26 positive and 25 negative statements about, physics. The students were expected to express their attitude to physics by indicating their extent of agreement of disagreement with these statements on a 5-point scale.

Factorial validation

The scores obtained from the items were inter-correlated. The correlation matrix was then factored using the principal axes method. This extracted the maximum amount of variance with the smallest possible residuals. The correlation matrix was condensed into the smallest number of orthogonal factors. The factor loadings on the principal axes were obtained. After the factors have been determined, they were rotated for interpretation of the factors as well as for comparison with others.

Normal verima rotation was employed and the valid factors were then rotated as shown on table 2.

Discussion

For research question 1, the factor loadings of the items of attitude to physics presented in table 3 provided the answer. Factor 1 had the greatest number of items leaded on it.

Table 3: show that attitude to physics could be explained by five (5) factors. This is in line with the findings of Okoye (1987) on the students evaluation of teachers of Colleges of Education on which resulted in six subscales with thirty items. Thus this present study shows that attitude to physics is not just a unidimensional Construct but one which could be explained in terms of at least five factors with associated twenty-four (24) items.

The five factors accounted for approximately, 13.6%, 9.9%, 8.5%, 11.1% and 9.5% respectively of the total variance. In all this model can only account for 82.6% of total variance in attitude to physics as represented by the fig. 1 below.

From the model, it was shown that" students attitude to physics was related positively to the received social values of physics (13.6%). He has positive attitude to physics because he feel that the knowledge of Physics will enable him solve practical problems, understand other objectives, and more so develop critical ideas. This is in line with the finding by Igwe (1972) that most girls are interested in physical sciences because they think that such sciences lead to prestigious professions. The above results imply that attitude to physics is influenced by the perceived value of physics. Thus the general negative attitude to physics by students can be attributed to their lack of conviction of its importance.

The items of factor 2 are manifestation of attitude of physics related to physics method activities. The factor loadings had a percentage communality of 9.9% of the total variance of attitude to physics. In line with this, Moore and Poper (1978) showed that students attitude to science is related to science method activities among other factors.

Table.1 The principal factor leading of items

	FACTOR 1	FACTOR 2 2	FACTOR 3 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8	FACTOR 9	FACTOR 10
ITEM 1	0.11377	0.33792	0,49252	0.18483	0.16123	0.06047	0.22660	0.01394	0.09197	0.26976
ITEM 2	0.35562	0.33213	0,35543	0.17206	0.41110	0.35253	0.15531	0.07156	0.01845	0.15483
ITEM 3	0.40577	0.06350	0.17148	0.23335	0.07321	0.40604	0.31033	0.16188	0.006924	0.15187
ITEM 4	0.23298	0.13169	0.62271	0,16511	0.27878	0.14220	0.29354	0.111585	0.02868	0,16534
ITEMS	0.57313	0.15273	0,00360	0.10043	0.41323	0.27423	0.00625	0.00602	0.12618	0,15681
ITEM 6	0.37995	0.27749	0.22833	0.35828	0.14000	0.15388	0.30395	0.06685	0.12257	0.15681
ITEM 7	0.62069	0.022242	0.022261	0.07329	0.09959	0.11758	0.23631	0.24498	0,30895	0.04934
ITEMS	0.37574	0.03256	0.00765	0.24735	-0.18727	0.21127	-0.28032	-0,21776	0.36225	-0.18271
ITEM 9	-0,03020	0,22596	0.18012	0.03287	0.31062	0,51687	0.39261	-0.21061	0.08353	-0.15455
"ITEM 10	0.50141	0,23071	0.09884	0.18128	-0,15511	-0.02306	0.01324	-0.03319	0.15283	0.24943
Item 11	0.49987	-0.08310	-0.25937	0.21985	0.16977	0.02628	-0.04551	-0.07508	0.22324	0.01463
Item 12	0.50659	-0.18031	-0.24411	0.25418	0.03368	-0.06668	-0.06588	-0.09359	0.17621	-0.20456
Item 13	0.20847	-0.32007	0.20770	-0.19029	-0.02080	0.14918	-0.10309	0.15150	0.26571	0.37236

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6 6	FACTOR 7	FACTOR 8	FACTOR 9	FACTOR 10
Item 14	0 38034	0.24188	0.22061	0.47517	-0.30913	0.00634	-0,11938	0.19925	0.00153	-0.03444
Item 15	0.22397	-0.14451	0.22102	-0.06356	-0.18955	0.38322	0.01380	-0.08100	0.08296	-0.08911
Item 16	0.43511	-0.06377	0.01396	-0,15078	0.02223	-0.23497	0.15066	-0,25294	-0.00365	-0.21121
Item 17	0.23798	0.24981	-0.0005	0.02768	-0.20897	0.45429	0.11251	-0.47556	-0.05266	0.07738
Item 18	0.04848	0.08452	0.67900	0.26876	-0.27316	0.01080	0.09421	0.03574	0.0660f	0.02439
Item 19	0.38652	0.46060	0.07521	-0.13326	0.14256	0.08330	-0.09837	-0.27877	0,12335	-0.19745
Item 20	0.45550	-0.10498	0.14968	0.02900	0.30407	-0.13941	0.21031	-0.20669	0.03663	*-0.22172*
Item 21	0.51039	0.03492	-0.17126	0.10998	0,07806	0.12616	-0.27724	-0.10814	0.15743	0.24708
Item 22	0,42714	0.33435	-0.342199	0.01433	-0.01182	-0.27424	0.10727	-0.04379	0.03138	0.17305
Item 23	0,54049	-0.28177	0.13250	0.30319	0.02178	0.10468	-0.21130	-0.09274	-0.20489	0.00950
Item 24	0.34911	0.32751	-0.22591	-0.31953	-0.11563	0.16762	0.10319	-0.19761	0.20389	0,10532

Item 25	0.58441	"SsW[8]"	-0.21146	-0.11795	-0.14223	0.01980	0.01482	0-02805	0.0805	-0.07935
Item 26	0.49069	-0.02545	-0.23304	0.18678	0.08533	-0.02474	-0.22584	-0.05757	-0.19986	-0,37009.
Item 27	0.01762 0	0.45891	-0.15174	-0.20758	0.391237	0.16168	-0.03699	0.2335	0.30892	-0.00451 0
Item 28	5773 1	25182	27739	-0.04967	0.09172	08540	0.25156	0.03201	07981	0.09990

Table.1 Continued

Item 29	**0.53566**	**0.21180**	**-0.02205**	**-0.05680**	**-0.00110**	**-0.03886**	**-0.01860**	**-0.09272**	**0.29248**	(
Item 30	0.43938	034647	0.03408	0.15222	0.05960	0.03975	0.190013	0.065441	0.19157	0.24831
Item 31	0.47829	0.26603	0.29484	0.09602	0.29584	0.09896	0.05950	0.20546	0.21434	0.21153
Item 32	0.45689	0.22840	0.16858	0.00455	0.07125	0.12953	0.13370	0.06617	0.0095	0.17668
Item 33	0.13193	0.2148	0.07629	0.48792	0.12919	0.04722	0.42286	0.15597	0.16889	0.13103
Item 34	0.46556	0.29298	0.00208	0.14650	0.04885	0.010787	0.19000	0.23762	0.02762	0.26786
Item 35	U.40138	0.24254	0.01958	0.41737	0.09449	0.08989	0.22773	0.33360	0.07522	0.05462
Item 36	0.57024	0.00323	0.15699	0,^2306	0.11184	0,07584	0.12329	0.08901	0.22425	0.10946
Item 37	0.23280	0.49965	0.22454	0.13823	0.29037	0.10061	0.04155	0.27274	0.08366	0.10973
Item 38	0.38385	0.09207	0.17004	0.132934	0.16651	0.12971	0.0100089	0.24726	0.20226	0.070629
Item 39	0.27503	0.44201	0.18787	0.007876	0.09901	0.29723	0.9753	0.00954	0.24465	0.00091
Item 40	0.50514	0.11849	0.17539	0.05792	0.18487	0.23161	0.10670	0.00905	0.17083	0.11005
Item 41	0.394441	0.31516	0.19363	0.03355	0.12868	0.08220	0.15993	0.46992	0.03516	0.20419
Item 42	0.24382	0.02927	0.21496	0.24183	0.27519	0.29004	0.08311	0.26485	037998	012915
Item 43	0.47367	0.23584	0.02140	0.04920	0.19844	0.03662	0.17148	0.08975	0.12418	0.39007
Item 44	0.43996	0.03357	0.03848	0.50163	0.27020	0.18125	0.22771	0.08178	0.28389	0.11180

Table.1 Continued

Item 45	0.370730	0.492029	0.20910	0.15062	0.00143	0.01283	0.3341	0.13643	0.27629	0.00144
Item 46	0.25090	0.10726	0.07486	0.35216	0.36375	0.15956	0.08827	0.10880	0.23210	0.09485
Item 47	0.46927	0.31981	0.12025	0.09512	0.07693	0.19442	0.47598	0.25544	0,07889	0.09659
Item 48	0.22971	0.04956	0.12025	0.07371	0.43806	0.07580	0.00592	0.00914	0.34951	0.10540
Item 49	0.51311	0.35450	0.07501	0.09249	0.14751	0.06880	0.31823	0.26954	0.02931	0,05719
Item 50	0.38795	0.9879	0.05375	0.09512	0.07693	0.34608	0.29910	0.19604	0.09849	0.2119
Item 51	0.67513	0.25502	0.12224	0.12900	0.05492	0.03996	0.07326	0.04708	0.16596	0.15000

Table.2 Normal V arimae Rotated Factor Loadings of the Items

ITEM	FACTOR 1 THE VALUE OF	FACTOR 2 PHYSICS METHOD ACTIVITIES	FACTOR 4 FEAR OF FAILURE IN PHYSICS	FACTOR 6 POOR UNDERSTANDING PHYSICS	FACTOR 8 THE PROBLEM FROM PHYSICS	CALCULATED COMMUNALITY
1	0.03100	0.12079	0.01791	0.07465	0.07952	0.5274
2	0,03578	0.2312	0.06878	0.67682	0.06186	0.5218
3	0.10045	0.11257	0.02115	0.16246	0.9736	0.0592
4	0.06775	0.00163	0.02522	0.75929	0.15050	0.6044
5	0.41341	0.39538	0.09564	0.13480	0.10145	0.3546
6	0.00224	0.01265	0.46241	0.42664	0.228.75	0.3960
7	0.73137	0.00777	0.23168	0.15487	0.06780	0.6172
8	0.11370	0.11644	0.07816	0.01384	0.01585	0.0330
9	0.07702	0.29099	0.22581	0.14373	0.21672	0.2089
10	0.20870	0.05057	0.09425	0.14795	0.21627	0.1237
11	0.28297	0.25459	0.06062	0.09917	0.06688	0.1629

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Table.2 Continued

12	0.40757	0.10489	0.00544	0.07583	0.03976	0.1851
13	0.12858	0.25489	0.19121.	0.07731	0.03334	0.1252
14	0.03198	0.13225	0.19430	0.09453	0.55484	0.3730
15	0.02779	0.22212	0.07697	0.05775	0.08045	0.0700
16	0.19682	0.23738	0.09803	0.07518	0.07343	0.1157
17	0.13257	0.03806	0.13014	0.00914	0.03763	0.0279
18	0.10229	0.02610	0.23855	0.34632	0.51674	0.4115
19	0.14619	0.06147	0.07208	0.38943	0.02553	0.2303
20	0.32966	0.43753	0.07208	0.26204	0.21114	0.3859
21	0.61184	0.03943	0.02878	0.04404	0.09008	0.3868
22	0.10716	0.07685	0.01434	0.06408	0.02605	0.0224
2.3	0.43357	0.22329	0.22329	0.18524	0.8902	0.2970
24	0.26828	0.15346	0.37111	0.06675	0.04757	0.2400
25	0.59955	0.28757	0.33966	0.03689	0.01258	0.5590

Table.2 Continued

26	0.40119	0.02846	0.00547	0.07014	0.02987	0.1678
	0.09320	0.05754	0.02486	0.15706	0.20022	0.0745
28	0.45261	0.37353	0.07232	0.08799	0.03771	0.3588
29	0.12856	0.13895	0.16013	0.22408	0.01120	0.1118
30	0.07654	0.24563	0.49935	0.05046	0.10429	0.3290
31	0.17158	0.04983	0.17680	0.10358	0.21349	0.1206
32	0.07260	0.51181	0.06954	0.02237	0.02662	0.2726
33	0.06044	0.06274	0.09361	0.07126	0.77929	0.6287
34	0.17102	0.51278	0.00671	0.00608	0.10380	0.2997
35	0.10997	0.04142	0.00258	0.07167	0.51308	0.2822
36	0.25445	0.2780	0.28075	0.07519	0.19717	0.2664
37	0.10057	0.17862	0.04101	0.02530	0.18051	0.0769
38	0.35188	0.17226	0.12779	0.05125	0.19224	0.2094
39	0.01055	0.20166	0.08790	0.01259	0.05568	0.0518

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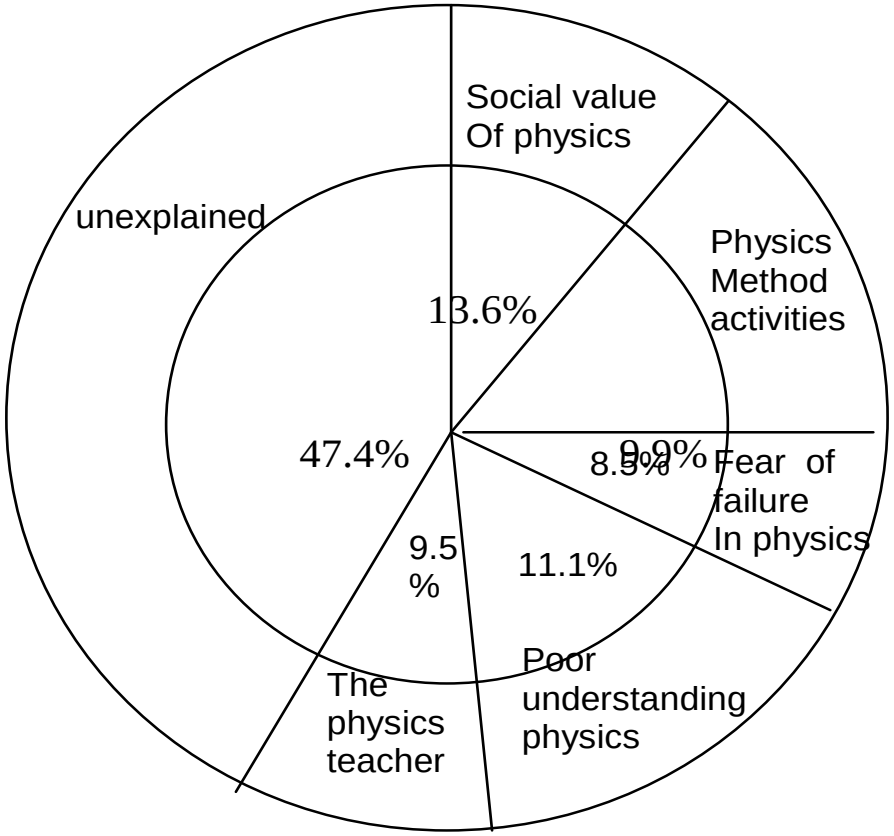
Table.3 Continued.

Factor four fear of future	A mention of physics exam makes me feel nervous	0.37111	0.70075
	I do not find enough time of studying physics	0.49935	Q.50729
	Poor performance by others in physics make me dislike physics.	8.50% 0.39235	0.18973
	I dislike Physics because other students say that it is a hard subject.	0,69710	0.13983
	I am afraid of passing Physics Exams	0.50883	0.07518
Factor SIX Poor Understandin	Find Physics Lessons difficult to understand	0.70466	9.11515
	Physics concepts are confusing to me	0.67682	3.31039
	I dislike physics because of the hard calculations involved.	% 0.75929	11.06 2.38849
	All aspects of physics are difficult, So I dislike it.	0.38943	0.90164
Factor EITHT The Physics Teacher. 0.41138	The physics teacher determines my interest in physics	0.55484	
	The way physics is taught makes me dislike it	0.51674 9.50%	0.98237
	The physics teacher makes me dislike Physics	0.77929	1.19965
	I dislike physics because the physics teacher does not teach it well.	0.51308	0.50729

Fig.1 Attitude to physical model



Moreover, Mojekwu (1989) asserted "involving students in practical session related to their life activities result in developing positive attitude to science". Thus the general negative attitude to physics by secondary school students is attributed to the method and activities involved in learning the subject.

Another factor that contributed to attitude to physics by students is the fear of future activities in physics examinations (Table 3). This factor contributed 8.5% of the Total variance in attitude to physics scale. This finding agrees with the report of Leake (1966) that "fear of future failure or experience of past in science is a serious problem working against science education". According to Sarason (1980), "the person who fears an examination seems preoccupied with self doubt and the consequences of failure". Physics teachers should in their efforts to improve the students' attitude to physics, avoid examination centeredness when teaching. The teacher should create an environment which motivates the students to seek scientific knowledge. Poor understanding of physics concepts and calculation constitute the items of factor six (Table 3). The items of this factor range from difficult in understanding physics; confusing physics concepts to hard calculation involved in physics. These areas are to be studied and harnessed in any physics classroom to identify the attitudes of students, especially the Mathematical background of the students.

Lastly, the physics teacher as a factor in the determination of students' attitude to physic; has many items associated to him. These include the teacher's interest, his teaching methods, his knowledge of the subject and his general dispositions to students. These items are useful in finding the physics attitudes of secondary school students.

Conclusion

The study sought to develop and factorially validate an attitude to physics scale (ATPS in all, twenty four items of satisfactory loading and purity were found to explain the five factor-structure of students' attitude to physics. These factors accounted for 52.6% of the total variance in attitude to physics, each factor accounting for 13.6% 9.9%, 8.5%, 11.1% 9.5[r] respectively. With a high reliability coefficient of 0.82, it is recommended that physics teacher: use this instrument in assessing their students' attitude to physics.

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