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A PROTOCOL FOR CONSTRUCTION AND VALIDATION OF BIOLOGY ANXIETY SCALE

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ABSTRACT

Cause of anxiety is very much widespread. Among different kinds of anxiety, academic anxiety is important anxiety type which generally encounters pupils. From various previous studies we can see almost all students are very easily caught by anxiety. Academic anxiety includes subject wise anxieties also. Biology is generally known as one of the most favourite subjects among students. Still, many of them are seen having anxiety in Biology. Chief aim of the present paper is construct and validate 'Biology Anxiety Scale'. Total 504 senior secondary students from India, took part in present study. Exploratory factor analysis and Confirmatory factor analysis were done to get the structural validity of scale with 252 sample size each. As a result, 3 dimensional and 20 items containing scale is generated. Three dimensions found were: biology test anxiety, biology class room and environment anxiety and biology laboratory anxiety. Alpha coefficient of the whole test found 0.935 and 0.896, 0.946 and 0.875 for each dimension.

KEYWORDS: Biology, Anxiety, Biology anxiety, Test anxiety, laboratory anxiety.

INTRODUCTION

Cause of anxiety is very much widespread. Among different kinds of anxiety, academic anxiety is important anxiety type which generally encounters pupils. From various previous studies we can see almost all students are very easily caught by anxiety. Academic anxiety includes subject wise anxieties also. Biology is generally known as one of the most favourite subjects among students. Still, many of them are seen having anxiety in Biology. To measure the amount of anxiety among students it is necessary to measure it. To measure anxiety in Biology, Biology Anxiety Scale is constructed. Anxiety in students can be initiated with different kinds of classroom situations. We can cite example of evaluation anxiety which can be triggered by real life or imaginary social evaluation. It includes intrapersonal

communication agitation, fear of test and social anxiety etc. Interpersonal communication agitation may be seen among students because of their subjective fear, their inferiority complex in comparison to their co-students and teachers. Previous studies prove that almost 70% of the undergraduate students reported felt communication education. Anxiety related to any test is very common also. Lack of preparation, loss of self-confidence, anxiety of getting lower scores etc. are the chief causes of anxiety related to test. On the other hand, social anxiety represents feelings of embarrassment due to performance pressure felt by students and caused by environmental cues. The motto of the present study is to form and standardise Biology anxiety scale. Through which the amount of anxiety can be measured among different levels of students.

CAUSES OF ANXIETY IN BIOLOGY

Many previous studies shows that student have persistent anxiety in science subjects. If a teacher can make and keep his or her students motivated, that causes the highest success of being a teacher. Lack of motivation is another cause of anxiety. Biology curriculum includes chapters like classification of organisms, biochemistry, physiological processes, different diagrams etc. So, it is very important to measure anxiety in subject Biology in this scale by Problem solving, Interest, Apprehension and Communication. [16] conducted history with university students Biology Laboratory anxiety. To measure laboratory anxiety in biology the researcher constructed and used 15 items containing Biology Laboratory anxiety Scale. First of all, 18 items containing preliminary scale was framed then it was sent to five experts. Final draft scale contains 15 items. Items were constructed according to as per need of study and keeping an eye on total Biology Laboratory classes' contents. 5point Likert Scale used to get result having points: Never, sometimes, often, usually, and always.

METHOD

Aim of the Study

Present experiment was done to form and standardise Biology Anxiety Scale to estimate anxieties related to Biology test, classroom environment and Biology Laboratory Anxiety among secondary and senior 11th and 12th standard school students.

Sample

The sample of this study includes total 504 higher secondary (+2) school students for the year 2021-22 of 5 different Govt. Sponsored schools of Alipurduar district of West Bengal. namely: "Barabisha High School (H.S.), Kamakhyaguri Mission High School (H.S.), Daldali High School (H.S.), Volka High School (H.S.), Kumargramduar MS High School (H.S.)" of West Bengal, India. All students were aged ranged from 16 to 19. Among them 286(56.74%) were male and 218(43.25%) female.

Scale development process

1. One by one interview of students who lives in class 12 and some first year Biology Honours and Medical student to know which kind of difficulties they are facing/ faced during their senior secondary level with Biology Subject.

2. Done literature review to know how many kinds of anxiety can be seen in students and how the scale items can be written or generated. Review of literature can help a researcher to form a idea about a phenomenon and helps in development of items pool. Review of literature also helps in comparison and criticisms of existing scales to form more certain items for a new scale.

3. 80 items pool was generated at first stage of scale constructed. Then it was passes with in-depth analysis and consultation with one-by-one items. And then proper guidance and suggestions by respected Supervisor, 32 items were excluded as they cannot express the whole essence of anxiety in Biology as per theoretical foundation of the study among our target group.

4. Then the scale was sent to two language experts for its correction and reframe. Biology anxiety scale 1st draft was sent to experts for their expert comment ensuring its validity. After receiving their valuable comments 6 items were discarded and some words were reframed.

5. Now the 1st draft of scale is ready for administration and finalisation. Total 504 students of class 11th and 12th standard, i.e. senior secondary level of 5 different senior secondary schools under "West Bengal Council for Higher Secondary Education" (WBCHSE) and who opted biology as their elective subject but chosen as the sample for this study.

6. KMO value for the same is found 0.933 proving the adequacy of sample for the present study. Data collected after due permission of head of the institutions, after getting response the responses were coded in Microsoft excel as per need of study. Then they are analysed with SPSS 26 software. After analysis 20 items scale was developed with 3 dimensions.

FINDINGS

Findings related to Content Validity

Many subjective experts critically reviewed the scale items which includes concepts and definitions of event and items selected for operationalize the study, expressed that taking expert's review is more structured and helps a researcher to establish validity of the scale. Content validity is the logical process where connection between test items and objective and vertical domains are established. For the present study, after the construction of scale items, at first it was sent to 2 different language experts. As the scale is constructed in English language, it was sent to one associate professor in English and another experienced PGT School Teacher with 15 years' experience. After their valuable suggestions, rectification was made in language, now the scale was sent to different experts including 05(five) Associate Professors, one Assistant Professor from Govt. University, 02(two) experienced teachers with 15 and 30 years of teaching experience of different subjects Education, Higher Education, Zoology, Psychology and Biology. As per their consent, the scale items were reduced from 48 to 42.

Construct validity of the scale

Construct validity ensures the amount of validity of a test or research. To get construct validity Exploratory and Confirmatory factor analysis conducted here.

Exploratory Factor Analysis (EFA)

EFA was conducted with 252 sample sizes. Kaiser-Meyer-Olkin Measure of Sampling Adequacy value shows

0.933, when the KMO value (Table 1) exceeds 0.7 that means sample size is adequate [7]. Here value is 0.933 which depicts the sample size is ample for the present study. Bartlett's test was significant ($\chi 2 = 1083.614$, $p=.000$) indicates the validity of factor analysis.

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.933
Bartlett's Test of Sphericity	Approx. Chi-Square	1083.614
	Df	251
	Sig.	0.000

As EFA was applied to the data, the factor load values of the scale, which was confined to three factors, were investigated. The difference in their factor loads for many items was found to be less than 0.10, hence these items were erased off the items. Finally, the exploratory factor analysis was done to the current 20 items in the same way. The measured structure of the three factor-structure was found to have a variation of 68%. The eigenvalue of the first factor was determined, and there were 5 items in it. There are 8 elements in the second factor, and the eigenvalue of the factor lies in-between 0.6 and .83. Finally, in the third factor, there are 7 items and the eigenvalue of the factors were found in-between .51 and .68.

Table 2. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulativ e %	Total	% of Variance	Cumulativ e %
1	9.582	47.909	47.909	9.582	47.909	47.909
2	2.764	13.822	61.731	2.764	13.822	61.731
3	1.451	7.255	68.987	1.451	7.255	68.987

Table 3. Rotated Component Matrix

	Components of the study		
	1	2	3
CE02	0.836		
CE08	0.803		
CE05	0.794		
CE01	0.767		
CE06	0.764		
CE03	0.763		
CE04	0.761		
CE07	0.751		
LAB 01		0.819	
LAB05		0.803	

LAB02		0.802	
LAB03		0.793	
LAB04		0.790	
LAB06		0.668	
LAB07		0.440	
BIO04			0.870
BIO01			0.834
BIO03			0.737
BIO02			0.666
BIO05			0.573

Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis was conducted with separate 252 responses. First the CFA was conducted with 4 dimensions and no significant results found and chi square goodness of fit and factor loading value that is lambda value found not significant.

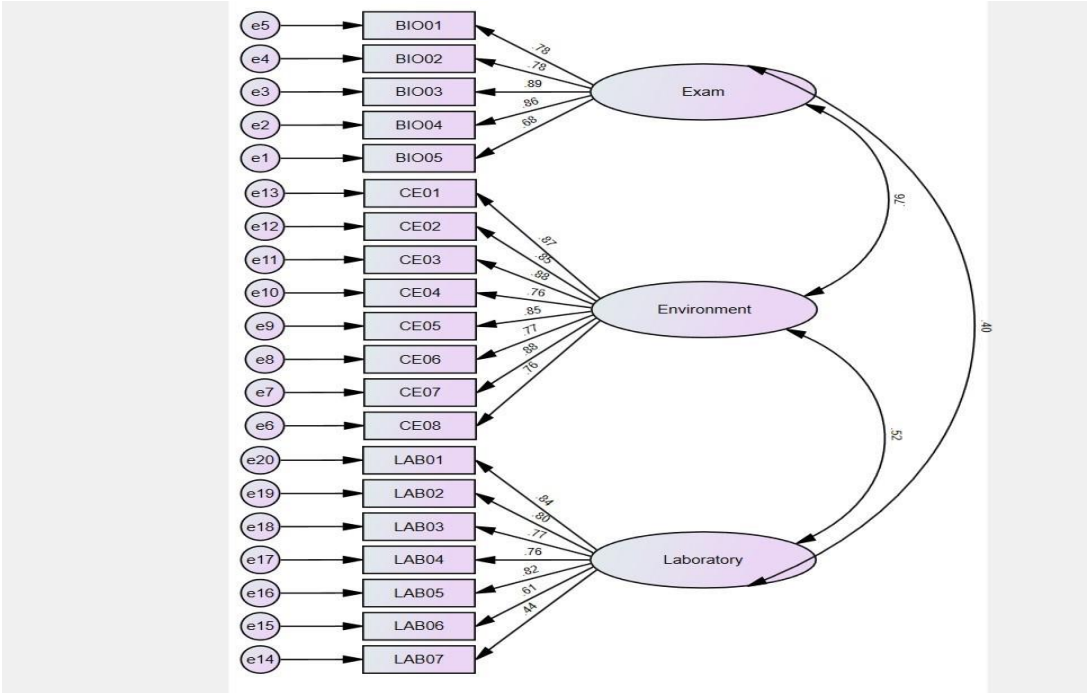

FIGURE 1. Lambda value (Factor Load Value) of the scale

The structural validity of the 3-dimensional was determined using confirmatory factor analysis (CFA). P value found from Chi square 1083.614 is 0.00 which is found significant (Table 4). The t values of all 20 items were determined to be significant in the CFA findings. Figure 5 depicted the scale's factor load values (Lambda). “Corrected item-total correlations” range between 0.45and 0.73. [7] explained that items with value of more 0.3 are considered as distinctive and good items, and should be kept for study. Here all 20 items show

values more than 0.3, so all the items here are good fit for then scale.

Table 4. Different Consistency indices

Consistency	Acceptable Range	References	Value	Result
$\chi 2$/sd	<5 Medium consistent	[1]	1083.614/	Medium consistent
CFI	>0.90	[1]	0.914	Acceptable
NFI	>0.90	[1]	0.906	Acceptable
RFI	>0.85	[1]	0.909	Acceptable
PCFI	>0.80	[1]	0.903	Acceptable
PCLOSE	>0.05	[1]	0.07	Acceptable
TLI	>0.90	[1]	0.907	Acceptable
SRMR	<0.8	[1]	0.7	Acceptable
RMSEA	<0.08	[1]	0.044	Acceptable

Reliability of the scale

To obtain reliability of the scale Cronbach alpha reliability co-efficient, Split helves reliability and Guttman split half co-efficient were calculated.

Reliability co-efficient (Cronbach's alpha)

[7] explored that Cronbach's alpha reliability co-efficient reliability value of a test if exceeds 0.7 it is considered as reliable. Cronbach's alpha values of 3 dimensions and the whole test are given in the following Table 5.

Table 5. Cronbach alpha value of individual dimensions and whole test

Name of Dimension	Cronbach's Alpha
Biology Test Anxiety	0.896
Biology Classroom and Environment Anxiety	0.946
Biology Laboratory Anxiety	0.875
Total Cronbach alpha	0.935

Cronbach Alpha value of whole test was computed as 0.935 which means this scale consists of a high internal consistency. Difference of reliability between below 27% and the top 27% groups were investigated for each item by t-test. The results of t-test are as follows:

Table 6. T-test result for top 27% and below 27% group

Name of Dimension	t value	P value
Biology Test Anxiety	- 26.08	.000
Biology Classroom and Environment Anxiety	- 26.952	.000
Biology Laboratory Anxiety	- 27.633	.000

Total	- 26.88	.000

The value of the 3 dimensions were found significant at the level of $p<0.001$, which means that the scale has enough discrimination power to differentiate students with low score from students with high scores. Split half reliability was also tested. Where the reliability for 1st Part with 10 items was calculated 0.933 to and 2nd part with 10 items was 0.880 which are also satisfactory.

Guttman split-half coefficient was calculated 0.799 and Spearman-Brown Coefficient 0.805 Both are acceptable.

Item Analysis

Table 6. Mean value, SD value and Item total correlation values of Biology Anxiety Scale

	Mean	Std. Deviation	Corrected Item-Total Correlation
BIO01	3.30	1.349	0.572
BIO02	3.08	1.524	0.661
BIO03	3.21	1.651	0.730
BIO04	3.41	1.576	0.625
BIO05	3.07	1.491	0.638
CE01	3.59	1.492	0.776
CE02	3.49	1.248	0.754
CE03	3.46	1.468	0.799
CE04	3.49	1.367	0.691
CE05	3.78	1.346	0.745
CE06	3.29	1.383	0.705
CE07	3.73	1.430	0.806
CE08	3.17	1.404	0.686
LAB01	3.46	1.435	0.601
LAB02	3.77	1.263	0.549
LAB03	3.11	1.451	0.498
LAB04	3.95	1.236	0.536
LAB05	3.77	1.424	0.611
LAB06	3.22	1.604	0.445
LAB07	3.41	1.537	0.392

According to [7] corrected item total correlation values more than 0.3 are acceptable for scale items. Here the 20 items scale's corrected item total

correlation values are found from 0.392 to 0.806 which all are acceptable and distinctive.

RESULTS

Reliability analysis, EFA and CFA were performed to get the result. The final biology anxiety scale was constructed with 20 items and three dimensions. Three dimensions of the scale are as follows: Biology test anxiety, Biology Classroom and Environment Anxiety and Biology Laboratory Anxiety. Final Biology Anxiety Scale comprises of 13 positive items showing positivity towards anxiety in Biology, whereas 7 items are marked as negative items which shows negativity towards Biology anxiety. A Five-point Likert scale was used, from Strongly Disagree to Strongly Agree were the measures of different levels of Biology Anxiety for present scale.

Dimensions of Biology Anxiety Scale

After the literature review items which were previously used in relevant studies of anxiety measurement and which were eligible for structure and content of a biology course (i.e. lab, exam, environment, Subjective) were selected. Some items were constructed with respect to the purpose of the scale and goes of Biology course, some items are generated according to the need of study and to fill up previous research gap found in literature review. Final Biology anxiety scale contains 3 dimensions:

a. Evaluation Anxiety in biology or Test Anxiety [16].

b. Biology Classroom Environment & Learning Anxiety [8] [14] [14] [8]

c. Biology Laboratory Experiences Anxiety [6] [4]

DISCUSSIONS AND SUGGESTIONS

Test or evaluation anxiety is a very common Factor among all categories of students. Almost all ages and categories of students irrespective of Gender and socio-economic background show amount of anxiety before, during and after a test. So, to know more about biology anxiety, it is very important to measure the level of test or evaluation anxiety in biology. Many previous researchers categorised test anxiety into two subcategories namely state and trait test anxiety. State test anxiety is linked with worry and emotional condition. State test anxiety also being the mediator connecting performance evidence goals to performance attainment. War retention palpitation etc comes under the components of state test anxiety. Trait test anxiety is considered to be equivalent to the fear of failure and it is situation specific. constructed ‘Children’s Test Anxiety.

Scale’. 50 items initial scale was constructed, then it was administered to a sample size 230 among grade 3 to 6 students from which final 30 items scale with 3 dimensions constructed and established.

Shah 2019 worked on test anxiety scale; following him here the sub domains which were followed to constructed following Biology Anxiety Scale: Before exam, During exam, After exam.

Comfortable and friendly atmosphere in class as well as in society makes a child more enthusiastic thus helping them to feel free to ask a question. Positive Learning environment promotes happiness and better learning outcomes. So, environment is very sensitive factor in case of formation of anxiety. Positive reinforcement by environment triggers better learning outcomes on the other hand negative environmental cues causes’ growth of anxiety. Following points were considered during the construction of scale items in Biology class and environment and learning anxiety category: Previous Experience, Motivation and Friend/ Teacher [14]

Biology is a branch of science which deals with living organisms. So practical

knowledge is one of the most important things needed for Biology learning and to get practical knowledge and hand-to-hand experience in Biology learning, laboratory is the ideal place. In biology laboratory students deals with chemicals, specimens, different instruments, different models and charts etc. When they have to deal with such things it causes development of anxiety among them. Many previous studies have shown the same results. Laboratory anxiety in Biology domain is included here to measure the level of laboratory among students in biology. This domain consists of items considering following points according to [6] pointed out 6 points for expressing acute laboratory anxiety in chemistry like working with chemicals, working procedure, use of laboratory equipment, data collection, group work among students and use of time during laboratory session. Laboratory learning always have major impact in teaching science. Students may have anxiety about their science laboratory sessions. Science students make grow anxiety in laboratory learning because development of skill to apply theoretical knowledge is required for practical education. So, it is very important to find out if anxiety related to laboratory is present or not in a science learning student. Different previous researches like [6], [16], Berber (2013) etc. developed different laboratory anxiety scales in Physics and Chemistry in different times [6] constructed a Chemistry Laboratory Anxiety Instruments with 30 items and 5 dimensions having six items in each dimension. [3] adapted the same scale which now developed with 20 items and internal consistency for this scale found 0.86.[16] constructed Physics Laboratory Anxiety Scale with 18 items and single factor. This scale found internal consistency of Cronbach Alpha with 0.94. On the other hand, [4] formed and standardized Physics laboratory anxiety scale with 16 items and 4 sub dimensions. Cronbach Alpha of this scale found 0.87. The motto of construction of Biology anxiety scale is to measure the amount of anxiety in Biology in different dimensions like Test Anxiety in Biology, Biology Classroom and environment anxiety and Biology Laboratory Anxiety. Results found satisfactory among Senior secondary students and it is now ready to administer to estimate Biology Anxiety among students.

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