SCIENCE SELF-EFFICACY SCALE: DEVELOPMENT AND VALIDATION

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ABSTRACT:

This paper aimed at the development and validation of Science Self-efficacy Scale by following Likert technique. The steps for the development of the scale involved Planning of the scale, Preliminary draft of the scale, try out, item analysis, final draft of the scale, reliability, validity. Four dimensions viz. Self-confidence, Positive Attitude towards Science/ Physiological arousal, Performance Outcome Expectation and Social Persuasion were chosen. Initially, 70 items for the scale were framed in the said four domains. Collected items were thoroughly screened and edited and

42 items pertaining to the domains were included in the preliminary draft of the scale.The scale was administered on a sample of 150 VIII grade students of science of Government Model Senior Secondary School, Sector 23-A, Chandigarh. Item analysis was carried out by employing t-test for the 42 test items and finally 37 items were left.Again, the test was administered for standardization. Cronbach alpha was calculated to establish internal consistency and was found to be 0.943. Reliability of the scale was also determined by test-retest method and spilt-half methods and was found to be high. Face validity and content validity was established.The tool was found to be highly reliable and valid.
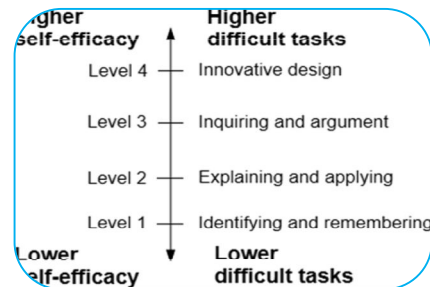
KEYWORDS: Science self-efficacy, Item analysis, Reliability, Validity.

INTRODUCTION:

Many students have difficulty in school not because they are incapable of performing successfully- but they have learned to themselves as incapable of handling academic work. It poses the challenges to the teachers to create academically conducive environment in their classes that can improve the level of low efficacious students. Efficacious teachers create classroom climates in which academic rigor and intellectual challenge are accompanied by the emotional support and encouragement necessary to meet that challenge and achieve academic excellence. So, all teachers should seriously share their responsibility in nurturing the self- beliefs of their students. As Bandura (1986) has argued "educational practices should be gauged not only by the skills and knowledge they impart for present use but also by what they do to students' beliefs about their capabilities, which affects how they approach the future. Students who develop a strong sense of self-efficacy are well equipped to educate themselves when they have to rely on their own initiative."

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SELF-EFFICACY

When one is able to present the knowledge possessed in an effective manner in relation to ones expectation and perception about oneself, it leads to the self-efficacy of an individual in that area of performance. Bandura(1997a) defined self-efficacy expectations as beliefs about one's ability to perform a given behaviour successfully and thereby bring about desired consequences.

Self-efficacy also influences individuals thought patterns and emotional reactions. People with low personal self-efficacy may envisage and believe things are tougher than they really are, a belief that nurtures stress, depression and a restrictive vision of how best to solve a problem. People with high personal Self-efficacy, in contrast, approach difficult tasks and activities with feelings of serenity (Phan, 2012). Tanner and Jones (2003) defined self-efficacy construct as people's judgment for their capabilities to organize and execute courses of action required to attain designated types of performances; it is concerned not with the skills one has but with the judgments of what one can do with whatever skill one possesses.

Efficacy beliefs influence whether people think erratically or strategically, optimistically or pessimistically. They also influence the courses of action people choose to pursue, the challenges and goals they set for themselves and their commitment to them, how much effort they put forth in given endeavors, the outcomes they expect their efforts to produce, how long they persevere in face of obstacles , their resilience to adversity, the quality of their emotional life and how much stress and depression they experience in coping with taxing environmental demands and the life choices they make and the accomplishments they realize. In addition, the efficacy beliefs vary in strength. Weak efficacy beliefs are easily negated by disconfirming experiences, whereas people who have a tenacious belief in their capabilities will persevere in their efforts despite innumerable difficulties and obstacles. They are not easily persuaded by adversity (Bandura, 2006).

SCIENCE SELF-EFFICACY

A strong sense of efficacy enhances human accomplishment and well-being in a number of ways. Confident individuals approach difficult tasks as challenges to be mastered rather than as threats to be avoided. They have greater interest and deep engrossment in activities and set themselves challenging goals and maintain strong commitment to them, and heighten and sustain their efforts in the face of failure. They more quickly recover their confidence after failures or setbacks, and attribute failure to insufficient effort or deficient knowledge and skills which are acquirable. High self-efficacy helps create feelings of serenity in approaching difficult tasks and activities. Conversely, people who doubt their capabilities may believe that things are tougher than they really are, a belief that fosters stress, depression, and a narrow vision of how best to solve a problem. Not surprisingly, confidence in one's academic capability is a critical component of school success.

Students who have strong beliefs about their ability in science tasks and activities tend to select such task and activities and put more effort forth to succeed on these tasks. On the other hand, students who don't believe they will be successful in science are likely to avoid science activities and spend less effort for these activities (Britner and Pajares, 2006). Indeed, many studies reveal a significant relationship between self-efficacy, science achievement and science related choices across grade level (Andrew, 1998). So, we may define Science self-efficacy as one's judgment in relation to expectation and perception about his/her own capabilities to execute his/her course of action, with the skills he/she possesses to attain a required level of designated performance in the subject of science.

PURPOSE OF THE SCALE
SCIENCE SELF EFFICACY SCALE

Science Self Efficacy Scalewas developed with the purpose to know the level self-efficacy among the class VIII students of Government Schools of Chandigarh with respect to science subject in India.

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Target Population
The students studying in class VIII Government Schools of Chandigarh formed the target population.

Objectives
• To develop the Science Self - Efficacy Scale.
• To validate the Science Self - Efficacy Scale.

Need for the development of ScienceSelf-Efficacy Scale
For the construction of scale, literature on Self-Efficacy for various subjects were studied (Bong, Cho, Seon-Ahn & Jin-Kim, 2012; Malpass, O'Neil & Hocevar, 1999; Pintrich & De Groot, 1990; Akin, 2008; Bruning, Dempsey, Kauffman, McKim & Zumbrunn, 2013; Pajares & Valiante, 1997; Rapoo, 2000; Rani, 2011& Kinnedy, 1996; Bhalia, 2013; Vibha, 2001; Ames, 1984; Nichols & Miller, 1994; Cheng & Chiou, 2010; Malpass, O'Neil & Hocevar, 1999; Bandura, 1993; Eklund, Loeb, Hansen & Andersson-Wallin, 2012; Kinnedy, 1996; Huang, 2013; Kinnedy, 1996; Gungoren & Sungur, 2009; Anderman &Young, 1994; Britner & Pajares, 2001; Guvercin, 2008) were reviewed.The above scales were developed and standardized in different subjects like English, Mathematics, Biology etc. for different grades. Moreover, they were developed for students in the different cultural context at foreign places. Therefore, to fulfill the requirement of appropriate Science Self-Efficacy Scale, the researcher felt the need to construct a scale especially for assessing Science Self-Efficacy of VIII grade students of Government schools of Chandigarh.

Procedure for development of the scale
To fulfill or achieve the objective of development of the scale, As Bandura (2006),suggests that self-efficacy scales must be tailored to activity domains and asses the multifaceted ways in which efficacy beliefs operate within the selected activity domain. The efficacy scales must be linked to factors that in fact, determine quality of functioning in the domain of interest.

Components selected for the Science Self-Efficacy Scale are:
- Self Confidence: The faith in oneself and one's abilities to perform a certain task successfully, developed through experience.
- Positive Attitude towards Science: It means to keep a set of ideas, values and thoughts that tend to look for the good, to advance and overcome problems, to find the opportunities in every situation and to look as it is said 'on the bright side of life'. It also means to have courage and exceed oneself, getting up whenever one falls.
- Performance Outcome Expectation: Performance outcome expectations define the specific results expected, the extent (how much is expected), and the time frame. Good performance expectations allow one to know and determine if what has been set out to be accomplished has been achieved.
- Social Persuasion: A deliberate attempt on the part of one party to influence the attitudes or behaviour of another party so as to achieve some predetermined end. The communicator sends a message to a target person hoping to evoke a particular response.

Preparation of first draft of the Tool
A) Planning the Scale
For scale construction, initially review of related literature regarding self-efficacy and science self-efficacy was done. Of the areas identified after the review and scrupulous discussion with experts, namely four skills viz. Self-confidence, Positive Attitude towards Science/ Physiological arousal, Performance Outcome Expectation and Social Persuasion were chosen. Initially, 70 items for the scale were framed in the said four domains. Suggestions for addition, deletions and modification of items were sought from 20 experts – six from the Department of Education, Panjab University,five from University School of Open Learning, Panjab University, four from Government College of Education,

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Sector 20, two from Dev Samaj College of Education, Sector 36 and five experienced science teachers from secondary schools of Chandigarh. After discussion with experts, collected items were thoroughly screened and edited. 42 items pertaining to the four domains were included in the preliminary draft of the scale. All the statements were carefully worded for the use by students, with a careful observation of items with experts. Items that seemed repetitive or ambiguous were rectified. Pre-try-out on the ten students of class VIII was also conducted and their suggestions were also sought regarding the language.

B) Preliminary form of the scale

After preliminary screening, editing of the statements and their pre-try out and modification, the preliminary form of the scale comprised of 42 items of Likerttype on a five-point rating scale.

C) Scoring

The scoring was based on five-point Likert type scale. A positive item weighed score of 5 for Strongly Agree (SA), 4 for Agree (A), 3 for Undecided (U), 2 for Disagree (DA), and 1 foe Strongly Disagree (SD) and a negative item weighed score 1 for Strongly Agree (SA), 2 for Agree (A), 3 for Undecided (U), 4 for Disagree (DA), and 5 for Strongly Disagree (SD).

Table 1
DISTRIBUTION OF ITEMS IN FOUR AREAS OF SCIENCE SELF-EFFICACY (PRELIMINARY DRAFT)

Components	Items	Total items	Positive items	Total items	Negative Items	Total items
Self Confidence	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	11	1, 2, 5, 6, 7, 9, 10	7	3, 4, 8, 11	4
Positive Attitude towards Science	12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,	12	14, 15, 16, 18, 20, 21, 23	7	12, 13, 17, 19 , 22,	5
Performance Outcome Expectation	24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34	11	24, 25, 27, 28, 31, 33, 34	7	26, 29, 30, 32	4
Social Persuasion	35, 36, 37, 38, 39, 40, 41, 42	8	35, 36, 37, 38, 39, 40, 41, 42	8	-	0
Total		42		29		13

Try-out

The 42 statements were randomized and were provided with standard directions and administered on a sample of 150 VIII grade students of science of Government Model Senior Secondary School, Sector 23-A, Chandigarh. The response sheets were collected and scored for each individual separately.

Item-Analysis

The responses of the subjects were scored by weight age to the items described above. The weight age score for each item and for each subject was summed up. On the basis of the total scores 27% of high scores (high group) and 27% of low scores (low group) among the group were identified. Their scored responses, in terms of weighted scores for each item was worked out. Item analysis was carried out by employing t-test for the 42 statements for the higher and lower group. Thus, the significance of difference between the means was worked out to find out the discriminating power of each item; how well each item could distinguish between individuals having different attitudes. Only those items, which showed a significant difference between high and low groups at least at 0.05 level,

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were selected for inclusion in the final form of the scale. Out of 42 items 5 items were rejected as the t-ratio was found to be not significant even at 0.05 level (Thakur, 2018).

Final form of the Scale

The final form of the Science Self-Efficacy scale consisted of 37 statements in four domains. There are 26 positive items and 11 negative items. The distribution of items in four domains and positive and negative items has been presented in Table.

Table2
DIVISION OF ITEMS ACCORDING TO FOUR DIMENSIONS OF SCIENCE SELF EFFICACY SCALE (FINAL DRAFT)

Components	Items	Total items	Positive items	Total items	Negative Items	Total items
Self Confidence	1, 2, 3, 4, 5, 6, 7, 8, 9	9	1, 2, 4, 5, 7, 8	6	3, 6, 9	3
Positive Attitude towards Science/ Physiological arousal	10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21	12	12, 13, 14, 16, 18, 19, 21	7	10, 11, 15, 17, 20	5
Performance Outcome Expectation	22, 23, 24, 25, 26, 27, 28, 29, 30, 31	10	22, 23, 25, 26, 28, 29, 31	7	24, 27, 30	3
Social Persuasion	32, 33, 34, 35, 36, 37	6	32, 33, 34, 35, 36, 37	6	-	0
Total		37		26		11

ESTIMATING RELIABILITY

For the tests measuring psychological traits assumed to be relatively stable over time, a measure of the stability of test scores over time is essential. The test is administered, a period of time elapses, and the same test is re-administered.

For Science Self-Efficacy scale, reliability was determined by test-retest method. The test was administered to 300 students of class VIII of Government Model Senior Secondary School, Sector 33-A, and Government Model Senior Secondary School sector 19-C of Chandigarh. The same test was re-administered after one month to them.

Thetest-retest reliability was found to be 0.93, which is fairly high. The reliability of this test was also measured by split half methodby using Spearman Brown's formula that was found to be 0.81. As the Spearman Brown Formula assumed that variability of the two halves of the test are equal. An alternative formula (Gutman, 1945) does not make this assumption and the reliability by this method was found to be 0.86.The two formulae produce essentially the approximately similar value of reliability coefficient (0.81 and 0.86). Hence the Science Self-Efficacy Scale was considered highly reliable.

In addition to this, Cronbach's Alpha was also calculated to provide a unique estimate of the reliability for a given test. The value of Cronbach's Alpha Coefficient normally ranges from 0 to 1. The closer is this value to 1.0, the greater is the internal consistency of the items included in the scale. The reliability of the Science Self-Efficacy Scale when computed in form of Cronbach's Alpha was found to be 0.943 for 37 statements included in 4 dimensions. This value indicates that the Science Self-Efficacy Scale has high internal consistency.

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Table 3
Reliabilities of the Test by Different Methods

Method	Reliability Coefficient
Test-Retest	0.93
Split-half method a) Spearman Brown's	0.81
b) Guttman's	0.86
Cronbach alpha	0.943

It is evident that the scale possessed adequate internal consistency therefore it was considered reliable for administration.

Validity
A) Face Validity

The unanimity of 20 experts about the items was taken as an indicator of face validity of the scale. For content validity, the dimensions were administered to five experts to assess the relevancy of the items to the category to which they belong. Items having 80% of agreement were selected.

B) Content Validity

It is concerned with the content of the test. Content means the substantive constituents of materials their factual and informational component. It is determined by substantially comparing the test items to be postulated content domain. The validation process is logical and rational, involving the judgments of correspondence between the test and underlying domain.   Twentyexperts were approached to establish the content validity of the tool. Content validity ratio (CVR)was calculated for each item which range from -1 to +1. For all 37 items CVR was found to be positive which indicates that half the subject experts rated the item as essential.

Interpretation of the scores

The minimum and maximum obtained score on this scale was 82 and 172 respectively. The mean score was found to be 127 and SD was found to be 16.99. The students can be categorized in accordance with their raw scores.

Table 4
Classification of Raw Scores into various Levels of Science self-efficacy

Range	Interpretation
145 and above	High science Self-efficacy
Between 110 and 144	Moderate science self-efficacy
109 and below	Low science Self-efficacy

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