Development and Validation of Science Self Efficacy Scale (SSES) for Secondary School Students

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Abstract

The research study was taken to develop a suitable and reliable scale for measuring self efficacy belief in science subject among secondary school students. In this research study, a collection of 55 items were constructed to develop the 'Science Self Efficacy Scale' (SSES) based on the literature review related to discussion with experts. The items were arranged into five dimensions of science self efficacy, namely, 'self confidence', 'self regulation', 'self concept', 'perceived science efficacy' and 'outcome expectancy'. These items were graded on five point Likert scale. The process of validation was accomplished with 300 students of 14–15 years age group, studying science as a subject, and selected randomly from Government schools of Haryana, India. The process of item analysis was done by calculating t-values. Fourteen items of the scale were dropped, and finally, 41 items were kept. The calculated value of Cronbach's alpha came out to be 0.86 and for the split-half method, it was 0.76. The construct validity of the scale was determined by calculating the co-efficient of correlation between the scores of this scale and the score obtained by using 'Self Efficacy Scale' (SES) by Singh and Narain, 2014. The percentile norms for the scale were obtained after validating the normality score by Q-Q plot. The result suggests that SSES may be a helpful tool for future research to assess self belief in persons, particularly in science subject. The SSES scale is relevant to students, psychologists and school teachers. This tool can be used for evaluation and understanding of self efficacy level in science, thereby helping them in planning and implementing different kinds of strategies for enhancing their self efficacy level.

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Introduction

Adolescence is a crucial and immense phase in the development and socialisation of an individual that nurtures a person for future challenges. It is also considered an important phase where an adolescent spends remarkable time in the school environment. The favourable school environment and instructions may lead to the establishment of good relations with peers, teachers and the community.

It also helps in the development of managerial and leadership skills among students (Dunn 1998; Moos, 1979). In the words of Roeser, Midgley, and Urdan, 1996, students who got desired opportunities to learn in a school environment exhibit proper adjustment, emotional development and academic excellence (Church, Elliot, and Gable, 2001). Bandura (1994) hypothesises that in cooperative and holistic learning environment students feel satisfied and pleasant as they work in togetherness. In addition to this, various teaching-learning activities like slide shows, visual and virtual mode of learning, outdoor and indoor activities and the use of other online and hands-on resources along with the conventional method of teaching makes learning more creative and stimulating (NCERT, 2019).

Science education at the school level is acclaimed for developing scientific values like scientific temper, rationality, reasoning, problem solving, etc. But there are barriers in the science education system and the major barriers include attitudinal, architectural, administrative and divergent socio-economic status (UNESCO, 2010). Therefore, there is a need to amend the confidence and attitude of student from rote learning to experimental or practical learning approach towards science subject and giving ample freedom to teacher and students to bring reform in science curriculum by discovering new areas of science (NEP, 2020). The problem-solving instructions and blended learning (Chung and Ro, 2004; Abdelraheem, 2014) showed a marked effect on children's creativity and self efficacy as well. Various research studies (Alt, 2015 and Goldstein, 2016) determine that problem and project-based learning method leads to a more positive constructive learning environment that promotes active participation and motivation thereby, reducing fear, leading to increased self efficacy and making learning more enjoyable.

Conceptual Framework

The inception of self efficacy can be outlined back to the social cognitive theories of learning. It emerged amongst 1940s and 1980s (Heider, Rotter, Seligman, Weiner, Bandura and Skinner as cited in Flammer, 2001). Heider (1958) proposed attribution by considering that individuals look for a rational justification after the occurrence of an event or behaviour and called it 'situational attribution' or 'external

attribution'. If the motive of behavioural outcome was ascribed to various environmental aspects and come from the individual, it was 'personal attribution' or 'internal attribution'. The individual having secondary or external attribution got a lower control level. In the words of Bandura (1999), self efficacy is a belief about one's ability to perform behaviours or accomplish a behavioural approach. Danehower (1988) further illustrated that efficacy beliefs lead to better performance. Bandura (1997) in his book '*Self efficacy: The Exercise of Control'* emphasised that self efficacy functions with various socio-cognitive factors in human success and accomplishment.

After carrying out a comprehensive literature review and discussion with the expertise of the field, it has been observed that enhancing self efficacy belief is a continuous process and an important variable affecting a child's development in science subject and many tools were given for measuring self efficacy. Thorough observing and investigating varied available tools for evaluating the self efficacy level of learners, it was perceived that very few tools are reliable in the Indian context. If an instrument were to be developed to assess the feeling of self efficacy in the science subject, then remedial or intervention actions can be implemented to bring reform in pedagogical strategies and classroom learning environment. Therefore, it was decided by the investigator to develop and standardise a Science Self Efficacy Scale (SSES) meant exclusively for students in the subject of science.

Methodology

The procedure of scale development and validation was done in five fundamental stages namely: scale conceptualisation, scale construction, item scoring, final tryout, item analysis and selection of item, reliability and validity of the scale. The process of scale validation is shown in Figure 1.

Scale Conceptualisation (Defining various elements)
Scale Construction
Item Scoring, Tryout and Review the Scale
Final Tryout, Item Analysis and Item Selection
Tool Validation and Norms

Fig.1: Process of tool construction and standardisation

Science Self Efficacy: Conceptual Framework

Self efficacy is also called personal efficacy. It is defined as individualised faith in personal abilities for desired results. Bandura (1994) believed that with high self efficacy one takes the difficult task as a challenge. Such people recover from setbacks and challenges easily. Science self efficacy helps to determine individualised faith in personal abilities for the production of the desired achievement in science. People take the difficult tasks as a challenge and

try to find the solutions to problems scientifically, with patience, without losing their self confidence and recovering themselves from setbacks if they are unable to find solutions. They recover easily and take interest in doing science practically.

This scale was constructed to assess the self efficacy of Class IX students in science subject. Finally, five components or elements were selected for test construction. These five elements were 'self confidence', 'self regulation', 'science self concept', 'perceived science efficacy' and 'outcome expectancy'. Each element is briefly discussed below:

(i) **Self Confidence:** Self confidence is how one feels about oneself and one's abilities (Greenacre, Tung and Chapman, 2014). The defining characteristics of self confidence are mastering particular activities; trusting in one's ability to achieve goals, achieving goals through hard work and overcoming any doubts and obstacles positively, accepting difficult challenges and continuing work in the face of setbacks or failure and taking it as a part of everyday life.

(ii) **Self Regulation:** Self regulation is the ability to develop, execute and assess the expected behaviour to achieve goals (Winne, 2021). The behavioural characteristics associated with it include goal setting, interest, self motivation, cooperation, help seeking, ignoring distraction, focussing and maintaining attention on set goals, curiosity and enthusiasm to do new or goal-directed activities and judging the effectiveness of the plan.

(iii) **Self Concept:** Self concept is an individual's belief about themself as to how they think, evaluate or perceive themself and how others think about themself (Schwarzer and Warner, 2013). It is the concept of oneness. The characteristics of self concept are self image (what you see for yourself), self esteem (self worth in the eyes of others), recognition, ideal self and competitiveness (Elliot, 1984; Gecas, 1982).

(iv) **Perceived Science Efficacy:** It is faith in an individual's perceived abilities for successful performance of behaviour which leads to the development of a specific result or outcome. The defining characteristics associated with it are perceived capability in doing science practicals, skills in doing practicals effectively and efficiently and goal attainment (Croker, Andersson, Lush, Prince and Gomez, 2010).

(v) **Outcome Expectancy:** It refers to faith that one's efforts will lead to the attainment of desired results or goals (Cook and Artino, 2016). The behavioural characteristics include an individual's performance, ability, systematic effort, self determination and organisation.

Description of Science Self Efficacy Scale

This scale was prepared to assess the self efficacy of Class IX students in the subject of science. The science self efficacy scale included 55 items categorised into five elements, namely self confidence, self regulation, self concept, perceived science efficacy and outcome expectancy. Table 1 shows the items, composed of different elements of science self efficacy.

The scale contains 28 positive and 27 negative statements or items and details are specified in Table 2.

Item Scoring

The responses for positive items ranged from 'strongly agree to strongly disagree' and the pattern of scoring was from 5 to 1 respectively; whereas, for negatively keyed items reverse scoring patterns were followed. The responses for negative items ranged from 'strongly agree to strongly disagree' and the pattern of scoring was from 1 to 5 respectively. The item scoring details are given in Table 3.

Construction and Standardisation

(i) Preliminary draft: The review of related literature in self efficacy

Table 1: Items Distribution in Five Elements of Science Self Efficacy Scale

S. No.	Elements	Number of Items	Question Number of Items
1.	Self Confidence	13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
2.	Self Regulation	17	14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30
3.	Self Concept	12	31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42
4.	Perceived Science Efficacy	05	43, 44, 45, 46, 47
5.	Outcome Expectancy	08	48, 49, 50, 51, 52, 53, 54, 55

Table 2: Positive and Negative Items of Science Self Efficacy Scale

Nature of Items	Question Number of Items	Total
Positive	1, 3, 5, 7, 8, 11.12, 14, 16, 17, 19, 24, 25, 29, 30, 33, 34, 36, 37, 41, 42, 44, 45, 47, 48, 49, 50, 53	28
Negative	2, 4, 6, 9, 10, 13, 15, 18, 20, 21, 22, 23, 26, 27, 28, 31, 32, 35, 38, 39, 40, 43, 46, 51, 52, 54, 55	27

Table 3: Pattern of Scoring for Positive and Negative Items

Items	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Positive Items	5	4	3	2	1
Negative items	1	2	3	4	5

and science self efficacy was referred for scale development. Initially, items related to different elements of science self efficacy were outlined. The opinion or characteristics associated with the Science Self Efficacy Scale were summarised on five point Likert Scale (Likert, 1932). The front page contains basic information about students and further instructions like the purpose of the scale and how to answer the items were also briefly written in it. In the preliminary draft, sixty statements of the Science Self Efficacy Scale were constructed. The scale was sent to experts from education, psychology and science education for their views regarding the relevance of elements, ability to understand content and items covering constructs. Based on experts' remarks, a few items were amended and consented items were finalised for scale. Further, screening of language was done by Hindi and English language experts. At last, the primary scale retained fifty-five items.

(ii) Pilot study: Pilot study was conducted on fifty students of Class IX. After administration of the test, modifications to ambiguous items were sought keeping in view the understanding problems, language suitability, doubts and repeated statements.

(iii) Try out: After modifying the items of the test, administration of scale was implemented on 300 sample students of Class IX. The students were instructed to finish the test as soon as possible without any time constraints. After data collection, items of statements were analysed.

(iv) Item analysis and item selection: Analysis of items is a technique to assess the scale items qualitatively as well as quantitatively. Qualitative analysis is done based on the content and structure of items. Quantitative analysis is done by calculating item difficulty and item discrimination. After administrating the preliminary draft of the scale, containing 28 positive items and 27 negative items, the process of item analysis was done. A response sheet of 300 students was arranged in ascending order for item analysis. Upper 27 per cent and lower 27 per cent responses were selected for analysis of items (Kelley, 1939). The item discriminating value was calculated by applying the 't'-test. The table value of 't' was 2.67 at the 0.01 significance level. Therefore, items having a higher calculated value, or equal to the table value of 't' test, were retained whereas others were discarded. The obtained t-values are given in Table 4.

In Table 4, it was experienced that 't' value for 14 items had poor discriminative power. These 14 items have 't' values lesser than 2.67. Therefore, total 14 items having serial number 6, 10, 21, 22, 26, 27, 28, 32, 33, 35, 38, 39, 43 and 53, which were not according to the required 't' value,

were dropped. A total of 41 items were retained out of 55 items.

(v) Reliability: The scale's reliability was measured by the application of Cronbach's alpha and split-half method. Cronbach alpha assesses the internal reliability of scale. Table 4 showed the Cronbach

Table 4: Item Analysis of Science Self Efficacy Scale

Item Number	t-value	Cronbach's Alpha if Item Deleted	Result	Item number	t-value	Cronbach's Alpha if Item Deleted	Result Significant at 0.01 level
1	5.658	0.793	Selected	29	7.874	0.790	Selected
2	5.786	0.793	Selected	30	5.407	0.792	Selected
3	3.327	0.798	Selected	31	40.784	0.794	Selected
4	7.554	0.790	Selected	32	0.060	0.806	Rejected
5	3.360	0.797	Selected	33	2.393	0.799	Rejected
6	1.945	0.808	Rejected	34	5.396	0.793	Selected
7	5.638	0.793	Selected	35	1.657	0.808	Rejected
8	4.019	0.796	Selected	36	5.738	0.793	Selected
9	4.992	0.793	Selected	37	3.577	0.796	Selected
10	0.506	0.806	Rejected	38	2.180	0.800	Rejected
11	5.084	0.793	Selected	39	0.248	0.806	Rejected
12	5.276	0.793	Selected	40	7.507	0.789	Selected
13	3.232	0.811	Selected	41	5.606	0.793	Selected
14	4.909	0.794	Selected	42	7.187	0.792	Selected
15	7.859	0.790	Selected	43	1.368	0.808	Rejected
16	4.954	0.796	Selected	44	4.675	0.794	Selected
17	4.696	0.794	Selected	45	3.590	0.796	Selected
18	6.600	0.791	Selected	46	3.132	0.798	Selected
19	3.717	0.795	Selected	47	7.538	0.790	Selected
20	3.503	0.798	Selected	48	5.787	0.793	Selected
21	2.383	0.799	Rejected	49	4.866	0.793	Selected
22	2.166	0.801	Rejected	50	5.158	0.794	Selected
23	6.791	0.791	Selected	51	4.354	0.796	Selected
24	8.310	0.789	Selected	52	8.562	0.789	Selected
25	4.945	0.795	Selected	53	0.880	0.802	Rejected
26	1.682	0.801	Rejected	54	5.502	0.814	Selected
27	2.537	0.810	Rejected	55	6.874	0.791	Selected
28	1.547	0.807	Rejected	—	—	—	—

alpha value and it was 0.86 after eliminating poor items from the scale, which is rationally high for reliability. Split-half method is another way to judge the reliability of the scale. The value of split-half method of the present was 0.76 (Nunnally, 1978) which is reliable. Therefore, these two methods of reliability measurement give the indicator of good reliability of SSES. Table 4 indicates the different measures of reliability calculated for SSES.

(vi) Validity: Validity of the Science Self Efficacy Scale was determined by establishing content validity, face validity and construct validity. For determining content and face validity the initial draft of the Science Self Efficacy Scale was given to experts, as mentioned earlier, chosen from various fields. Based on comments received from various experts, out of 60, 5 items were dropped and few items were amended and approved items were retained in the scale. In addition to this, screening of language for this scale was done by English and Hindi language experts. At last, commonly approved 55 statements were retained. Construct validity of Science Self Efficacy Scale was established by calculating the co-efficient of co-relation between the total scores of Science Self Efficacy Scale and scores of its five different elements. The value of co-efficient of co-relation between different constructs of Science Self Efficacy Scale varies from 0.68 to 0.90 and the level of significance was 0.01. The coefficient of correlation/ Pearson correlation is given at Table 5.

From Table 5 of the inter-correlation matrix, it is evident that the items under different constructs of the Science Self Efficacy Scale are inter-correlated.

(vii) Norms: Norm is the median or average of the present achievement of a given group in a given test. It is used to compare data. As science self efficacy was standardised on three hundred

Table 5: Inter-correlation Matrix between Various Constructs of Science Self Efficacy

Elements	Self Confidence	Self Regulation	Self Concept	Perceived Science Efficacy	Outcome Expectancy	Total Scores
Self Confidence	1	0.655**	0.545**	0.483**	0.496**	0.824**
Self Regulation	0.655**	1	0.649**	0.546**	0.641**	0.908**
Self –Concept	0.545**	0.649**	1	0.479**	0.509**	0.797**

Perceived Science Efficacy	0.483**	0.546**	0.479**	1	0.480**	0.685**
Outcome Expectancy	0.496**	0.641**	0.509**	0.480**	1	0.754**
Total Scores	0.824**	0.908**	0.797**	0.685**	0.754**	1

** Significant at the 0.01 level

students of Class IX, the test norms were established by testing the data for normality by using the 'Shapiro-Wilk Test' and 'Q-Q plot' shown in Figure 2.

The value of 'Shapiro-Wilk Test' was found to be 0.36, higher than 0.05, showing that there was a normal distribution of sampled data. The percentile norms were arranged based on scores of the science Self efficacy scale obtained from three hundred subjects. The scores of Science Self Efficacy Scale ranged from 92 to 167. The interpretations were grouped into five categories, i.e., very good, good, average, poor, and very poor. A detailed explanation of

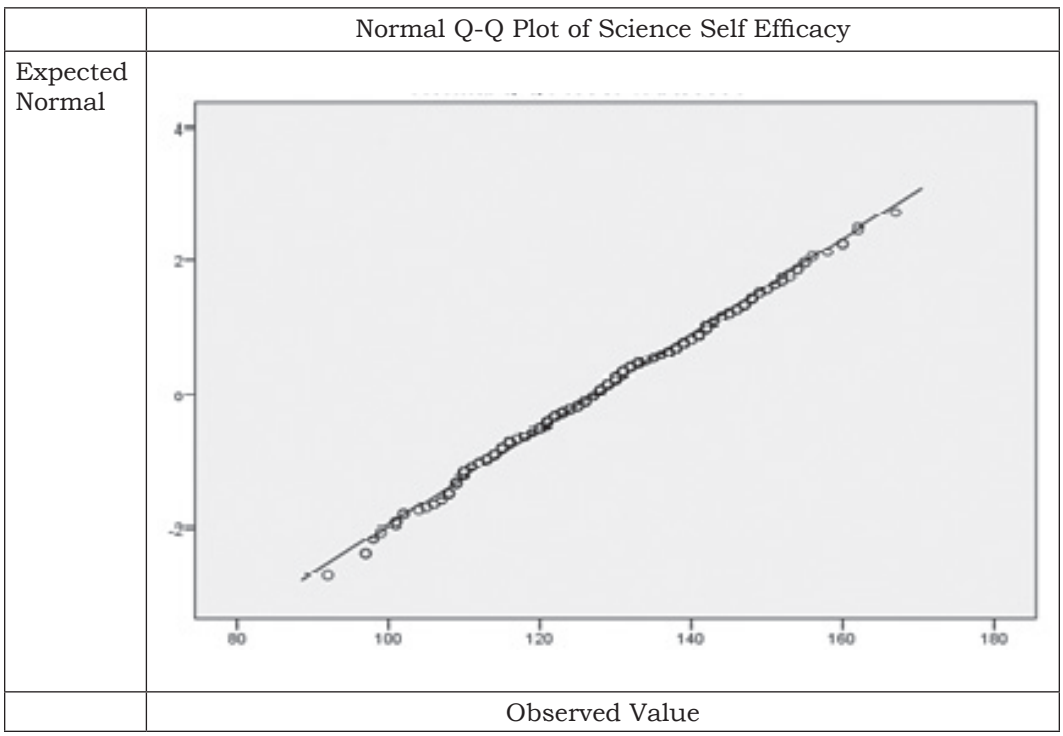

Fig. 2: Q-Q Plot Showing the Normal Distribution of Sampled Data

Table 6: Percentile Norms for Science Self Efficacy and their Interpretation

Percentile	Scores of Science Self Efficacy	Quantitative Interpretation	Qualitative Interpretation
95th	151.00	146 and above	Very good
90th	146.00		
80th	140.80	136 to 145	Good
75th	138.00		
70th	135.00	120 to 135	Average
60th	130.00		
50th	127.00		
40th	123.40		
30th	120.00		
25th	117.25	110 to 117	Poor
20th	115.00		
10th	109.00	109 and below	Very poor

norms for science self efficacy is given in Table 6.

Description Regarding Final Science Self Efficacy Scale (SSES)

The Science Self Efficacy Scale (SSES) was designed to assess the self efficacy of students in science subject. The scale contains 41 items, and these items were arranged into five sub elements: self confidence, self regulation, self concept, perceived science efficacy and outcome expectancy. The respondents were supposed to respond against five categories against each items, i.e., very good, good, average, poor, and very poor. The final Science Self Efficacy Scale items are given in Table 7.

Discussion

The findings of the present study reveal that SSES is a reliable and valid tool for assessing self efficacy in science subject. The SSES includes both positive and negative items and has been developed in both English and Hindi languages. The statistical analysis reveals that the scale is reliable and valid and would be an effective tool in assessing self belief of students who generally find difficulty in understanding and application of scientific concepts. The construct validity of the scale was assessed with a standardised general Self Efficacy Scale (SES) given by Singh and Narain (2014). Regardless of the above limitation, the results of the study reveal that SSES may be a valuable tool to assess science self efficacy among students.

Table 7: Description of Final Science Self Efficacy Scale

S.N.	कथन/Statements
1.	मुझे वैज्ञानिक समस्याओं का समाधान करना पसंद है। I like to solve scientific problems.
2.	विज्ञान के प्रयोगों के असफल होने पर मैं अपना धैर्य खो देता/देती हूँ। I lose my patience whenever I fail in science experiments.
3.	मैं मुश्किल वैज्ञानिक कार्यों को आसानी से करने में सक्षम हूँ। I am capable of doing difficult scientific tasks easily.
4.	मैं कड़ी मेहनत करने पर भी असफल होता/होती हूँ। I am unable to get success despite doing hard work.
5.	मैं वैज्ञानिक चुनौतियों का सहजता से सामना कर सकता/सकती हूँ। I can face scientific challenges with ease.
6.	जब तक मुझे सफलता नहीं मिलती तब तक में बारम्बार प्रयास करता/करती हूँ। I keep on trying again and again until I succeed.
7.	मैं स्वयं अधिकतर वैज्ञानिक शंकाओं का समाधान करने के समर्थ हूँ। I find myself capable of solving most of the scientific doubts at my own.
8.	जब चीजें मेरे नियत्रंण में न हो तो मैं आसानी से निराश हो जाता/जाती हूँ। I usually get frustrated whenever the things are not under my control.
9.	मैं निष्कर्ष निकालने और प्रयोग के बाद परिणामों की व्याख्या करने में सक्षम हूँ। I am capable of drawing conclusions and interpreting results after experimentation.
10.	मैं चीजों को बारिकी से देखता/देखती हूँ। I observe things minutely.
11.	मैं प्रयोग करने में अच्छा/अच्छी नही हूँ। I am not good at experimentation.
12.	मुझे लगता है कि वैज्ञानिक अध्ययन और वैज्ञानिक अविष्कार लक्ष्य निर्धारित करते है। I feel that scientific studies or inventions are target/goal oriented.
13.	मैं विज्ञान विषय से सम्बंधित प्रयोगों को करने में रूचि खो चुका/चुकी हूँ। I have lost interest in doing science experiments.
14.	मैं निरंतर स्वयं को लक्ष्य प्राप्ति के लिए प्रोत्साहित करता/करती हूँ। I consistently encourage myself in achieving the set goals.
15.	मैं अपनी परियोजना के काम के दौरान अपनी प्रगति पर निगरानी रखता/रखती हूँ। I keep on monitoring my progress during my project work
16.	मैं वैज्ञानिक समस्याओं पर ध्यान देने में असमर्थ हूँ। I am unable to pay attention on scientific problems.
17.	मुझे स्वयं विज्ञान प्रयोगशाला में प्रयोग करना पसंद है। I like to perform experiments in science laboratory on my own.
18.	कई बार दिया स्वपन (दिन के सपने) मेरे कार्य करने में रूकावट पैदा करते हैं। Frequent day-dreaming disturbs my working.
19.	मैं विज्ञान के क्षेत्र में नए विकास को जानने के लिए हमेशा उत्सुक नहीं रहता/रहती हूँ। I am not always curious to know new developments in science field.
20.	मैं अपने निर्धारित लक्ष्य के लिए अपनी प्रगति पर नजर रखता/रखती हूँ। I, keep tracking my progress for set goals.
21.	मैं वैज्ञानिक समस्याओं के हल के लिए दूसरों की मदद लेने में झिझक महसूस नहीं करता/करती हूँ। I do not hesitate in seeking help from others to solve scientific problems in hand.

22.	मैं खुद को कठिन और जटिल समस्याओं को पता करने के लिए प्रेरित करता/करती हूँ। I keep on motivating myself to solve the difficult and complex scientific problems.
23.	मैं वैज्ञानिक परियोजनाओं से संबंधित मुश्किल हालात से निपटने में प्रोत्साहित महसूस करता/करती हूँ। I feel motivated in handling difficult situations related to science project.
24.	मैं अक्सर विज्ञान की परीक्षा के दौरान चिंतित रहता/रहती हूँ। I often feel worried during science tests.
25.	प्रयोग करते समय ए में अपनी गहातियों से सीखता/सीखती हूँ। While doing experiments, I tend to learn from my mistakes.
26.	जब मुझे मुश्किल काम करने को कहा जाता है, तो में और अधिक दृढ बन जाता/जाती हूँ। Whenever I am asked to do difficult tasks, I become more determined.
27.	मैं अपने दोस्तों के सुझावों को सकारात्मक रूप से होता/लेती हूँ। I take my friend's suggestions positively.
28.	अंतिम परिक्षा के प्रदर्शन में मैं खुद को दुर्भाग्यपूर्ण मानता/मानती हूँ। I consider myself unlucky in the performance of final exam.
29.	मैं अपनी क्षमताओं पर विश्वास करके अपने जीवन में सब कुछ प्राप्त कर सकता/सकती हूँ। I can achieve everything in my life by believing in my own abilities.
30.	मैं निरंतर प्रयास के साथ हर मुश्किल काम पूरा कर सकता/सकती हूँ। I can complete every difficult task with continuous effort.
31.	में आमतौर पर वैज्ञानिक अवधारणाओं को अधिक आसानी से सीखता/सीखती हूँ। I usually learn scientific concepts more easily.
32.	विज्ञान के सिद्धांत को समझने के लिए क्षेत्रीय यात्रा एवं सर्वेक्षण बहुत उपयोगी है। Field visits/surveys are very useful in understanding the science principles.
33.	मैं अपने आप को कुछ प्रयोग कुशलता से करने में असमर्थ पाता/पाती हूँ। I find myself unable to perform some experiments skillfully.
34.	यदि मैं विज्ञान से जुड़ी समस्या में फंस जाता/जाती हूं तो लगातार प्रयत्न करने पर समाधान ढूंढ लेता/होती हूँ। When I am confronted with science related problems, I find solutions through consistent effort.
35.	मेरा पूरा प्रयास विज्ञान गृहकार्य को सफलतापूर्वक पूरा करने में मेरी मदद करता है। My whole hearted efforts help me in finishing science homework successfully.
36.	यदि मैं वैज्ञानिक क्रियाकलापों को सुनियोजित ढंग से करूँ तो सफलता प्राप्त कर सकता/सकती हूँ। I can get success if I do my scientific activities through a well-planned way.
37.	मैं विज्ञान कार्य में साथी की आलोचना के बावजूद दृढ़ रहता/रहती हूँ। I remain determined to undertake scientific work despite the criticism from fellows.
38.	किसी नकारात्मक टिप्पणी से मैं और विचलित हो जाता/जाती हूँ। I get disturbed with negative comments.
39.	मैं अपने वाक्य पर ध्यान केंद्रित करने में सक्षम नहीं हूँ। I am unable to focus my attention on my goal.
40.	मुझे विज्ञान प्रदर्शनी और प्रश्नोत्तरी में भाग लेना अच्छा नहीं लगता है। I don't like to participate in science exhibitions and quiz, etc.
41.	मैं अक्सर विज्ञान के याद किए हुए तथ्यों को भूल जाता हूँ। I often forget the learned concepts of science.

If their self efficacy level is assessed at the initial level and proper interventions are adopted, it may increase their self belief and confidence to handle any problematic situation related to science.

Conclusion

The literature review in the science education area showed that there is a dearth of scales or tools to assess students' science self efficacy. Hence SSES was developed by the researcher after following a subsequent procedure for standardisation. The SSES can be used in several ways, because it is a simple tool to conduct and assess self belief or Self efficacy along with its five sub-elements. The research study was completed on a sample of 300 school students. The tool was prepared with the aim to develop science self efficacy of school students. Total 41 items were included in the final scale and were tested for their content, face and construct validity. Like other scales, it has certain limitations that need to be considered before its use. This tool does not contain culture-specific content and can be used across the national boundaries after determining its reliability and validity. It is an effective tool for evaluating the student's self efficacy level in science so that remedial intervention programme can be induced to make science learning more valuable and practical.

References

Abdelraheem, A.Y. 2014. Enhancing Students' Learning and Self efficacy through Blended Learning in a Teachers' Program. *Journal of Educational Technology*. Vol. 10, No. 4. pp. 29–39.

Alt, D. 2015. Assessing the contribution of a constructivist learning environment to academic Self efficacy in higher education. *Learning Environments Research*. Vol. 18, No. 1. pp. 47–67.

Bandura, A. 1994. Self efficacy. In V. S. Ramachaudran (Ed.), Encyclopedia of human behavior. Vol. 4. pp. 71–81. Academic Press. (Reprinted in H.Friedman [Ed.], Encyclopaedia of mental health. San Diego: Academic Press, 1998.

———. 1997. Self efficacy: The exercise of control. New York, Worth Publishers.

———. 1999. Social cognitive theory: An argentic perspective. *Asian Journal of Social Psychology*. Vol. 2. pp. 21–41.

Chung, N. and G. Ro. 2004. The effect of problem-solving instruction on children's creativity and Self efficacy in the teaching of the practical arts subject. *Journal of Technology Studies*. Vol. 30, No. 2. pp. 116–122. Retrieved from https://eric.ed.gov/?id=EJ905134

Church, M.A., A. J. Elliot, S. L. Gable. 2001. Perceptions of classroom environment, achievement goals, and achievement outcomes. *Journal of Educational Psychology*. Vol. 93, No. 1. pp. 43–54.

Cook, D. A. and A. R. Artino. 2016. Motivation to learn: an overview of contemporary theories. *Medical Education*. Vol. 50, No. 10. pp. 997–1014. Retrieved from doi:10.1111/medu.13074

Croker, K., H. Andersson, D. Lush, R. Prince and S. Gomez. 2010. Enhancing the student experience of laboratory practicals through digital video guides. *Bioscience Education*. Vol. 16, No. 1 pp. 1–13. Retrieved from doi:10.3108/beej.16.2

Danehower, C. 1988. An empirical examination of the relationship between Self efficacy and expectancy. In D. F. Ray (Ed. Southern Management Association proceedings. pp. 128–130. MI: Southern Management Association.

Dunn, R.J. 1998. Organisational dimensions of climate and the impact on school achievement. *Journal of Instructional Psychology*. Vol. 25, No. 2. pp. 100–115.

Elliot, G. C. 1984. Dimensions of the self concept: A source of further distinctions in the nature of self consciousness. *Journal of Youth and Adolescence*. Vol. 13, No. 4. pp. 285–307. Retrieved from doi.org/10.1007/BF02094866

Flammer, A. 2001. Self efficacy. International Encyclopaedia of the Social and Behavioral Sciences. pp. 13812–13815. Retrieved from doi:10.1016/b0-08-043076-7/01726-5

Gecas, V. 1982. The self concept. *Annual Review of Sociology*. Vol. 8. pp. 1–33. Retrieved from doi.org/10.1146/annurev.so.08.080182.000245

Goldstein, O. 2016. A project-based learning approach to teaching physics for pre-service elementary school teacher education students.*Cogent Educati*on. Vol. 3, No. 1. pp. 1–12. Retrieved from doi: 10.1080/2331186X.2016.1200833

Greenacre, L., N. M. Tung and T. Chapman. 2014. Self confidence, and the ability to influence. *Academy of Marketing Studies Journal.* Vol. 18, No. 2. pp. 169–180.

Heider, F. 1958. *The Psychology of Interperson*al *Relations*. Wiley. Human inference: Strategies and shortcomings of social judgment, Englewood Cliffs, NJ: Prentice-Hall.

Kelley, T. L. 1939. The selection of upper and lower groups for the validation of test items. *Journal of Educational Psychology*. Vol. 30. pp. 17–24.

Likert, R. 1932. A technique for the measurement of attitudes. *Archives of psychology*. No.140. New York University, New York.

Moos, R. H. 1979. Educational climates. In H. J. Walberg (Ed.) Educational environments and effects: Evaluation, policy, and productivity. pp. 79–100. Berkeley, CA: McCutchan.

National Council of Educational Research and Training. 2019. Learning outcome at the secondary stage. NCERT Publication Division, New Delhi.

National Policy on Education. 2020. Ministry of Education, Government of India, New Delhi.

Nunnally, J. C. 1978. *Psychometric Theory (2nd Ed.).* McGraw Hill, New York.

Roeser, R. W., C. Midgley and T. C. Urdan. 1996. Perceptions of the school psychological environment and early adolescents' psychological and behavioral functioning in school: The mediating role of goals and belonging. *Journal of Educational Psychology*. Vol. 88, No. 3. pp. 408–422.

Schwarzer, R. and L. M. Warner. 2013. Perceived Self efficacy and its relationship to resilience.In Resilience in children, adolescents, and adults. pp. 139–150. Springer, New York, NY. Retrieved from doi; 10.1007/978-1-4614-4939-3_10

Singh, A.K. and S. Narain. 2014. *Self efficacy Scale*. Agra: National Psychological Corporation.

United Nations Educational, Scientific and Cultural Organisation. 2010. *Current Challenges in Basic Science Education.*

Winne, P. H. 2021. Cognition, metacognition, and self regulated learning. In *Oxford Research Encyclopedia of Education.*