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Unlocking Science Potential: Developing a New Attitude Scale SS-SAS for Young Learners

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Abstract

The aim of this examination is to develop an attitude scale for measurement of scientific attitude of upper primary students. The development was carried out by researchers with the help of 20 subject area experts, and 240 students of approved schools of state of Rajasthan State/central boards BE/CBSE board studying in classes 6–8. The study consists of five parts, namely literature review, components of scientific attitude to be measured, development of scale, expert opinions, administration of scale and computation of reliability and validity. For identifying the components of scientific attitude an extensive review of related was carried out and five components were identified. An initial draft of scientific attitude scale (SAS) comprising of 65 items was forwarded to 20 experts for Face and Content validity. Subsequently Content Validity Ratios were calculated and Final SAS tool comprising of 62 items was formulated. This was then administered to 20 percent (48) of total sample (240 students) students. Reliability of the test was calculated for SAS using Split Half (Odd-Even) Correlation and split half reliability to the correlation coefficient yielded a reliability coefficient of .882. Tool had five aspects on scientific attitude for which separately Pearson"s correlation has been found out to be 0.799. Final outcome of the study. The scale with 62 statements was ready to be used.

Keywords: Scientific attitude, scientific attitude scale, SS-SAS, content validity ratio, statistical analysis

INTRODUCTION

Young students' curiosity, intellect, and problem-solving abilities are greatly enhanced by science instruction [1, 2]. For students to have a greater awareness of scientific ideas and their uses, they must have a favorable attitude toward knowledge [3]. However, research suggests that students' attitudes toward science often decline as they progress through school, with many developing negative perceptions of science and its relevance to their lives. [4]

Field of study on educating science to young learners is a cornerstone of modern society, driving innovation, technological advancements, and economic growth. However, despite its importance, science education faces numerous challenges, including declining student interest, inadequate teacher training, and insufficient resources [5]. Students' attitudes to science have a significant impact on the degree of involvement they are with the subject matter. A positive attitude toward science can foster motivation, curiosity, and a deeper understanding of scientific concepts, while a negative attitude can lead to disengagement and underachievement.

The development of a scientific attitude is a complex process influenced by various factors, including teaching methods, classroom

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environment, and societal norms. Research has shown that students' attitudes toward science are shaped by their experiences in the classroom, with teachers playing a critical role in promoting or discouraging interest in science [6, 7].

Despite the importance of scientific attitude in science education, there is a scarcity of research on the development and validation of instruments to measure scientific attitude among upper primary students [8]. Existing scientific attitude scales are often designed for older students or focus on specific aspects of scientific literacy, leaving a gap in the assessment of scientific attitude among younger learners [9, 10].

Research has consistently shown that students' attitudes toward science are shaped by a complex interplay of factors, including teacher-student interactions, classroom environment, and societal influences [11]. Despite the significance of scientific attitude, existing research has focused primarily on older students, leaving a knowledge gap regarding the attitudes and motivations of younger learners. The development of a scientific attitude scale (SAS) for young learners is essential for several reasons [12, 13].

1. *Early intervention:* Identifying and addressing negative attitudes toward science at an early age can prevent long-term disengagement and underachievement.
2. *Tailored instruction:* A SAS can provide teachers with valuable insights into their students' attitudes, enabling them to design instruction that meets the diverse needs of their students.
3. *Program evaluation:* A SAS can serve as a tool for evaluating the effectiveness of science education programs and interventions aimed at promoting scientific literacy.

RATIONALE

This study aims to address the research gap by developing and validating a new scientific attitude scale (SAS) specifically designed for upper primary students. The SAS will provide a reliable and valid tool for measuring scientific attitude among young learners, enabling teachers, educators, and policymakers to assess and promote scientific literacy.

SCIENTIFIC ATTITUDE

According to several scientists and experts in psychology, a scientific mindset eliminates superstitions and incorrect ideas that are prevalent in society and fosters the practice of sound intellectual observation, experimentation, and problem-solving skills. Scientific attitude is a tendency to question assumptions think and act in a certain way, establish cause- and-effect relationships and change one's views based on evidence. K.BAROT, D. et al. [14] says that “the term scientific attitude is a state of mind that defines a belief in empirical evidence, intellectual curiosity, passion for truth, sensitivity to evidence, and the need for open communication in science”.

Scientific attitude implies those factors that characterise scientific thinking and which can be developed through the teachings of science. Belief, feeling, and action are its four main components, based on Korur, F. et al. [15]. According to Khan, M. et al.'s study report [16], there are seven indications of scientific attitudes: curiosity, respect for facts and data, critical thinking, creativity and discovery, collaborating and open-mindedness, persistence, and environmental sensitivity. According to Mahajan, M. et al. [17], a scientific attitude is characterized by open-mindedness, a desire for precise knowledge, poise in procedures, a quest for knowledge, and an anticipation that the application of confirmed knowledge would lead to the solution of the issue. Accuracy, intellectual honesty, open-mindedness, suspended discretion, critical thinking, and a tendency of seeking out cause and effect relationships are all components of a scientific mindset, argues Md. Ashique Husain et al. [18].

The following components that make up the scientific mindset [19] had been identified for this study:

a. Rationality
b. Open-Mindedness

c. Confidence in Scientific method
d. Curiosity
e. Aversion to Superstition

Rationality

"The quality of being centered on or in accordance with reason or logic" is its definition. Students' capacity for reasoning and deploying logic to solve issues is measured by irrationality.

Open-Mindedness

The readiness to look for information that undermines one's preferred ideas, plans, or objectives and to fairly assess such material when it is accessible in order to modify preexisting perceptions and conclusions is known as open-mindedness. It's the capacity to reject creative and distinctive methods in favor of fresh experiences and ideals.

Confidence in Scientific Method

The process of producing facts via experimenting and testing is known as the scientific method. It entails making observations, forming theories, forecasting, and carrying out experiments to evaluate the outcomes. Being certain that the scientific technique may generate the intended outcomes is known as confidence in the approach being used.

Curiosity

Curiosity is the desire to learn more, appreciate novel circumstances, look for solutions to the "why" and "how" questions, and have an in-depth understanding of the world [13]. It is not limited to any specific area of science. It includes the desire to comprehend more in order to discover solutions of one's own.

Aversion to Superstition

Superstitions are "a belief or way of functioning that is based on fear of the unknown and faith in magic or luck: a belief that certain occurrences or circumstances will bring good or bad luck," defined to the Britannica Dictionary. It suggests a conduct that rejects mystical convictions and accepts only scientific explanations and facts as part of a scientific perspective.

REVIEW OF RELATED LITERATURE

When Narayanan, K. A. et al. [20] developed attitude to science ratings for use with children between the ages of five and eleven, they showed that the passion of both boys and girls for science gradually declines with age. Similar drop in school enjoyment: As students age older, their enjoyment in school likewise decreases. Jones, K., Kind, P., and Barmby, P. (2007). Three of the constructs—learning science in school, science besides school, and future involvement in science—loaded on one general attitude towards science factor, according to developing attitudes towards science evaluations.

Parween Nahid Anwar, S. M. [21] looked at scientific viewpoint scales in India and developed and validated a new scale. Based on Pell, T. et al.'s study on psychometric considerations of scientific attitude in the disciplinary Journal of Environmental and Science Education [22], a science teacher may use the Scientific Perception Scale (Sood and Sandhya, 1978) to gauge secondary students' scientific attitudes. In her review work on the difficulties in monitoring scientific attitude, P. W. Hastuti, S. N. et al. [23] come to the fact that pre-service or in-service training programs seldom provide professionals with instruction on how to create scientific attitude measurement tests. In her work, Rani, B. et al. [24] looked at 23 scientific attitude assessments in India [25]. Vandana Kaushik, D. J. et al. [26] developed an attitude scale for students of classes 6 – 10^{th}. Alparslan University, Turkey developed an attitude scale to measure students‟ attitude toward science for college students.

In order to determine the perceptions of middle school children (grades 5 through 8) toward science, Y Varaprasada Reddy, D et al. [27] created and validated an Attitude towards Science Training Scale (AtSL) for Pakistani students in grades 8 and 9. Using Robert Ausubel's "Meaningful Learning Model," some Pakistani academics developed and tested a tool to gauge students' scientific attitudes and dispositions.

RESEARCH GAP

Despite the importance of scientific attitude, there is a scarcity of research on the development and validation of attitude scales specifically designed for young learners. Existing scales are often adapted from instruments designed for older students or focus on narrow aspects of scientific literacy, limiting their utility and validity for assessing the attitudes of younger students.

METHODOLOGY

In the study, an instrument was developed to find out the scientific attitude of upper primary school children attitude towards science. The instrument development for the study was realized in the winter semester of 2023 academic year with the participation of 240 RBSE board schools students selected from four schools of Jaipur district.

TARGET POPULATION

The sample of study consisted of 240 RBSE board schools students studying in 6–8th grades chosen from four schools of Jaipur district. Details of the students are given in Table 1.

CONSTRUCTION OF SCIENTIFIC ATTITUDE SCALE

It was planned with the purpose of measuring the attitude at Upper primary (6 – 8th) class students. The statement was intended to represent intellectual, emotional, positive and negative statements. This would represent the universe of content of the five components of scientific attitude identified for present study as illustrated in Figure 1.

DEVELOPMENT PROCESS

The development of the scale comprised of the following four stages:

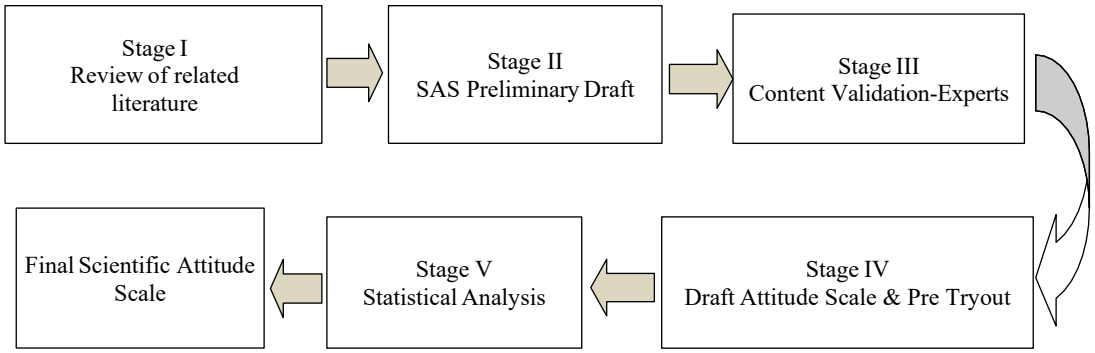

Figure 1. Stages in Designing an Attitude Scale.

Table 1. Details of students.

Control Group			Experimental Group		Class Total
Class	*Public Schools-1*	*Public School-2*	*Public Schools-3*	*Public School-4*	
6	19	21	20	20	80
7	10	30	24	16	80
8	12	28	21	19	80
Total	41	79	65	55	240

Stage I

At the onset an extensive study of related literature, Thesis, Review papers, and Attitude scales on Scientific attitude, its components, measurement of scientific attitude, development of Scientific Attitude scale scales in India and abroad was carried out by the researcher.

Stage II

Based on the above studies five components of scientific attitude was finalised by the researcher. Based on various Scientific Attitude scales a preliminary draft consisting of 90 statements (positive and negative) was prepared. Subsequently after interaction with subject experts and Guide this was reduced to 65 Statements on a five point Likert type scale such as "Strongly Agree", "Agree", "Cannot Say", "Disagree" and "Strongly Disagree".

Stage III

The preliminary draft scale was forwarded to a panel of 20 experts for Content validation based on Relevance, Clarity and Language. The Experts were asked to mark the same on a scale of 1 to 3. Distribution is as given in Table 2 below.

Content Validity Ratio (CVR) was calculated and 3 statements with CVR < 0.7 were discarded. Further, four statements with CVR > 0.8 but Clarity < 0.6 were modified as discussed in Table 3 and Table 4. The draft scale with 62 statements in five dimensions comprising of 29 positive and 33 negative statements was prepared AS.

Table 2. Rating Scale for Experts.

Relevance (R)	
Very Relevant	1
Need some revision	2
Not Relevant	3
Clarity (C)	
Very Clear	1
Need some revision	2
Not Clear	3

Table 3. Distribution of statements in the Scientific attitude scale (SAS) is as below.

S. N.	Dimension	Ser Number of Statements	Total Items	Positive	Negative
1	Rationality	1–17	17	10	07
2	Open Mindedness	18–29	12	04	08
3	Confidence in Scientific Measures	30–41	12	09	03
4	Curiosity	42–50	09	06	03
5	Aversion to superstition	51–62	12	-	12

Table 4. Distribution of positive and negative statements in the SAS is as below.

Statements	Total Number	Serial Numbers
Positive	29	2, 3, 4, 5, 6, 8, 9, 10, 11, 14, 19, 21, 24, 25, 30, 32, 33, 34, 35, 38, 39, 40, 41, 42, 43, 44, 45, 48, 50.
Negative	33	1, 7, 12, 13, 15, 16, 17, 18, 20, 22, 23, 26, 27, 28, 29, 31, 36, 37, 46, 47, 49, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62.
Total	62	

Stage IV-Preliminary Try out.

Sample of 48 students (20 per cent of the total sample of 240 students) were selected. 16 students each from class 6, class 7 and class 8 (16×3=48) were taken to administered the draft Scientific attitude scale. Their responses were recorded for statistical analysis.

SCORING ON THE TOOL

Present scientific attitude scale is a five point Liker type scale and every items are in the statements form with five responses as indicated in Table 5 below. There is no right or wrong answer in the scale. The students have to select the most appropriate response category on a scale of 1 to 5. The scoring was done by assigning point values as shown below to each of the attitude items. The scale contains five subscales determined on the basis of components of scientific attitude. Scores for various subscales can be determined by adding the total for positive items and the total of negative items and sum total score of five sub-scales is equal to the total scores of the entire scales. The range of the entire scale is (1–5 × 62) = 62–310.

Stage V-Statistical Analysis.

The reliability of the test was calculated for SAS developed by the researcher using Split Half Correlation. In order to determine internal credibility, the split-half approach partitioned the test into two portions, Odd and Even. Tool has five aspects on scientific attitude for which separately Pearson‟s correlation has also been found out. Overall reliability established on total aspects of the developed tool was 0.882 which indicates strong reliability, suggesting that the test's different sections are measuring the same thing consistently. Details are summarized in Table 6 below.

CONCLUSION

The final Scientific Attitude Scale (SAS) consisted of 62 statements distributed across five key dimensions, incorporating 29 positive and 33 negative statements designed to holistically assess learners' scientific disposition. The scale underwent rigorous statistical testing, and based on the obtained results, both the reliability and validity indices were found to be highly acceptable. This confirms that the SAS is a dependable and psychometrically sound instrument for measuring upper primary students' attitudes toward science, including curiosity, open-mindedness, rational thinking, and evidence-based reasoning. The findings affirm that the tool can effectively differentiate between varying levels of scientific attitude among learners. However, the research was conducted with participants from a single city within the jurisdiction of the Rajasthan Board of Secondary Education,

Table 5. Assignment of Scores.

	Positive Item	Negative Item
SA (Strongly Agree)	5	1
A (Agree)	4	2
CN (Cannot Say)	3	3
D (Disagree)	2	4
SD (Strongly Disagree)	1	5

Table 6. Split Half Method Scale for all variables/aspects.

S.N	Aspects	Items numbers	Total items	Pearson's Correlation	Reliability
1	Rationality	1–17	17	.703	.825
2	Open Mindedness	18–29	12	.644	.783
3	Confidence in Scientific Measures	30–41	12	.604	.753
4	Curiosity	42–50	10	.611	.758
5	Aversion to Superstition	51–62	11	.501	.717
Total Scores		62	0.799		0.882

which limits the generalizability of the results. Regional, cultural, and curricular variations may influence scientific attitude, suggesting that broader sampling is needed to strengthen the applicability of the instrument. Therefore, future studies should include additional validation across diverse geographical locations, school types, and educational boards. Such extended validation will enhance the robustness of the SAS and provide researchers with a valuable, standardized tool for investigating scientific attitude at the upper primary level.

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