Investigating Science Students Readiness to Perform Practical's at Secondary Level

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Abstract

The Science Practical's Readiness Assessment (SPRA) aims to evaluate the readiness of secondary-level students to perform science practicals effectively. This study addresses the crucial need for students to be well-prepared for practical science activities, which are vital for their overall scientific understanding and competence. The research involved developing a comprehensive instrument with 50 items across four key factors: access to resources and facilities, teacher support and guidance, interest and motivation, and self-efficacy and confidence. After expert evaluation by 14 specialists, 19 items were discarded due to low content validity ratios (below 0.45). The remaining items were administered via a Google form in a WhatsApp group of school students. Exploratory factor analysis using varimax rotation confirmed the validity of the scale. The instrument's reliability was verified with a Cronbach's alpha of 0.921. The study's findings highlight critical areas for improvement in science education and offer a validated tool for assessing student readiness.

Keywords: Students Readiness, Secondary Schools Practical, Inclusive Education.

Introduction

Science education is crucial for developing critical thinking and problem-solving skills, which are essential for navigating and understanding the complexities of the natural world. One of the core components of effective science education is the integration of practical science activities. These activities offer students practical experiences that surpass mere theoretical understanding, enabling them to engage actively to engage directly with scientific concepts, conduct experiments, and observe phenomena in real time. Practical science activities help students bridge the gap between theory and practice, fostering a deeper and more comprehensive understanding of scientific principles.

However, the success of these practical activities largely depends on students' readiness to engage in them. Readiness, in this context, refers to the extent to which students are prepared and equipped to perform science practicals effectively. It encompasses various factors such as access to necessary resources and facilities, the level of support and guidance provided by teachers, students' intrinsic interest and motivation, and their self-efficacy and confidence in conducting experiments (Abrahams & Reiss, 2012).

The importance of assessing students' readiness cannot be overstated, as it directly influences their learning outcomes and overall educational experience. Students who are well-prepared for practical activities are more likely to engage meaningfully, retain information better, and develop a positive attitude toward science. Conversely, a lack of readiness can lead to

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frustration, disengagement, and a diminished interest in science subjects (Bennett & Holman, 2002).

Given the critical role of practical science activities in education and the varying levels of student readiness, this study aims to develop and validate a comprehensive instrument known as the Science Practicals Readiness Assessment (SPRA). The SPRA is designed to systematically evaluate the readiness of secondary-level students to perform science practicals. By identifying strengths and areas for improvement, the SPRA provides valuable insights that can help educators and policymakers enhance the quality and effectiveness of science education (Eccles & Wigfield, 2002).

Through a meticulous process of item development, expert review, and validation, the SPRA aims to offer a reliable and valid measure of students' readiness. This instrument will serve as a crucial tool for schools to assess and improve their science programs, ensuring that all students have the opportunity to succeed in practical science activities. Ultimately, the goal is to foster a generation of students who are not only knowledgeable in scientific theories but also adept at applying them in practical, real-world contexts (Deci & Ryan, 2000).

Literature Review

Practical work in science education has long been recognized as a critical element in fostering a deep understanding of scientific concepts and processes. Research consistently highlights the numerous benefits of practical science activities, including enhanced student engagement, improved comprehension of complex theories, and increased interest in science subjects. These hands-on experiences enable students to apply theoretical knowledge in real-world contexts, thereby solidifying their learning and making science more accessible and enjoyable.

Studies indicate that practical science activities are instrumental in developing essential skills among students. These skills include:

Scientific Inquiry: Engaging in practical experiments allows students to formulate hypotheses, design and conduct experiments, and draw conclusions based on empirical evidence. This process mirrors the work of professional scientists and helps students understand the nature of scientific investigation (Darling-Hammond et al., 2017).

Experimentation: Through hands-on activities, students learn how to manipulate variables, control experimental conditions, and systematically observe and record data. This experiential learning is crucial for grasping the principles of experimental design and methodology.

Data Analysis: Practical work often involves collecting, analyzing, and interpreting data. Students develop critical thinking and analytical skills as they learn to process and make sense of their experimental results (Osborne et al., 2003).

Problem-Solving: Practical activities frequently present challenges that require students to think creatively and solve problems. This aspect of practical work helps students build resilience and adaptability, which are valuable skills both within and beyond the realm of science (Bandura, 1997).

Challenges in Implementing Practical Science Activities

Despite the clear benefits, the effective implementation of practical science activities in schools faces several challenges:

Inadequate Resources: A significant barrier to effective practical science education is the need for adequate resources. This includes insufficient laboratory equipment, limited access to materials, and inadequate space for conducting experiments. Schools with limited budgets often need help to provide the necessary tools and environments for practical work, which can severely limit students' opportunities for hands-on learning.

Lack of Teacher Support: Teacher support and guidance are crucial for the successful execution of practical activities. However, many teachers may need more training or confidence to facilitate these activities effectively. With proper support, students may receive the instruction and feedback they need to benefit from practical experiences fully.

Low Student Motivation: Motivation plays a crucial role in students' engagement with practical activities. Factors such as a lack of interest in science, perceived difficulty of experiments, and prior negative experiences can diminish students' enthusiasm and willingness to participate in practical work. Addressing these motivational issues is essential for maximizing the impact of practical science education.

Impact on Students' Readiness

Understanding the factors that influence students' readiness to engage in practical science activities is critical for improving science education. Readiness encompasses not only the availability of resources and teacher support but also students' intrinsic interest and confidence in their abilities. By identifying and addressing the barriers to readiness, educators can create more effective and engaging practical science experiences.

The research underscores the need for comprehensive assessments of students' readiness to perform practicals, as this can inform targeted interventions and resource allocation. Tools like the Science Practicals Readiness Assessment (SPRA) are designed to evaluate these factors systematically, providing valuable insights for educators and policymakers.

Practical work is a vital component of science education that significantly enhances students' learning experiences and skill development. However, challenges such as inadequate resources, lack of teacher support, and low student motivation can impede the successful implementation of practical activities. Understanding and addressing these challenges through systematic assessments and targeted improvements is essential for fostering a more effective and engaging science education.

Theoretical/Conceptual Framework

The conceptual framework of this study focuses on four key factors that influence secondary students' readiness to perform science practicals. These factors are critical in determining how well students are prepared to engage in hands-on science activities and achieve meaningful learning outcomes. The framework integrates aspects of educational theory and practical application to provide a comprehensive understanding of student readiness.

Access to Resources and Facilities: This factor encompasses the availability and quality of necessary equipment, materials, and laboratory space required for conducting science practicals. Adequate resources and facilities are fundamental for effective science practicals. With the proper tools, students can fully engage in experiments and experience the scientific process firsthand. Schools need to ensure that students have access to well-equipped laboratories, sufficient quantities of consumable materials (such as chemicals and specimens), and appropriate safety gear. A lack of resources can lead to incomplete experiments, reduced learning opportunities, and diminished student interest in science. Conversely, well-resourced environments can enhance the practical learning experience, making science more accessible and engaging.

Teacher Support and Guidance: This factor refers to the role of teachers in providing instruction, feedback, and encouragement to students during science practicals. Teachers are pivotal in facilitating practical science activities. They guide students through the experimental process, explain complex concepts, ensure safety protocols are followed, and provide constructive feedback. Adequate teacher support can demystify challenging experiments and make science more approachable. Inadequate teacher support can leave students confused and disengaged, while solid support can boost student confidence and interest in science. Teachers who are well-trained and enthusiastic about practical science can inspire students and enhance the overall learning experience.

Interest and Motivation: This factor captures students' enthusiasm and intrinsic motivation to engage in science practicals. Students' interests and motivation are crucial for active participation in science practicals. Intrinsic motivation drives students to explore and understand scientific concepts deeply rather than merely completing tasks for grades. Motivated students are more likely to persist through challenges and develop a lasting interest in science. Low motivation can result in minimal effort and engagement, reducing the effectiveness of practical activities. High levels of interest and motivation can lead to more profound learning, more excellent retention of knowledge, and a positive attitude towards science (Shulman, 1986).

Self-Efficacy and Confidence: This factor pertains to students' belief in their ability to perform practical tasks and experiments successfully. Self-efficacy influences how students approach practical science activities. Students who believe in their capabilities are more likely to take on challenging experiments, persist through difficulties, and achieve better results. Building self-efficacy involves providing opportunities for success, offering positive reinforcement, and helping students develop problem-solving skills. Low self-efficacy can lead to anxiety and avoidance of practical tasks, hindering learning. High self-efficacy fosters resilience, encourages experimentation, and promotes a growth mindset, which is essential for scientific inquiry (Millar, 2004).

Methodology

Item Piloting

The development of the Science Practicals Readiness Assessment (SPRA) began with the creation of an initial instrument consisting of 50 items. These items were designed to comprehensively measure the four critical factors identified in the conceptual framework: access to resources and facilities, teacher support and guidance, interest and motivation, and self-efficacy and confidence. To ensure the content validity of these items, a panel of 14 experts in science education reviewed the instrument. Based on their feedback, 19 items were discarded due to poor content validity ratios, which were below the acceptable threshold of 0.45. This rigorous piloting process resulted in a refined instrument comprising 31 items that accurately represented the key factors (Kaiser, 1974).

Content and Construct Validity

Prior to pilot testing the instruments, it is advisable first to establish the face and content validity. Consequently, a panel of 14 experts was invited to assess the language appropriateness and relevance of the items concerning students' disposition toward technology acceptance. Additionally, these experts were asked to evaluate the items using Lawshe's (1975) three-point scale, which includes categories of essential, necessary, and unnecessary. The results of the content validity ratio for the items and the content validity index for the finalized scale are detailed in table 1 below.

Table 1: Content Validity Estimates

Items	CVR	Items	CVR
Q1	.71	Q18	.85
Q2	.57	Q19	1
Q3	1	Q20	.45
Q4	.71	Q21	.85
Q5	1	Q22	1
Q6	.57	Q23	.57
Q7	.85	Q24	1

Q8	.85	Q25	.71
Q9	.57	Q26	.85
Q10	.71	Q27	.71
Q11	.71	Q28	.57
Q12	.85	Q29	1
Q13	1	Q30	1
Q14	.57	Q31	.71
Q15	.45	Q32	.57
Q16	1	Q33	.85
Q17	.57		
CVI = 0.74			

Construct Validity

Thirty-three items, determined through expert opinion, were administered to 107 undergraduate students who responded to the request. The questionnaire was distributed via Google Forms across various WhatsApp student groups. The sample consisted of 83 (77.6%) female and 23 (21.5%) male students. Exploratory factor analysis (EFA) was initially conducted using varimax rotation to identify the convergence of items into three factors.

Furthermore, DeVellis (2012) suggests employing theory, the scree test, and parallel analysis for factorization during scale development. Table 2 outlines the steps taken for scale development as recommended by experts. Additionally, Tabachnick & Fidell (2013) advocate for utilizing varimax rotation in EFA**.**

KMO and Bartlett's Test

The suitability of the data for factor analysis was confirmed by the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity.

Table 2: KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.771
Bartlett's Test of Sphericity	2016.431
df	496
Sig.	.000

The KMO measure of 0.771 indicates a good level of sampling adequacy. This suggests that the data collected for the SPRA are sufficiently coherent and suitable for conducting factor analysis. A KMO value above 0.7 generally indicates that the correlations between variables are strong enough to proceed with factor analysis, ensuring that the relationships among items are robust and meaningful.

Additionally, Bartlett's Test of Sphericity yielded a highly significant result ($\chi^2 = 2016.431$, $p < 0.000$). This indicates that the correlations among items are significantly different from zero, supporting the factorability of the correlation matrix. In simpler terms, it confirms that the variables in the SPRA dataset are interrelated enough to extract meaningful factors through factor analysis.

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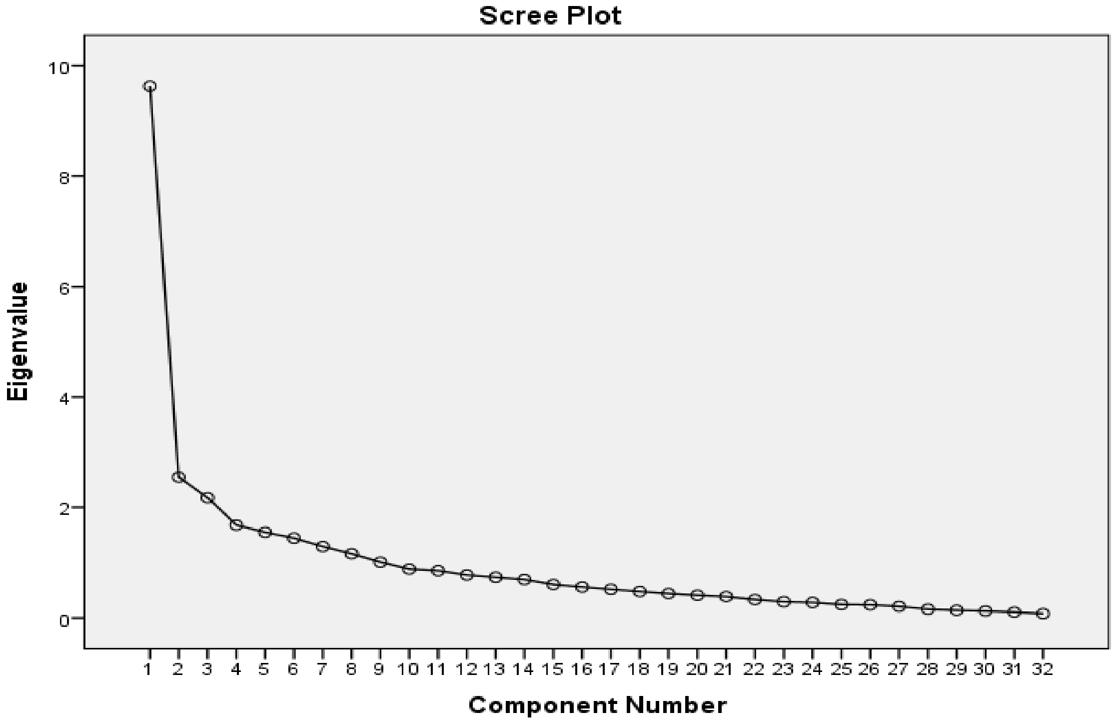
Scree Test

The scree test, a graphical method used to determine the number of factors to retain, identified four distinct factors that best represented the data. These factors aligned with the conceptual framework of the study. The scree test indicates a lively four-factor solution from the plot.

Nevertheless, experts have voiced criticism of the scree test for its tendency to encourage subjective judgments and advocate for parallel analysis as a more reliable measure.

Figure 1: Scree plot presenting four factor solution



Total Variance Explained and Parallel Analysis

The total variance explained by these four factors was substantial, indicating that the SPRA instrument effectively captured the key dimensions of students' readiness for science practicals. The rotated component matrix provided further confirmation by showing that the items loaded strongly onto their respective factors, demonstrating clear alignment with the theoretical constructs (Field, 2013).

Parallel analysis offers greater robustness compared to the scree test by comparing the eigenvalues of the components derived from the actual data with those generated randomly. A component is deemed valid if its actual eigenvalue exceeds the randomly generated eigenvalue, and invalid if it falls below this threshold (Kline, 2013). Table 2 demonstrates that all four components meet this criterion, as their actual eigenvalues surpass the randomly generated eigenvalues.

Table 3: Parallel Analysis

Components	Initial Eignvalue	Random Eignvalue	Decision	% of Variance	Cumulative%
1	9.627	1.373310	**Accepted**	30.086	30.086
2	2.548	1.207776	**Accepted**	7.964	38.049
3	2.174	1.081629	**Accepted**	6.794	44.843
4	1.681	.987718	**Accepted**	5.253	50.096

Component Significance
Each row in table 3 corresponds to a component derived from the factor analysis. Components are typically retained if their initial eigenvalues exceed random eigenvalues, indicating they explain more variance than expected by chance.
Acceptance Decision
According to the results, all four components are retained for further analysis. This decision is based on their initial eigenvalues significantly surpassing random eigenvalues, suggesting substantial contributions to explaining variance in the SPRA dataset.

Percentage of Variance
% of Variance columns indicate how much of the total variance in the SPRA data is explained by each component. For example, the first component explains 30.086% of the variance, with subsequent components contributing additional percentages, culminating in a cumulative total of 50.096%.

Cumulative Percentage
The Cumulative % column demonstrates the combined contribution of each component to the total explained variance. This cumulative view helps in understanding the overall variability in students' readiness for science practicals assessed by the SPRA.

Table 4: Rotated Component Matrix[a]

Items	**Component**			
	1	**2**	**3**	**4**
Q1	**.592**	.052	.264	.537
Q2	.474	.154	.350	**.476**
Q3	.303	.087	-.100	**.691**
Q4	.028	.142	.278	**.669**
Q5	**.648**	.031	-.072	.324
Q6	-.197	.090	.415	**.534**
Q7	**.393**	-.142	.167	.205
Q8	.198	.214	-.005	**.574**
Q9	.240	**.698**	-.046	.146
Q10	-.040	**.684**	.159	.077
Q11	.221	**.667**	.144	.107
Q12	.054	**.733**	.077	.082
Q13	**.513**	.390	.174	-.295
Q14	.398	**.538**	.313	.130
Q15	-.077	**.698**	.269	.280
Q16	.441	**.660**	.006	.091
Q18	.143	.012	**.731**	.168
Q19	**.663**	.168	.165	.220
Q20	.111	.241	**.568**	.260
Q21	**.678**	.230	.006	.022
Q22	.271	.238	**.490**	-.021
Q23	**.317**	.300	.312	.289
Q24	.108	.302	**.447**	.378
Q25	**.457**	.417	.279	.206
Q26	**.401**	.159	.239	.395
Q27	.547	-.016	**.578**	.164
Q28	**.662**	.286	.171	.193
Q29	**.537**	-.123	.495	-.155

Q30	**.667**	.248	.053	.041
Q31	.017	.152	**.517**	.032
Q32	.094	.351	.071	**.369**
Q33	**.401**	.063	.342	.004

Reliability Analysis

The Cronbach's alpha coefficient of 0.921 obtained for the SPRA demonstrates that the items within the instrument consistently measure the various dimensions of students' readiness for science practicals. This high level of internal consistency signifies that the SPRA reliably captures the intended constructs, bolstering its validity as a valuable assessment tool in science education.

The reliability of 0.921 implies that educators can confidently use the SPRA to assess and understand students' preparedness for engaging in practical science activities. By reliably identifying both strengths and areas needing improvement, the SPRA enables educators to tailor their teaching strategies and support mechanisms effectively. This ensures that students receive the necessary resources and guidance to maximize their learning experiences in science.

Furthermore, the strong reliability of the SPRA supports its application in educational research and policy development. Policymakers can use the instrument's consistent results to advocate for improvements in science education programs, aiming to enhance overall student outcomes and foster greater interest and proficiency in scientific learning.

Looking ahead, ongoing validation and refinement of the SPRA will be crucial to maintain its reliability across different contexts and student populations. Continuous assessment and feedback from educators and researchers will further strengthen its utility and relevance in assessing readiness for science practicals, contributing to continuous improvements in science education practices.

Table 5: Cronbach Alpha of the Scale

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.921	.921	32

The methodological development and validation of the SPRA involved several critical steps to ensure its accuracy and reliability. Through expert review, rigorous statistical analysis, and reliability testing, the SPRA has been established as a robust instrument for measuring secondary students' readiness to perform science practicals. The comprehensive process used to develop and validate the SPRA underscores its potential utility in educational research and practice, offering valuable insights into the factors that influence students' engagement and success in practical science

Discussion

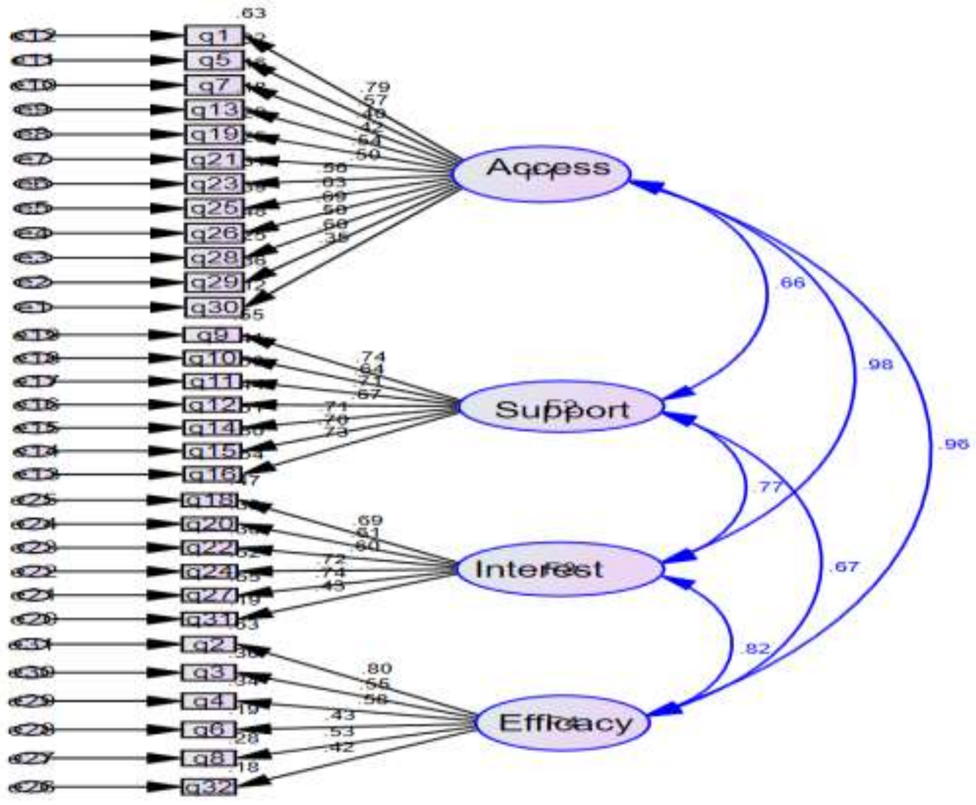
The successful validation of the Science Practicals Readiness Assessment (SPRA) instrument offers a reliable and robust tool for evaluating secondary students' readiness to engage in science practicals. This discussion elaborates on the implications of the findings and their potential impact on educational practice and policy.

Amos Graphics

Based on the findings presented in the table, a measurement model was constructed using AMOS-21 to critically confirm the internal factor structure. This model comprises 29 items and 3 components.

The model delineates four factors, each associated with a sufficient number of indicators, aligning with Kline's (2013) recommendation that a minimum of three indicators are necessary to measure a construct. Furthermore, the moderate correlations among the factors suggest unidimensionality and a lack of multicollinearity. In selecting the most appropriate indicators, eigenvalues were considered crucial, with each indicator exhibiting an eigenvalue above 0.40, which surpasses the threshold suggested by Hair et al. (2010). After reviewing the AMOS graphic for the scale, the next step involves examining the model fit indices.

Figure 2: Factors and indicators



Model Fit Indices

As per McDonald and Hu (2002), CFI, GFI, NNFI, and NFI are crucial indices to report, while Kline (2013) underscores the significance of SRMR, RMSEA, and CFI. Moreover, Basak et al. (2013) highlight RMR, GFI, AGFIA, NFI, and CFI as pivotal model fit indices. However, Hu and Bentler (1999) advise against considering these values as strict standards. In this analysis, the researcher regarded CMIN/df, RMR, GFI, AGFI, NFI, CFI, SRMR, and RMSEA as indicators of satisfactory model fit. The values for both goodness-of-fit indicators (CMIN/df, RMR, GFI, AGFI, NFI, and CFI) and badness-of-fit indicators (SRMR and RMSEA) fell within acceptable ranges according to expert recommendations.

Goodness-of-Fit Indices

These indices, such as Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI), and others, provide a measure of how well the hypothesized model fits the observed data. According to McDonald and Hu (2002), as well as Basak et al. (2013), these indices are crucial in determining whether the model adequately represents the relationships among variables in the data. They indicate the proportion of variance and covariance in the data that is explained by the model.

Badness-of-Fit Indices
Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) are typically considered badness-of-fit indices. These indices assess how well the model's predictions approximate the observed covariance matrix. Lower values of SRMR and RMSEA suggest better fit, with guidelines often suggesting values below 0.08 or 0.05 as indicative of good fit (Kline, 2013).

Interpretation and Caution
Hu and Bentler (1999) caution against strict adherence to cutoff values for these indices, emphasizing instead the importance of considering multiple indices together to gauge model fit comprehensively. They advocate for a holistic approach where no single index determines model acceptability but rather the pattern and consistency across several indices.

Practical Application
In practice, researchers should aim for a combination of high values for goodness-of-fit indices (CFI, GFI, NFI, etc.) and low values for badness-of-fit indices (SRMR, RMSEA) to suggest a well-fitting model. However, the specific thresholds can vary depending on the complexity of the model and the nature of the data.

Table 6: Goodness and badness model fit indices of the Techonology acceptance scale

Sr.#	Indicators	Estimates	Cutt off Value	Reference
1	CMIN/df	2.683	0< CMIN /df	Hair et al. (2010)
2	IFI	.651	>0.90	Hu et al. (1998)
3	PNFI	.465	>0.50	Mulaik et al. (1989)
4	NFI	.539	.90≤NFI≤.95	Basak et al. (2013)
5	CFI	.639	.90≤CFI≤.95	Basak et al. (2013)
6	PCFI	.551	>0.50	Mulaik et al. (1989)
7	RMSEA	.115	.05≤RMSEA≤.08	Hair et al. (2010)

Critical Factors Influencing Readiness
The validation process identified four key factors that significantly influence students' preparedness for science practicals:
Access to Resources and Facilities: The availability of necessary equipment, materials, and laboratory space is essential for conducting effective practical science activities. Schools with well-equipped labs provide students with the tools they need to experiment and learn hands-on, leading to better educational outcomes. Conversely, a lack of resources can hinder students' ability to perform experiments, thereby limiting their practical understanding of scientific concepts.
Teacher Support and Guidance: The role of teachers is pivotal in facilitating practical activities. Teachers who provide clear instructions, constructive feedback, and encouragement can enhance students' confidence and competence in performing practical tasks. Effective teacher support ensures that students understand the procedures and objectives of experiments, which is crucial for successful practical work.
Interest and Motivation: Students' intrinsic motivation and enthusiasm for science significantly impact their engagement in practical activities. Motivated students are more likely to approach experiments with curiosity and perseverance, which enhances their learning experience.

Schools need to foster a positive attitude towards science by making practicals interesting and relevant to students' lives.

Self-Efficacy and Confidence: Students' belief in their ability to successfully conduct experiments is crucial for their participation in practical activities. High self-efficacy encourages students to take on challenges, persist through difficulties, and learn from their experiences. Building self-efficacy involves creating opportunities for success and providing positive reinforcement.

Implications for Schools and Educators

The SPRA instrument provides valuable insights into these critical factors, allowing schools and educators to:

Identify Areas Needing Improvement: By assessing students' readiness across the four key factors, educators can pinpoint specific areas where improvements are needed. For instance, if students report low access to resources, schools can prioritize investments in laboratory equipment and materials. Similarly, if teacher support is lacking, professional development programs can be implemented to enhance teachers' skills in facilitating practical science activities (Hofstein & Lunetta, 2004).

Implement Targeted Interventions: The detailed information obtained from the SPRA can guide the development of targeted interventions. For example, motivational programs and activities can be designed to increase students' interest in science. Workshops and training sessions can be organized to build students' self-efficacy and confidence in performing practical tasks. Additionally, resources can be allocated more effectively to address the specific needs identified through the SPRA.

Enhance Practical Science Education: By using the SPRA to regularly assess students' readiness, schools can monitor the effectiveness of their interventions and make continuous improvements. This iterative process ensures that practical science education remains responsive to students' needs and adapts to changing circumstances.

Broader Educational Impact: The validated SPRA instrument not only benefits individual schools but also has broader implications for educational policy and research. It provides a standardized method for assessing practical science readiness, which can be used across different educational contexts. Policymakers can use the data from SPRA assessments to inform decisions about resource allocation, teacher training, and curriculum development. Researchers can utilize the SPRA to study the relationships between readiness factors and student outcomes, contributing to the broader understanding of effective science education practices. The validation of the SPRA instrument marks a significant advancement in the assessment of secondary students' readiness for science practicals. By highlighting the critical factors of access to resources, teacher support, interest and motivation, and self-efficacy, the SPRA provides a comprehensive tool for improving practical science education. Schools, educators, and policymakers can leverage this instrument to identify areas needing improvement and implement targeted interventions, ultimately enhancing the quality of science education and fostering a generation of students who are well-prepared for scientific inquiry and experimentation.

Conclusion

The Science Practicals Readiness Assessment (SPRA) instrument provides a comprehensive and reliable framework for evaluating secondary students' readiness to engage in science practicals. Through rigorous development and validation processes, the SPRA has demonstrated its effectiveness in measuring the four key factors that influence student readiness: access to resources and facilities, teacher support and guidance, interest and motivation, and self-efficacy and confidence.

The findings from the SPRA underscore the importance of these factors in shaping students' preparedness for practical science activities. By systematically assessing these dimensions, the SPRA enables educators to identify strengths and areas for improvement within their science programs. This targeted approach ensures that interventions are tailored to address specific needs, thereby enhancing the overall quality of science education.

Suggestions

To maximize the benefits of the SPRA and improve students' readiness for science practicals, schools and educators should consider the following recommendations:

Ensure Adequate Resources and Facilities: Investment in Laboratories: Schools should prioritize the allocation of funds to equip science laboratories with essential tools, materials, and safety equipment. Adequate resources are critical for enabling students to perform experiments effectively and safely.

Maintenance and Upgrades: Regular maintenance and periodic upgrades of laboratory facilities ensure that students have access to up-to-date and functional equipment.

Foster Supportive Teacher-Student Relationships

Professional Development: Provide ongoing professional development opportunities for teachers to enhance their skills in facilitating practical science activities. Training should focus on instructional strategies, safety protocols, and ways to motivate and support students.

Mentorship Programs: Establish mentorship programs where experienced science teachers mentor less experienced colleagues, sharing best practices and providing guidance on conducting effective practicals.

Promote Student Interest and Motivation

Engaging Curriculum: Develop a science curriculum that includes engaging and relevant practical activities. Incorporate real-world applications of scientific concepts to make learning more meaningful and exciting for students.

Extracurricular Activities: Offer extracurricular opportunities such as science clubs, fairs, and competitions to foster a love for science and encourage exploration beyond the classroom.

Enhance Student Self-Efficacy and Confidence

Positive Reinforcement: Use positive reinforcement to build students' confidence in their abilities. Celebrate successes and provide constructive feedback to help students learn from their experiences.

Scaffolded Learning: Implement scaffolded learning approaches that gradually increase the complexity of practical tasks. This helps students build their skills and confidence incrementally.

Future research should explore the application of the SPRA in diverse educational contexts to assess its generalizability and impact. Studies could investigate. Assess the effectiveness of the SPRA in different cultural and educational settings to determine its adaptability and relevance across various contexts. Examine the long-term impact of interventions informed by SPRA assessments on student performance in science practicals and overall scientific literacy.

Explore the relationship between students' readiness for science practicals and broader educational outcomes, such as critical thinking skills, problem-solving abilities, and interest in STEM careers.

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