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# TEACHERS' PERCEPTION TOWARDS THE USE OF VIRTUAL SCIENCE LAB APPS MODULE IN SECONDARY SCHOOLS

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## ABSTRACT

The study aimed to examine the perceptions of secondary school science teachers regarding the usefulness of virtual science lab Apps module in teaching science at the secondary level. The research targeted all secondary school science teachers from Bhagalpur district of Bihar, with a sample of 150 secondary school science teachers. A descriptive survey research design with a quantitative approach utilizing a five-point Likert scale perception tool to investigate the perceptions of secondary school science teachers regarding the usefulness of virtual science lab Apps module in science education was adopted. Data were analyzed using descriptive statistics and Chi-square test. The findings indicate that teachers generally hold positive perceptions of the VSLA module across various demographic and professional variables recognizing their potential to enhance student engagement and improve learning outcomes. The study suggests the need for capacity-building programs and infrastructural support to promote the integration of virtual labs in science education.

**Keywords:** Virtual Lab, Secondary Schools, Science Teachers, Teachers' Perception

## 1. INTRODUCTION

Science include extensive use of laboratories where complex and abstract concepts of science be learn by students with learning by doing or experiencing things. Science laboratories equip students with 21st century skills as well as positive attitude towards science (Gecer & Zengin (2015), Aydogdu & Kescrioglu 2005). But laboratory method encountered with various problems as individual physical space and equipment for every student, time constraints, safety measures for risky experiments, no scope of repetition or practice (Z. Tatli& A. Ayas 2013, Jong, Linn & Zacharia 2013). Due to various limitations of physical lab now virtual laboratory becomes a great alternative for science

experiments. It also presents a unique opportunity to enhance students' engagement and facilitate experiential learning without constraint of physical lab infrastructure (Alsharif, A. 2024).

Virtual science lab provides accessible, economic alternative, which contribute to make environment conducive, understandable and develop interest in constructing knowledge (Benzamin Tatira 2024, Asiksoy Gulsum 2023, Rashid et.al. 2021). These advanced digital tools have been shown to boost curiosity, confidence and learning satisfaction among students (Makransky & Petersen, 2021; Liu et al., 2025). Virtual Lab Applications (VL Apps) have emerged as a powerful tool and these applications provide interactive, hands-on experiences in a digital format, allowing students to engage with scientific concepts and experiments without the constraints of physical lab spaces, equipment, or safety concerns. Teacher plays an important role in integrating new digital technology in their classroom. Their attitude and perception influences a lot in integration of these tools and techniques in classroom practices. Virtual labs not only support student's learning but also enabling teachers to effectively incorporate this technology into their teaching practices (Shambare, Brian & Jita, Thuthukile 2024, Navarro et.al. 2024, Alneyadi, S. S. 2019).

Despite lots of potential of virtual labs in science education, little is known about how science teachers of Bhagalpur perceive these tools. This study aims to fill that gap by exploring their experiences, challenges and outlook regarding virtual labs. With this idea, the researcher listed different virtual lab apps available online for secondary level students and developed a Virtual Science Lab Apps (VSLA) Module. VSLA includes list of different Virtual Lab Apps available online with their specifications. This study also aims to investigate how secondary school science teachers perceive VSLA module in terms of usability, educational effectiveness and relevance to the existing curriculum of government secondary schools of Bhagalpur.

By understanding these perspectives, the research intends to provide insights that can inform policymakers, curriculum developers and educational institutions. Ultimately, the study aspires to contribute to the broader goal of making science education more equitable, engaging and effective for all learners.

In this context, this study aimed to investigate the perception of teachers towards VSLA Module. For this purpose, the following research questions were examined:

## 1.1. RESEARCH QUESTIONS

1) How do in-service secondary level teachers perceive the use and effectiveness of the VSLA module?
2) To what extent do gender, locality and educational qualification influence teachers' perceptions regarding the use of the VSLA module?
3) How do teaching experience and digital literacy affect teachers' perceptions regarding the use of the VSLA module?

## 1.2. OBJECTIVES

1) To study the perceptions of in-service secondary level teachers regarding the use of the VSLA module.
2) To compare the perceptions of in-service secondary level teachers regarding the use of the VSLA module with respect to gender, locality and qualification.
3) To examine the differences in perceptions of in-service secondary level teachers regarding the use of the VSLA module concerning teaching experience and digital literacy.

## 1.3. HYPOTHESIS

1) There is no significant difference among perceptions of In-service teachers teaching at the secondary level regarding the use of VSLA module with respect to gender.
2) There is no significant difference among perceptions of In-service teachers teaching at the secondary level regarding the use of VSLA module concerning locality.
    - There is no significant difference among perceptions of In-service teachers teaching at the secondary level regarding the use of VSLA module concerning qualification.

- There is no significant difference among perceptions of In-service teachers teaching at the secondary level regarding the use of VSLA module with respect to teaching experiences.
- There is no significant difference among perception of In-service teachers teaching at the secondary level regarding the use of VSLA module concerning digital literacy.

## 1.4. OPERATIONAL DEFINITIONS

**VSLA Module: -**An informative package developed by the investigator to summarize the detailed information regarding available virtual lab apps for Secondary-level science.

**Gender: -** In this study gender refers to the distinction between male and female.

**Locality: -** It refers to the immediate surroundings of a person. In present study locality refers to Area from where teachers or students belongs as rural or urban.

**Qualification: -** In this research qualification refers to the educational background of a teacher as Bachelor, Master or Ph.D. degree holder.

**Experience: -** For In-service teachers "experience" refers to the total number of years a teacher has been teaching in secondary school as a science teacher.

**Digital literacy:-** In present research, digital literacy refers to degree of the knowledge of VSLA user related to computer and similar devices as use of MS Word, MS Office, E-mails etc.

# 2. METHODOLOGY

## 2.1. RESEARCH DESIGN

The present study employed a descriptive survey research design with a quantitative approach to investigate the perceptions of secondary school science teachers regarding the usefulness of VSLA module in science education.

## 2.2. STUDY PARTICIPANTS

Data were collected from 150 in-service science teachers from different secondary schools of Bhagalpur district. Out of 150 teachers 112 teachers are from class 9-10 and 38 from class 11-12th.The investigator adopted a non-probability sampling technique, specifically the convenience sampling method. This method was considered suitable due to the accessibility and availability of the participants within the selected institutions. Yadav and Gupta (2026)

## 2.3. DATA COLLECTION TOOLS AND PROCEDURES

1) VSLA module -A Virtual Science Lab Apps (VSLA) module has been developed by the researcher in which Science related different virtual science lab apps have been categorized and analysed on the basis of its origin country, Branches of science, content covered, Technical feasibility, language, Interface type, Rating as well as on the basis of the developer of the app. It has 4 sections in which the first section of the VSLA module focuses on Science education, integrating the major disciplines of Physics, Chemistry, Biology and Environmental Science. In this section, a total of 56 virtual laboratory applications have been incorporated, including 15 applications related to Physics, 12 applications related to Chemistry and 8 applications related to Biology, along with 21 integrated laboratory applications designed to support interdisciplinary science learning.
2) Structured Perception scale-Data were collected using a structured Perception scale (Google Form questionnaire that included a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). A Perception scale that consists of 38 items was developed to assess In-service teachers' responses regarding the usefulness of the VSLA module. The face and content validity of the questionnaire was validated through expert review. The final version was distributed to selected participants using Google Forms. Respondents were given clear instructions and confidentiality of responses was ensured.

## 2.4. DATA ANALYSIS

- Quantitative data analyzed using descriptive statistics as Chi-square test, Graphical representation and percentage analysis.

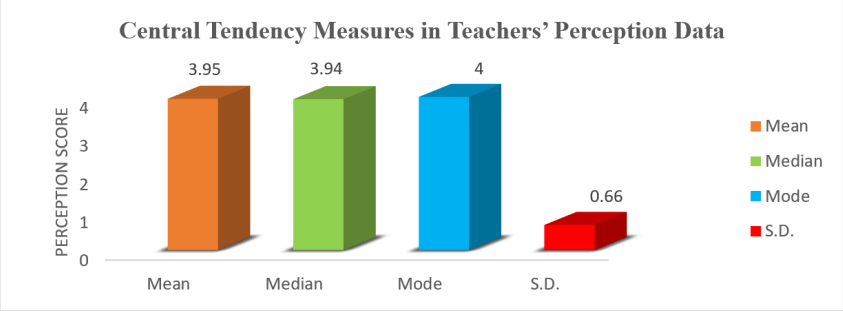
## 2.4.1. ANALYSIS OF PERCEPTIONS OF TEACHERS WITH RESPECT TO DIFFERENT DIMENSIONS

**Table-1**

**Table 1 Overall In-Service Teacher's Perception Score**

| Statistical Value | Perception Scores |
|---|---|
| Mean | 3.95 |
| Median | 3.94 |
| Mode | 4 |
| S.D. | 0.66 |

**Graph 1**




**Graph 1** A Comparative Analysis of Central Tendency Measures in Teachers' Perception Data

**Interpretation:**

The perception scores for teachers indicate an overall positive evaluation, with a mean of 3.95 showing that secondary school teachers are generally perceived favorably. The standard deviation of 0.66 indicates low variability in the responses. This means that teachers' perception scores are closely clustered around the mean, showing a high level of consistency in their opinions. In other words, most teachers share similar views about the VSLA Module, suggesting a stable and uniform perception among respondents.

**Hypothesis 1-** There is no significant difference among perceptions of In-service teachers teaching at the secondary level regarding the use of VSLA module with respect to gender.

## 2.4.2. ANALYSIS OF PERCEPTIONS OF IN-SERVICE TEACHERS WITH RESPECT TO GENDER

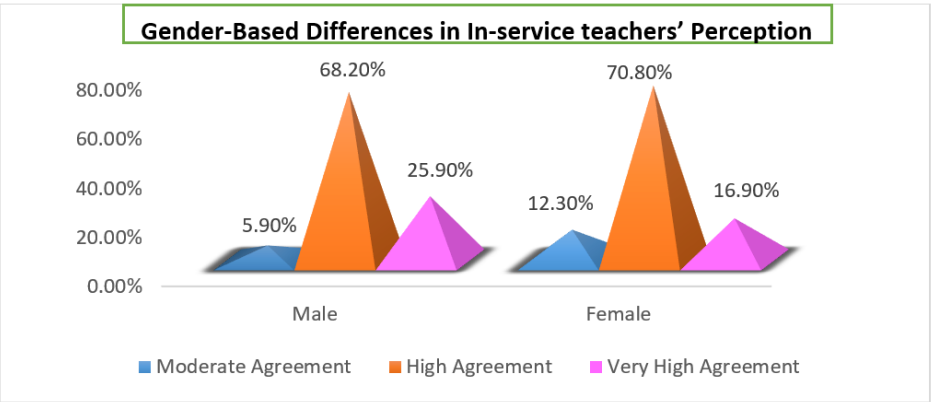
**Table 2**

**Table 2 Statistical Assessment of Gender-Based Differences Among In-service Teachers' Perception Through the Cross Tabulation**

| | | | Overall Total | | | Total |
|---|---|---|---|---|---|---|
| | | | Moderate Agreement | High Agreement | Very High Agreement | |
| Gender | Male | Count | 5 | 58 | 22 | 85 |
| | | Expected Count | 7.4 | 58.9 | 18.7 | 85.0 |
| | | % within Gender | 5.90% | 68.20% | 25.90% | 100.00% |
| | Female | Count | 8 | 46 | 11 | 65 |
| | | Expected Count | 5.6 | 45.1 | 14.3 | 65.0 |
| | | % within Gender | 12.30% | 70.80% | 16.90% | 100.00% |
| Total | | Count | 13 | 104 | 33 | 150 |

| | | | | |
|---|---|---|---|---|
| Expected Count | 13.0 | 104.0 | 33.0 | 150.0 |
| % within Gender | 8.70% | 69.30% | 22.00% | 100.00% |

**Graph 2**




**Graph 2** A Graphical Representation of Gender-Based Differences in in-Service Teachers' Perception Score**s**

**Interpretation:**

The cross-tabulation analysis indicates that the majority of both male and female respondents fall under the High Agreement category regarding the use of the VSLA Module. Among male teachers, 68.2% reported High Agreement, while 70.8% of female teachers also expressed High Agreement. The findings reflect a generally positive perception of the VSLA Module among secondary school teachers irrespective of gender. Although slight variations exist in the levels of agreement, the overall responses suggest favorable attitudes and acceptance of the module in the teaching-learning process.

**Table 3**

**Table 3 Examination of the Association Between Gender and Perception Scores of In-Service Teachers Using the Chi-Square Test**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 3.133[a] | 2 | 0.209 |
| Likelihood Ratio | 3.149 | 2 | 0.207 |
| Linear-by-Linear Association | 2.998 | 1 | 0.083 |
| N of Valid Cases | 150 | | |

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.63.

The results indicated that there was no statistically significant association between gender and agreement level, $\chi^2$ (2, N = 150) = 3.133, p = .209. Since the p-value was greater than the 0.05 level of significance, the null hypothesis was not rejected. Above findings suggest that Policies or programs aimed at improving teachers' performance or perceptions can be applied uniformly across genders, as the overall scores do not vary significantly between male and female teachers.

**Hypothesis 2-** There is no significant difference among perceptions of In-service teachers teaching at the secondary level regarding the use of VSLA module concerning locality.

## 2.4.3. ANALYSIS OF PERCEPTIONS OF IN-SERVICE TEACHERS WITH RESPECT TO THEIR LOCALITY

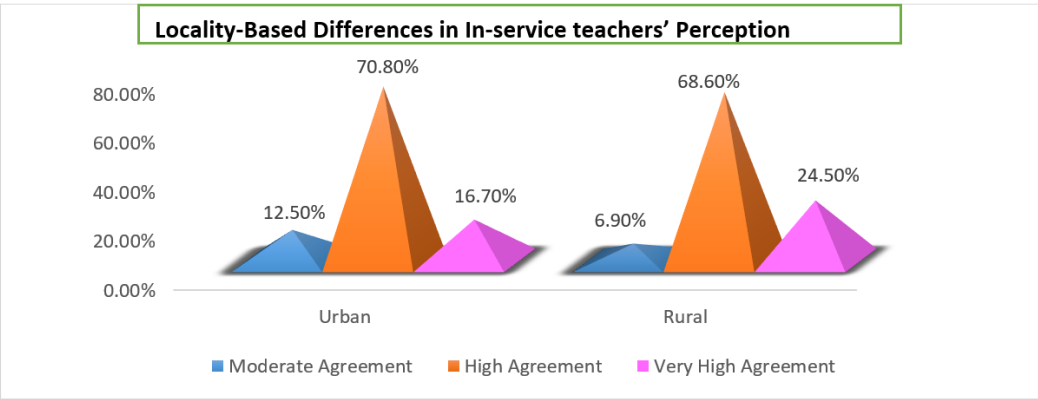
**Table 4**

**Table 4 Statistical Assessment of Locality-Based Differences among In-service teachers' Perception through the Cross tabulation**

| | Overall Total | Total |
|---|---|---|

| | | | Moderate Agreement | High Agreement | Very High Agreement | |
|---|---|---|---|---|---|---|
| Locality | Urban | Count | 6 | 34 | 8 | 48 |
| | | Expected Count | 4.2 | 33.3 | 10.6 | 48.0 |
| | | % within Locality | 12.50% | 70.80% | 16.70% | 100.00% |
| | Rural | Count | 7 | 70 | 25 | 102 |
| | | Expected Count | 8.8 | 70.7 | 22.4 | 102.0 |
| | | % within Locality | 6.90% | 68.60% | 24.50% | 100.00% |
| Total | | Count | 13 | 104 | 33 | 150 |
| | | Expected Count | 13.0 | 104 | 33.0 | 150.0 |
| | | % within Locality | 8.70% | 69.30% | 22.00% | 100.00% |

**Graph 3**




**Graph 3** A Graphical Representation of Locality-Based Differences in in-Service Teachers' Perception Scores

### Interpretation:

Data shows that among urban respondents (N = 48), 70.8 % reported High Agreement, 16.7 % reported Very High Agreement and 12.5 % reported Moderate Agreement. Among rural respondents (N = 102), 68.6 % reported High Agreement, 24.5 % reported Very High Agreement and 13% reported Moderate Agreement. This indicates that the majority of respondents, irrespective of locality, fall within the High Agreement category, suggesting a broadly similar pattern of overall agreement levels across locality. These results suggest that although both groups largely agree on the effectiveness of VSLA Module, rural respondents demonstrate slightly stronger levels of intense agreement (Very High), whereas urban show a comparatively higher percentage in the moderate category. The data reveals that both rural and urban respondents predominantly express High Agreement with the VSLA Module, indicating VSLA module as well as virtual science labs are well-accepted as an effective instructional tool among secondary school teachers.

**Table 5**

**Table 5 Examination of the Association Between Locality and Perception Scores of In-Service Teachers Using the Chi-Square Test**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 2.132[a] | 2 | 0.344 |
| Likelihood Ratio | 2.110 | 2 | 0.348 |
| Linear-by-Linear Association | 2.039 | 1 | 0.153 |
| N of Valid Cases | 150 | | |

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.16.

### Interpretation

The results indicated that there was no statistically significant association between locality and agreement level, $\chi^2$ (2, N = 150) = 2.132, p = .344. Since the p-value was greater than the 0.05 level of significance, the null hypothesis was not rejected. This suggests that urban and female respondents do not differ significantly in their overall agreement levels.

All expected counts were above 5, satisfying the assumptions of the Chi-Square test. As the p-value is greater than 0.05, the null hypothesis is not rejected. Similarly, the Likelihood Ratio (p = .348) and Linear-by-Linear Association (p = .153) were also non-significant, further confirming the absence of a meaningful relationship. Although one cell (16.7%) had an expected count less than 5, the minimum expected count was 4.16, which is close to the acceptable threshold, indicating that the assumption was not substantially violated. Therefore, there is no statistically significant association between locality and overall total scores. In other words, location does not appear to influence teachers' overall scores, confirming the similarity observed in the cross-tabulation.

**Hypothesis 3-** There is no significant difference among perceptions of In-service teachers teaching at the secondary level regarding the use of VSLA module concerning qualification.

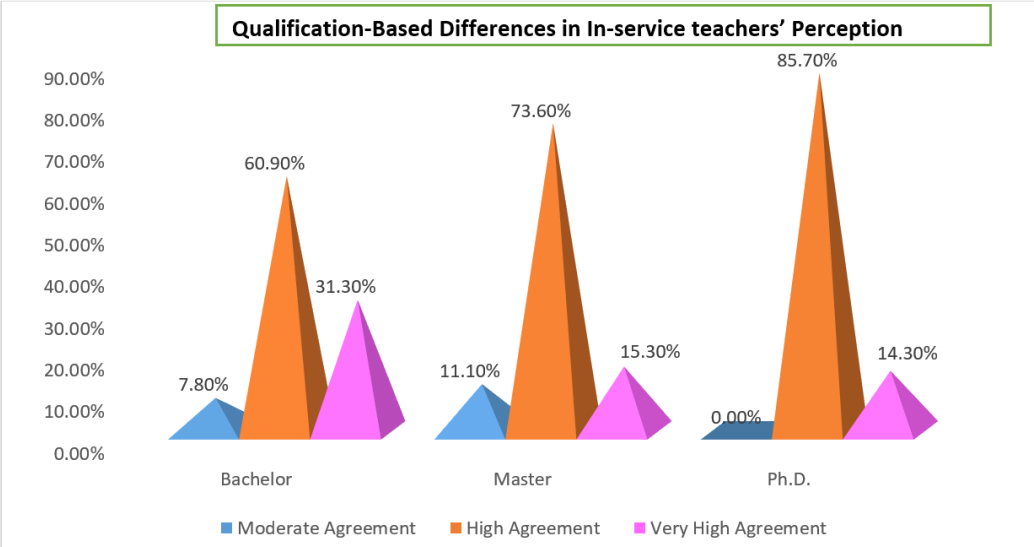
## 2.4.4. ANALYSIS OF PERCEPTIONS OF IN-SERVICE TEACHERS WITH RESPECT TO QUALIFICATION

**Table 6**

**Table 6 Statistical Assessment of Qualification-Based Differences Among In-Service Teachers' Perception through the Cross Tabulation**

| | | | Overall Total | | | Total |
|---|---|---|---|---|---|---|
| | | | Moderate Agreement | High Agreement | Very High Agreement | |
| Qualification | Bachelor | Count | 5 | 39 | 20 | 64 |
| | | Expected Count | 5.5 | 44.4 | 14.1 | 64.0 |
| | | % within Qualification | 7.80% | 60.90% | 31.30% | 100.00% |
| | Master | Count | 8 | 53 | 11 | 72 |
| | | Expected Count | 6.2 | 49.9 | 15.8 | 72.0 |
| | | % within Qualification | 11.10% | 73.60% | 15.30% | 100.00% |
| | Ph.D. | Count | 0 | 12 | 2 | 14 |
| | | Expected Count | 1.2 | 9.7 | 3.1 | 14.0 |
| | | % within Qualification | 0.00% | 85.70% | 14.30% | 100.00% |
| Total | | Count | 13.0 | 104.0 | 33 | 150 |
| | | Expected Count | 13 | 104 | 33.0. | 150.0 |
| | | % within Qualification | 8.70% | 69.30% | 22.00% | 100.00% |

**Graph 4**




**Graph 4** A Graphical Representation of Qualification-Based Differences in in-Service Teachers' Perception Scores

**Interpretation:**

The distribution of responses indicates that students having Graduation, Masters and Ph.D. degree generally demonstrate a positive perception towards VSLA module, with the majority falling under the High Agreement category. Among teachers having bachelor degree, 60.9% of reported High Agreement and 31.3% reported Very High Agreement, while only 7.8% indicated Moderate Agreement. Similarly, among teachers having Master degree, a larger proportion (73.6%) expressed High Agreement, followed by 15.3% Very High Agreement and 11.1% Moderate Agreement. among teachers having Ph.D. degree, the highest percentage (85.7%) was observed in the High Agreement category, with 14.3% reporting Very High Agreement and none indicating Moderate Agreement. The observed and expected counts are relatively close across categories, suggesting a consistent pattern of responses across qualification levels. Overall, the findings reflect strong acceptance and positive attitudes towards VSLA Module among secondary level teachers.

**Table 7**

**Table 7 Examination of the Association Between Qualification and Perception Scores of In-Service Teachers Using the Chi-Square Test**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 7.493[a] | 4 | 0.112 |
| Likelihood Ratio | 8.596 | 4 | 0.072 |
| Linear-by-Linear Association | 2.249 | 1 | 0.134 |
| N of Valid Cases | 150 | | |

a. 2 cells (22.2%) have expected count less than 5. The minimum expected count is 1.21.

**Interpretation**

The Chi-Square test examined the association between qualification (Bachelor, Master and Ph.D. holders) and teachers' perceptions on VSLA module. The results indicated no statistically significant association, $\chi^2$ (4, N = 150) = 7.493, p = .112, with the Likelihood Ratio (p = .072) and Linear-by-Linear Association (p = .134) also non-significant. Since the p-value was greater than the 0.05 level of significance, the null hypothesis was not rejected. It is noted that 2 cells (22.2%) had expected counts less than 5 and the minimum expected count was 1.21, likely due to the smaller number of teachers having Ph.D. degree compared to Graduates & Master degree. While this violates the Chi-Square assumption slightly, the overall pattern suggests that teachers' perceptions are not significantly different across qualification levels, despite the lower sample in Ph.D. level. From above it is suggesting that the level of study does not significantly influence teacher responses towards VSLA Module. Overall, the findings imply that module is widely accepted as an effective learning tool across secondary level teachers.

**Hypothesis 4-** There is no significant difference among perceptions of In-service teachers teaching at the secondary level regarding the use of VSLA module with respect to teaching experiences.

## 2.4.5. ANALYSIS OF PERCEPTIONS OF IN-SERVICE TEACHERS WITH RESPECT TO TEACHING EXPERIENCES

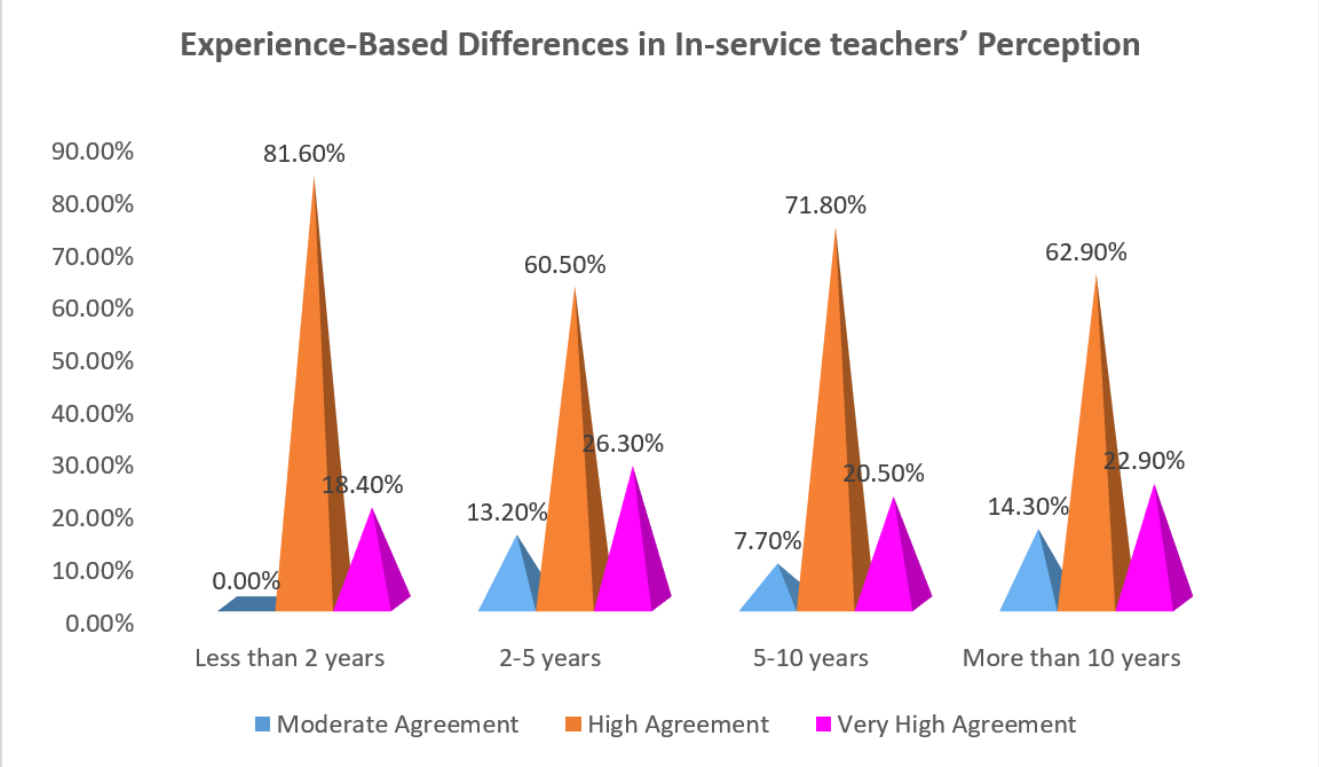
**Table 8**

**Table 8 Statistical Assessment of Teaching Experiences -Based Differences Among In-Service Teachers' Perception through the Cross Tabulation**

| | | | Overall Total | | | Total |
|---|---|---|---|---|---|---|
| | | | Moderate Agreement | High Agreement | Very High Agreement | |
| Experience | Less than 2 years | Count | 0 | 31 | 7 | 38 |
| | | Expected Count | 3.3 | 26.3 | 8.4 | 38 |
| | | % within Experience | 0.00% | 81.60% | 18.40% | 100.00% |
| | 2 to 5 years | Count | 5 | 23 | 10 | 38 |
| | | Expected Count | 3.3 | 26.3 | 8.4 | 38 |
| | | % within Experience | 13.20% | 60.50% | 26.30% | 100.00% |
| | 5 to 10 years | Count | 3 | 28 | 8 | 39 |

| | | | | | |
|---|---|---|---|---|---|
| | Expected Count | 3.4 | 27 | 8.6 | 39 |
| | % within Experience | 7.70% | 71.80% | 20.50% | 100.00% |
| More than 10 years | Count | 5 | 22 | 8 | 35 |
| | Expected Count | 3 | 24.3 | 7.7 | 35 |
| | % within Experience | 14.30% | 62.90% | 22.90% | 100.00% |
| Total | Count | 13 | 104 | 33 | 150 |
| | Expected Count | 13 | 104 | 33 | 150 |
| | % within Experience | 8.70% | 69.30% | 22.00% | 100.00% |

**Graph 5**




**Graph 5** A Graphical representation of Experienced-based differences in In-service teachers' perception scores

## Interpretation

The data indicate that teachers across all experience levels show a strong positive perception of VSLA Module, with the majority in each group reporting high agreement. Among teachers with less than 2 years of experience, none reported moderate agreement; 81.6% expressed high agreement and 18.4% very high agreement. In the 2-5 years group, 60.5% reported high agreement and 26.3% very high agreement, with 13.2% indicating moderate agreement. Similarly, teachers with 5–10 years of experience, high agreement increased to 71.8%, while moderate agreement declined to 7.7% and very high agreement was 20.5%. Among those with more than 10 years of experience, 62.9% expressed high agreement and 22.9% very high agreement, while 14.3% showed moderate agreement. This pattern suggests that less experienced teachers may be more receptive to integrating virtual science labs and use of module into their teaching practices, while more experienced teachers may rely more on traditional instructional approaches, resulting in comparatively lower perception scores.

**Table 9**

**Table 9 Examination of the Association Between Teaching Experiences and Perception Scores of In-Service Teachers Using the Chi-Square Test**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 7.582[a] | 6 | 0.270 |
| Likelihood Ratio | 10.520 | 6 | 0.104 |
| Linear-by-Linear Association | 0.533 | 1 | 0.465 |
| N of Valid Cases | 150 | | |
| a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 3.03. | | | |

### Interpretation

A chi-square test of independence was conducted to examine the relationship between years of experience (less than 2 years, 2-5 years, 5-10 years and more than 10 years) and the teachers' perceptions on VSLA module. The results indicated that there was no statistically significant association between the variables, $\chi^2$ (6, N = 150) = 7.582, p = .27. The likelihood ratio test also showed a non-significant result, $\chi^2$ (6) = 10.52, p = .10, supporting the same conclusion. Additionally, the linear-by-linear association test was not significant, $\chi^2$ (1) = 0.53, p = .47, indicating no significant linear trend across the ordered experience levels. However, it should be noted that 33.3% of the cells had expected counts less than 5, which slightly violates the chi-square assumption and may affect the robustness of the findings. Overall, the results suggest that years of experience were not significantly associated with the examined variable.

**Hypothesis 5-** There is no significant difference among perception of In-service teachers teaching at the secondary level regarding the use of VSLA module concerning digital literacy.

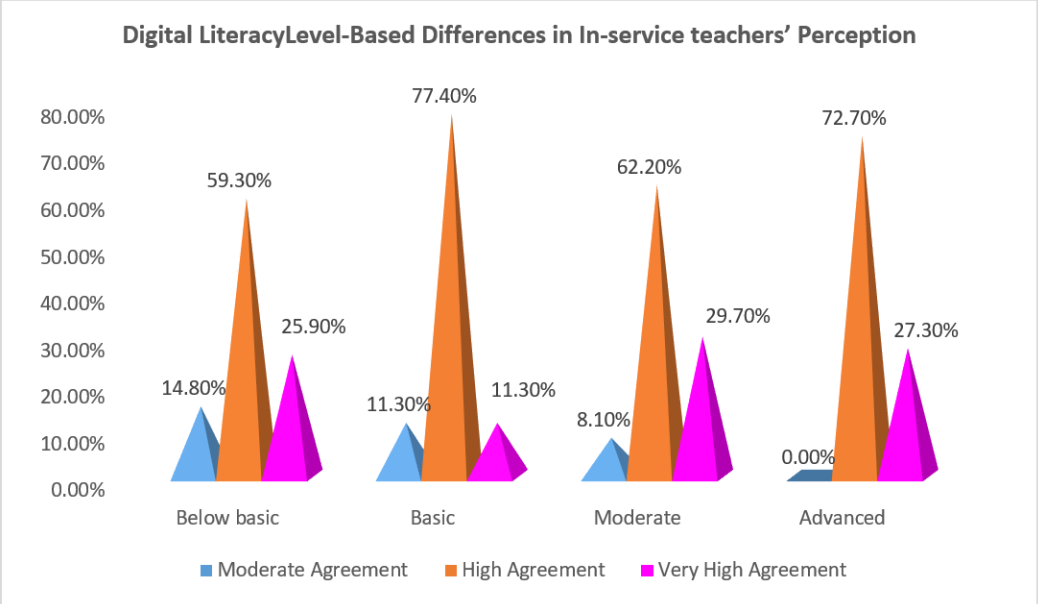
## 2.4.6. ANALYSIS OF PERCEPTIONS OF IN-SERVICE TEACHERS WITH RESPECT TO DIGITAL LITERACY

**Table 10**

**Table 10 Statistical Assessment of Digital Literacy-Based Differences Among In-Service Teachers' Perception Through the Cross Tabulation**

| Digital literacy * Overall Total Crosstabulation | | | | | | |
|---|---|---|---|---|---|---|
| | | | Overall Total | | | Total |
| | | | Moderate Agreement | High Agreement | Very High Agreement | |
| ICT knowledge | Below basic | Count | 4 | 16 | 7 | 27 |
| | | Expected Count | 2.3 | 18.7 | 5.9 | 27.0 |
| | | % within ICT knowledge | 14.80% | 59.30% | 25.90% | 100.00% |
| | Basic | Count | 6 | 41 | 6 | 53 |
| | | Expected Count | 4.6 | 36.7 | 11.7 | 53.0 |
| | | % within ICT knowledge | 11.30% | 77.40% | 11.30% | 100.00% |
| | Moderate | Count | 3 | 23 | 11 | 37 |
| | | Expected Count | 3.2 | 25.7 | 8.1 | 37.0 |
| | | % within ICT knowledge | 8.10% | 62.20% | 29.70% | 100.00% |
| | Advanced | Count | 0 | 24 | 9 | 33 |
| | | Expected Count | 2.9 | 22.9 | 7.3 | 33.0 |
| | | % within ICT knowledge | 0.00% | 72.70% | 27.30% | 100.00% |
| Total | | Count | 13 | 104 | 33 | 150 |
| | | Expected Count | 13.0 | 104.0 | 33.0 | 150.0 |
| | | % within ICT knowledge | 8.70% | 69.30% | 22.00% | 100.00% |

**Graph 6**




**Graph 6** A Graphical representation of Digital literacy level-based differences in In-service teachers' perception scores

## Interpretation

The data indicate that teachers across all digital literacy levels show a strong positive perception of VSLA module, with the majority in each group reporting high agreement. Among teachers who are in below basic level, 59.3% expressed high agreement and 25.9% very high agreement, while only 14.8% showed moderate agreement. Similarly, in the Basic level group, 77.4 % reported high agreement and 11.3% very high agreement, with 11.3% indicating moderate agreement. For teachers at Moderate level of digital literacy, 62.2% expressed high agreement and 29.7% very high agreement, while only 8.1 % showed moderate agreement. Notably, among those with advanced level of digital literacy, none reported moderate agreement; 72.7% expressed high agreement and 27.3% very high agreement. This trend suggests that as teachers with higher level of digital literacy showed more definite agreement about the usability of VSLA Module.

**Table 11**

**Table 11 Examination of the Association between Digital literacy and perception scores of In-service teachers using the Chi-Square Test**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 10.057[a] | 6 | 0.122 |
| Likelihood Ratio | 13.141 | 6 | 0.041 |
| Linear-by-Linear Association | 0.002 | 1 | 0.961 |
| N of Valid Cases | 150 | | |

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 2.34.

## Interpretation

The Chi-Square test examined the association among digital literacy (Below basic, Basic, Moderate and Advanced level) and teachers' perceptions on VSLA module. The results indicated no statistically significant association, $\chi^2$ (6, N = 150) = 10.057, p = .122, with the Likelihood Ratio (p = .041) and Linear-by-Linear Association (p = .961) also non-significant. Since the p-value was greater than the 0.05 level of significance, the null hypothesis was not rejected. It is noted that 4 cells (33.3%) had expected counts less than 5 and the minimum expected count was 2.34. From above it is suggesting that the level of digital literacy does not significantly influence teacher responses towards VSLA Module. Overall, the findings imply that module is widely accepted as an effective learning tool across secondary level teachers.

## 3. RESULTS

**Quantitative Findings:**

**Hypothesis 1-**Result indicates that the majority of in-service teachers, irrespective of gender, fall within the High Agreement category, suggesting a broadly similar pattern of overall agreement levels across genders. It is also visible that there is no statistically significant association between gender and overall total scores.

**Hypothesis2-**This indicates that the majority of respondents, irrespective of locality, fall within the High Agreement category, suggesting a broadly similar pattern of overall agreement levels across locality. These results suggest that although both groups largely agree on the effectiveness of VSLA Module, rural respondents demonstrate slightly stronger levels of intense agreement (Very High), whereas urban show a comparatively higher percentage in the moderate category. The data indicate that there is no statistically significant association between locality and overall total scores.

**Hypothesis 3-**The consistently high levels of agreement across teachers having Graduates, Masters and Ph.D. degree suggest that VSLA module as well as virtual science labs are an effective and well-received instructional tool at the secondary school level. Since teachers having Ph.D. degree show the strongest concentration in the High Agreement category. The overall pattern suggests that teachers' perceptions are not significantly different across qualification levels, despite the lower sample in Ph.D. level.

**Hypothesis 4-**VSLA Module are viewed favorably by teachers regardless of experience, with particularly strong endorsement from less experienced educators. The findings imply that current VSLA module as well as virtual labs are largely effective and satisfactory. However, the slightly higher percentage of moderate responses among more experienced teachers suggests the need for orientation, mentoring or training programs to help them better understanding and utilize this module. Overall, the statistical results suggest that years of experience were not significantly associated with the examined variable.

**Hypothesis 5-**VSLA Module are viewed favorably by teachers regardless of digital literacy level, with particularly strong endorsement from more techno-savvy educators. The findings imply that current VSLA module as well as virtual labs are largely effective and satisfactory. However, the slightly higher percentage of moderate responses among lower digital literate teachers suggests the need for orientation, mentoring or training programs to help them better understanding and utilize this module. The results indicated no statistical significant association among the level of digital literacy and teacher responses towards VSLA Module.

## 4. DISCUSSION

The findings of this study reveal that secondary school science teachers in Bihar hold a generally positive perception toward the usefulness of virtual labs in teaching science. The majority of teachers agreed that virtual labs provide a valuable supplement to traditional laboratories by enhancing students' conceptual understanding, improving engagement and offering safe, cost-effective alternatives to physical experiments. These perceptions are consistent with previous research that highlights the role of virtual labs in enriching science learning through interactivity and visualization of complex concepts (e.g., De Jong et al., 2013; Zacharia & Olympiou, 2011).

In-service teachers generally hold a positive perception of the VSLA Module, viewing it as useful and aligned with their professional needs. However, the strong agreement patterns indicate scope for refinement in terms of clarity, engagement and overall effectiveness to better support all science teachers and secondary-level learners.

The findings indicate that teachers generally hold positive perceptions of the VSLA module across various demographic and professional variables. Although slight variations are observed such as marginally higher agreement among female teachers, rural respondents, Ph.D. holders, less experienced educators and those with higher digital literacy, these differences are not statistically significant. This suggests that factors such as gender, location, qualification, teaching experience and digital literacy do not substantially influence teachers' overall perceptions. The consistently high levels of agreement across all groups reflect the broad acceptance and applicability of the VSLA module as an effective instructional tool. Therefore, virtual lab-based learning demonstrates strong potential for integration across diverse educational contexts.

The positive perception of VSLA Module across all teachers suggests that virtual lab based learning can be effectively integrated at all levels of higher education. Educators and curriculum planners can confidently use such resources to

enhance understanding, engagement and skill development. This also indicates that Virtual Labs have broad applicability and can support a wide range of teachers as well as learners effectively.

## CONFLICT OF INTERESTS

None.

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