

Content Knowledge of Teachers Teaching Science at Secondary Level in Relation to Gender, Qualification and Age

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Abstract:

Science is one of the compulsory subjects in the secondary level because; it helps the children to understand the existing world through their own sense. Students understand and reflect when the teacher teaches conceptually and experimentally. This type of teaching, require depth content knowledge of teachers but many secondary school teachers have insufficient content and pedagogical knowledge. This lack of knowledge can often lead to lack of confidence in teaching science. This paper describes a descriptive survey study on content knowledge of science teachers. The purpose of this study was to examine the level of content knowledge of science teachers in secondary school and investigate the differences in content knowledge of science teacher in relation to gender, qualifications, experiences and age. Investigator revealed that, most of science teacher teachers have average content knowledge and the level of content knowledge does not affect by gender, qualification, experiences and age of science teachers.

Keywords: content knowledge, Gender, Qualification and Age.

Rationale of the Study

Content knowledge is one of the significant determinants of teacher for effective teaching. The content knowledge encourages science teacher to reflect on their own understanding of science teaching. It provides a useful lens for teaching to begin to help students in scientific ways. Content knowledge is necessary for teacher, without content knowledge of subject, cannot teach well, conceptually and confidently in the class. Johnston, Morrison and Sharp (1971) found out that science teacher teaching chemistry majority have lack of conceptual knowledge. Similarly, Kaulaidis and Ogburn (1989) also found out that, pre-service and experienced teacher generally lack sufficient knowledge of strategies for teaching science. Science teacher often lack a deep conceptual understanding of the subject matter and having fragmented conceptualized poorly organised knowledge. Depth content knowledge develops pedagogical content knowledge which is necessary for science teaching (Carlsen, 1988, Grossman, 1990, Mc Nicholl et al., 2013, & Anderson et al., 2012). Those teachers possessing good subject matter knowledge, show positively affect the range of aspects, considered essential to good science teaching. Good subject matter knowledge helps successful teaching (Dejong, 2005 and Van Driel and Verloop, 2002 & Eunice et al., 2013).

Without depth content knowledge teacher cannot teach effectively. For effective teaching, teacher needs to develop-knowledge with respect to all of the aspects of pedagogical content knowledge and with respect to the entire topic they teach (Magnusson et.al., 1999). Lack of depth content knowledge leads misconceptions about topic understanding. (Nader et al., 2014), those teachers have fragmented; compartmentalized and poorly organized content knowledge and that teachers have less confident in teaching.

Munby, Russell and Martin, (2001) shows clear pictures of school learners, they did not have access to their teachers' thinking and decision making as they taught, because, teachers having less conceptual knowledge. NCF (2005) also found out the pedagogical content knowledge is the most important for teachers. Subject matter knowledge provides confidants to teacher in teaching science (Markik, Valanides and Eilks, 2006). But, beginning teachers usually have limited or minimal pedagogical content knowledge, experienced teachers possess an integrated and developed understanding of teaching (Lee, Brown, Luff and Roehring, 2007, & Kate et al., 2013).

In Indian context, the issue of basic learning; the ability of children to read simple text and to do simple arithmetic has been highlighted annually since 2005 by the annual status of education exercise. The latest estimates from 2008 ASER report indicate that 44% of children in class 5 cannot fluently read class 2 level text nor do a division sum of three digits divided by the one digit. Other studies also supported the findings; secondary school teachers have lack of conceptual knowledge.

Annually, SSA allocates substantial resource for teacher training. Despite large public spending on teacher's capacity development, there is relatively little research evidence on the average teacher's ability to teach. Even internationally, there have been relatively few attempts on a large scale to measure teacher ability to teach in a quantitative way. Peter Hudson (2013) revealed that, a biology teacher, when teaching chemistry or physics topics face more difficult to select appropriate instructional strategies and be less aware of student's difficulties than a physics teacher or chemistry teacher teach same topic.

In Bihar and other states, during teacher recruitment, knowledge of content in the primary school as well as secondary school text-books is not tested, nor is the ability to explain/ teach/ observed or assessed. It is as assumed those teachers' educational qualifications and pre-service teachers training will ensure that they have adequate knowledge and skills for teaching primary and secondary grades or it assumed that deficit in skills can be plugged via in-service training. Due to which, majority of science teachers have lack of conceptual knowledge or depth knowledge and have average content knowledge. Many ideas are currently being floated about content and mechanisms for assessing children. But what about the questions of assessing a teacher's ability to teach or is knowledge of the content he is expected to reach? Unlike many other government departments, most states recruit teachers without any test or assessment.

From the above discussion, it is discerning that majority of teachers lack content knowledge, which is necessary for effective teaching. Thus, research study on content knowledge of science teacher is relevant.

So, researcher raised following research questions.

- ❖ Does science teacher possess adequate content knowledge?
- ❖ Is there any significant difference in content knowledge of science teachers in relation to gender, qualification, experience?

Objectives of the Study

- To find out the content knowledge of teachers teaching science.
- To compare the content knowledge of male and female teachers teaching science.
- To compare the content knowledge of teachers teaching science having different qualification.
- To compare the content knowledge of teachers teaching science with different length of teaching experience.

Hypotheses of the Study

- There will be no significant difference between male and female science teachers with regard to content knowledge.

- There will be no significant difference in content knowledge of science teachers having different qualification.
- There will be no significant dimension in content knowledge of science teachers having different length of experience.

DESIGN OF THE STUDY

Method

For the present study the researcher has adopted the descriptive survey method. Descriptive research studies are designed to obtain pertinent and precise information concerning the current status of phenomenon. The investigator studied the content knowledge of science teachers in relation to gender, qualification and experience.

Sample

For the present study population belong to teacher teaching science at secondary level of Bhagalpur district of Bihar. The population referred to as male and female, different qualification, different age, experience science teachers. The sample for the present study consists of 20 science teachers selected from Bhagalpur district of Bihar. Out of 20 teachers, 13 teachers were male and 7 teachers were female; 11 teachers having B.Sc. with B.Ed. and 9 teachers having M.Sc. with B.Ed. qualification; 11 teachers having less than ten years' experience, 5 teachers having 11-20 years' experience and 4 teachers having above 20 years' experience; 12 teachers were of below 45 years age and 8 teachers were of above 45 years age. These samples were selected randomly.

Tool

The researcher used achievement test in science as a tool. The achievement test was developed by researcher with the consultation of expert. Initially test blue print developed by giving weightage to content, objectives, and different types of questions. The content of the test was drawn from class IX text book of Bihar state. The units such as Unit- I (the fundamental unit of life; cell), Unit- II (Tissue), Unit- III (Diversity in living organism), Unit- IV (Natural resources). The investigator used only multiple-choice questions. On the basis of blue print 50 questions were written. So then, out of 50 items / questions were edited to find out its suitability. Finally, 25 questions were retained for final draft. The investigator also developed scoring/ answer key for questions, for making evaluation objectives.

Procedure of the Data Collection

The investigator first met to head of the schools and then met to science teachers. The investigator requested science teacher to solve the problems, investigator collected responses about teacher's content knowledge. The test was administered individually. The researcher administered on 20 Bio-science teachers at secondary school and responses of all Bio-science teachers collected by investigator.

Statistical Technique Used

The answer scripts were evaluated on the basis of scoring key. Then all scores were converted into percentage, Mean value of whole group and sub-groups were calculated for interpretation. The investigator also used t-test for finding significant difference between teachers' content knowledge.

ANALYSIS AND INTERPRETATION

Analysis of data and interpretation of result is a significant phase of research study. The researcher analysed the collected data according to objectives. The researcher used statistical methods such as; Percentage, Mean, Standard-deviation, t-test for analyzing the data.

1. Content Knowledge of Science Teachers

The first objective of this research was to find out the content knowledge of science teachers. The researcher categories, teachers into three such as teacher have less than 40%, 40-60%, and above 60% content knowledge. The table-1 presents the frequency and percentage of teachers having different level of content knowledge.

Table No-1: Frequency and Percentage of Teachers having Different Level of Content Knowledge

Categories	Frequency	Percentage
More than 60%	3	15
40-60%	13	65
Less than 40%	4	20
Total	20	100

The table 1; shows that out of 20 teachers, 15% teachers got or secured more than 60% marks, 65% teachers secured 40-60% marks and 20% teachers secured less than 40% marks. It can be said that majority of science teachers have 40-60% of content knowledge. The Figure No.1 shows graphically the percentage of teachers having different level of content knowledge.

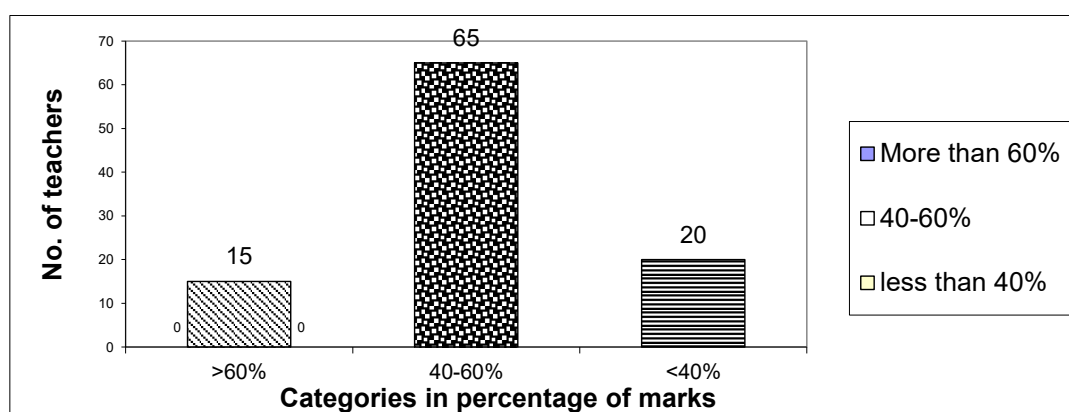


Figure No-1: Content Knowledge of Science Teachers

2. Content Knowledge of Male and Female Science Teachers

The second objective was to compare the content knowledge of male and female science teachers. For this, researcher calculated t-value which is presented in table2.

Table No-2: t-value of Content Knowledge of Male and Female Science Teachers

The table 2; indicates that the calculated t-value (0.700297) is smaller than the table value (2.10). so null hypotheses is accepted. It can be concluded that there is no significant difference in the content knowledge

Gender	N	Mean	SD	t-test	df	Result
Male	13	25.38462	6.131048	0.700297	18	Not Significant
Female	7	24.28571	5.707138			

of male and female science teachers. The difference in means is graphically presented in the Figure No. 2.

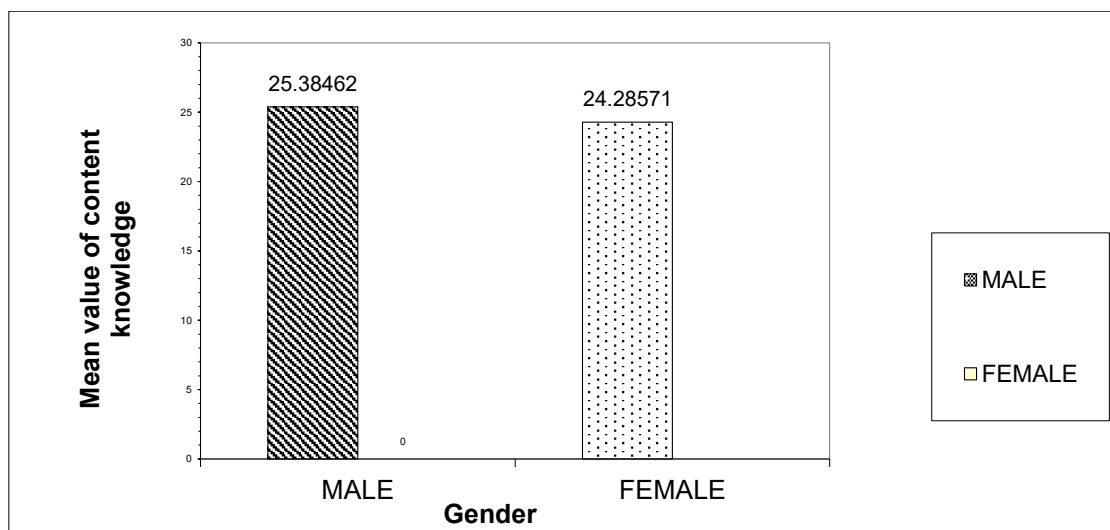


Figure No-2: Content Knowledge of Male and Female Science Teachers

3. Content Knowledge of Science Teachers in Relation to Qualification

The third objective was to compare the content knowledge of science teachers having different qualification i.e. - B.Sc. with B.Ed. and M.Sc. with B.Ed., for this researcher calculated t-value which is presented in table 3.

Table No-3: t-value of Content Knowledge of Science Teachers having Different Qualification

Qualification	N	Mean	SD	t-test	df	Result
B.Sc. With B.Ed.	11	24.18182	5.89607	0.505935	18	Not Significant
M.Sc. With B.Ed.	9	26	6			

Table No-3; indicates that calculated t-value (0.505935) is smaller than the table value (2.10). So, null hypotheses are accepted. It can be calculated that there is no significant difference in the content knowledge of teachers having B.Sc. with B.Ed. and M.Sc. with B.Ed. qualification. The difference in mean value is graphically presented the Figure No.3.

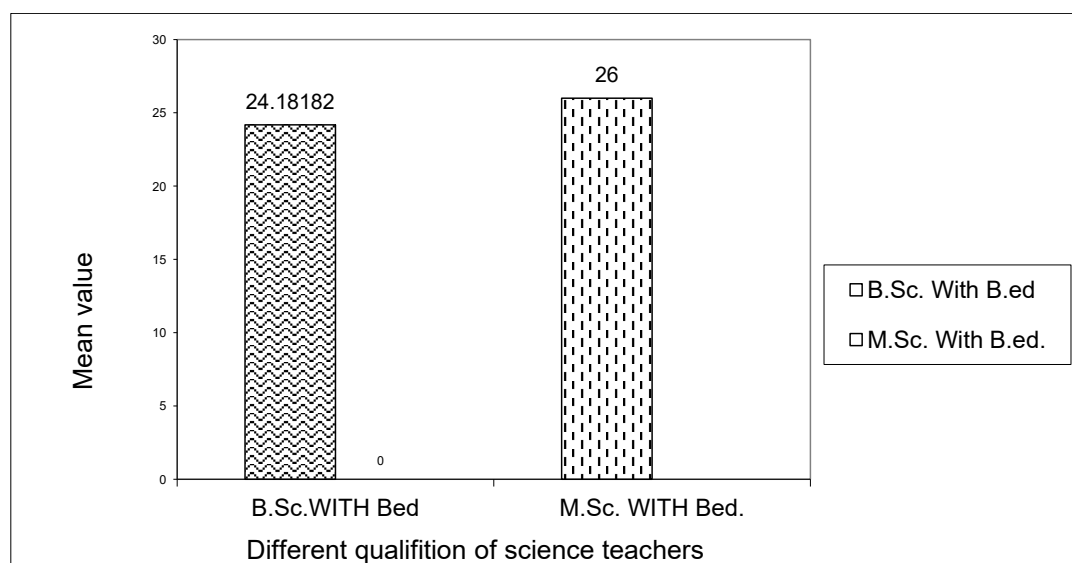


Figure No-3: Content Knowledge of Science Teachers having Different Qualification

4. Content Knowledge of Science Teachers having Different Length of Experiences

The fourth objective was to compare the content knowledge of science teachers in relation to their experience.

The researcher grouped the sample into three categories such as teachers having- less than 10 years' experience, between 11-20 years' experience, more than 20 years' experience. The Table No-4 presents t-value of teachers having less than 10 years and 10-20 years of experiences.

Table No.4: t-value of Pair Groups I (less than 10 yrs vs. 11-20 yrs) having Different Length of Experience

Experience	N	Mean	SD	t-value	df	Result
Below 10y	11	25.63636	6.0543	0.707584	14	Not Significant
11-20 Y	5	24.8	2.683282			

The table 4; revealed that calculated t-value (0.707584) of group 1st (less than 10 yrs vs.11-20 yrs) is smaller than the table value (2.14). So, null hypotheses are accepted. It can be calculated that, there is no significant difference in the content knowledge of teachers having below 10 yrs experience and 20 yrs experience. The difference in mean value graphically presented in Figure No.4.

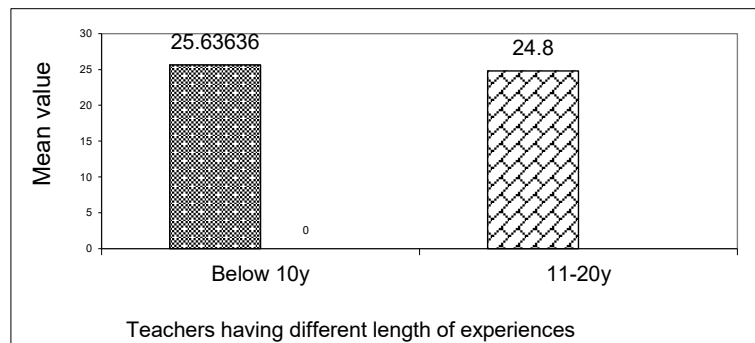


Figure No-4: Content knowledge of Science Teachers having 10 yrs Experience and 11-20 yrs Experience.

5. The researcher also computed t-value of teachers having less than 10 years and above 20 years' experience, which is presented in table no-5.

Table No-5: t-value of Pair Groups (less than 10 yrs vs. 20 yrs) having Different Length of Experience

Experience	N	Mean	SD	t-value	df	Result
Below 10Y	11	25.63636	6.0543	0.682523	13	Not Significant
Above 20y	4	23.5	9			

The table 5; indicates that t-value (0.682523) of group second (less than 10 yrs vs. 20 yrs) is smaller than the table value (2.16). So, a null hypothesis is accepted. It can be calculated that, there is no significant difference in the content knowledge of teachers having below 10 yrs experience and 20 yrs experience. The difference in mean value graphically presented in Figure No-5.

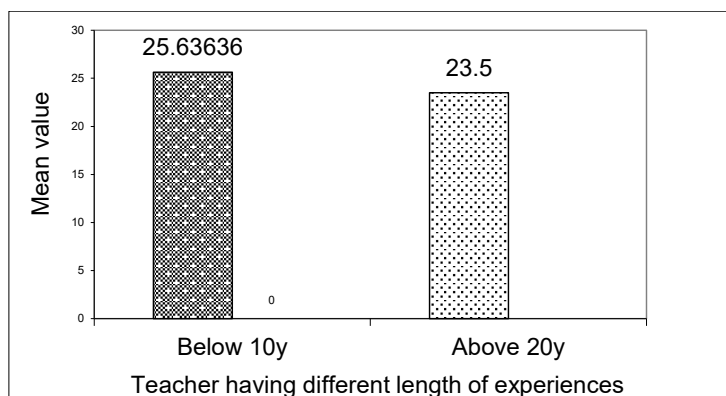


Figure No-5: Content Knowledge of Science Teachers having 10 yrs Experience and 20 yrs Experience.

6. The researcher also computed t-value of teachers having less than 11-20 years and above 20 years' experience, which is presented in table no-6.

Table No-6: t-value of Pair Groups III (11-20 yrs vs. above 20 yrs) having Different Length of Experience

Group III	N	Mean	SD	t-value	df	result
11-20y	5	24.8	2.683282	0.796149	7	Not Significant
Above 20Y	4	23.5	9			

The table 6 indicates that calculated t-value (0.796149) of group III 11-20 yrs vs. above 20 yrs experience) is smaller than the table value (2.36). So, null hypotheses are accepted. It can be concluded that there is no significant difference in content knowledge of science teachers having 11-20 yrs and above 20 yrs experience. The difference in mean value graphically presented in the Figure No-6.

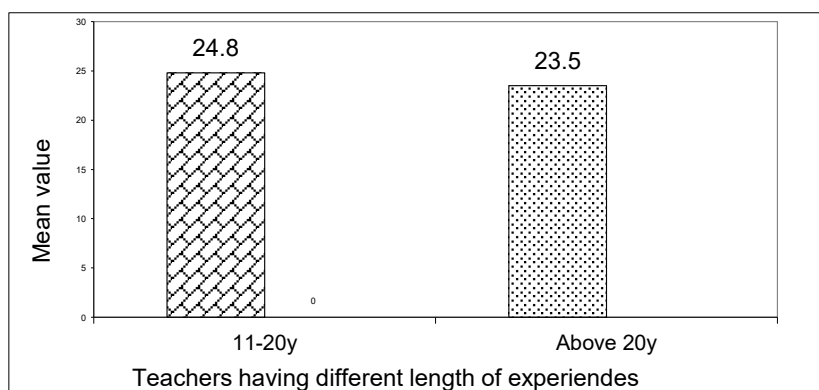


Figure No-6: Content Knowledge of Science Teachers having 11-20 yrs Experience and Above 20 yrs Experience.

7. Content Knowledge of Science Teachers having Different Length of Age

The last objective was to compare the content knowledge of science teacher having different age; (i.e. - Below 45 years, Above 45 years.). The researcher calculated t-value in table 7.

Table No-7: t-value of Science Teachers having below and Above 45 years of Age

Age	N	Mean	SD	t-value	df	result
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Below 45y	12	25.66667	5.773503	0.62072	18	Not Significant
Above 45Y	8	24.25	6.363961			

The table 7; indicates that calculated t-value (0.62072) is smaller than the table value (2.10). So, a null hypothesis is accepted. It can be concluded that there is no significant difference in content knowledge of science teachers having different age (below and above 45 years of age). The difference in mean value graphically presented in the Figure No.7.

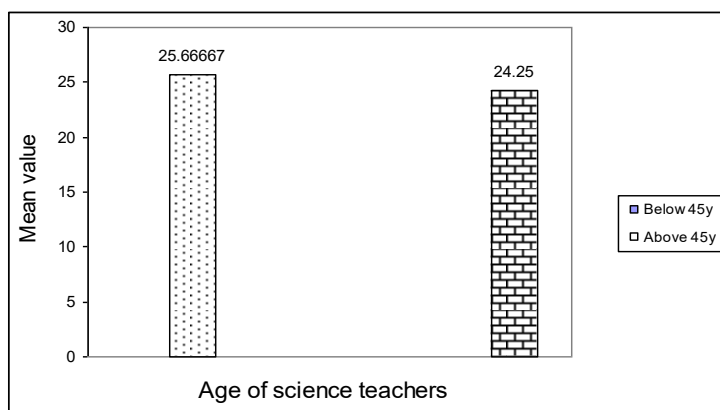


Figure No-7: Content Knowledge of Science Teachers having Different Age

MAJOR FINDINGS

The major findings of the study are...

- The content knowledge of science teachers is average. The maximum percentage (65%) of science teachers lie in the average content knowledge, 15% of the science teachers have high level of content knowledge and 20% have low/less content knowledge in science. Thus, science teachers must have forgotten their basic content of science subject. This situation is alarming and calls for an immediate action to improve content knowledge of science teachers at secondary level.
- Those science teachers (20%) have less content knowledge (below 40% marks obtained), they belong to rural areas, have not good infrastructure of school such as: library facilities, computer, internet, science magazines etc. have no attitude towards teaching and didn't take participate in the training program that emphasized content of science.
- Those teachers (15%) have high content knowledge (obtained more than 60% marks), they belong to urban schools, having good infrastructure of the schools, such as: library facilities, computer, internet, science magazines etc. and have own books related to science subjects.
- Male and female science teachers teaching at secondary level have similar content knowledge, no difference was found between them.
- Qualification doesn't seem to influence the content knowledge of teacher teaching science at secondary level.
- Experience of teachers teaching science at secondary level doesn't influence on the content knowledge.
- Age doesn't affect on content knowledge of teachers teaching science at secondary level.

DISCUSSION

The present study investigated the level of content knowledge among secondary school science teachers and examined its association with demographic and institutional variables. The findings reveal

that the majority of teachers (65%) demonstrate an average level of content knowledge, while 15% possess high mastery and 20% exhibit low content knowledge (scoring below 40%). Although the predominance of the average category suggests basic subject familiarity, the limited proportion of highly proficient teachers and the considerable percentage with inadequate knowledge raise concerns about the depth of conceptual understanding among science educators.

Research consistently emphasizes that strong subject matter knowledge is fundamental to effective teaching. Shulman (1986) argued that content knowledge forms the foundation of pedagogical content knowledge, enabling teachers to explain concepts clearly and address student misconceptions. Similarly, Darling-Hammond (2000) found a positive association between teacher subject competence and student academic achievement. Therefore, the presence of 20% teachers with low content mastery signals a need for systematic professional development interventions to strengthen foundational scientific understanding.

A significant finding of the study is the association between low content knowledge and rural school settings. Teachers with lower scores were primarily employed in schools lacking adequate infrastructure, including libraries, digital resources, and science-related materials. They also reported limited participation in professional development programs and comparatively weaker teaching attitudes. These findings are consistent with UNESCO (2015), which highlighted that resource-constrained educational environments negatively affect teacher development and instructional quality. The ASER (2009) reports similarly documented disparities between rural and urban schools in India, emphasizing the role of infrastructure and access to academic resources in shaping educational outcomes.

Conversely, teachers demonstrating high content knowledge were largely affiliated with urban schools that provided better infrastructure and academic support. Access to libraries, internet facilities, science magazines, and personal reference books appeared to facilitate continuous learning and deeper subject engagement. OECD (2018) reported that teachers working in resource-rich environments are more likely to participate in professional learning activities and maintain updated subject knowledge. These findings underscore the importance of institutional support systems in enhancing teacher competence.

The study further found no significant differences in content knowledge based on gender, qualification, teaching experience, or age. The absence of gender differences aligns with Hyde's (2005) Gender Similarities Hypothesis, which suggests that males and females perform similarly across cognitive domains when opportunities are equal. Additionally, the lack of association between qualification and content knowledge suggests that formal degrees alone may not ensure sustained mastery unless accompanied by continuous learning (Darling-Hammond, 2006). Likewise, experience and age did not significantly influence content knowledge, supporting research indicating that professional growth depends more on ongoing engagement than on years of service (Rice, 2010).

Overall, the findings indicate that contextual and institutional factors exert a stronger influence on teachers' content knowledge than demographic characteristics. Strengthening infrastructure, ensuring equitable access to professional development, and promoting continuous subject enrichment—particularly in rural schools—are essential for improving the quality of secondary science education.

CONCLUSION

Regarding the content knowledge of Bio-science teachers was average; the study revealed that, bio-science teachers in this sample do not bring a well-developed understanding of the essential concept of biological problems with them from secondary school. The results support the findings of previous studies, which are reported that prospective science teachers often have insufficient depth content knowledge (NCF, 2005). The investigator also found out that, the content knowledge is not depends on the gender differences, it depends on the interest and attitudes of the science teachers (Lee et al., 2007). Similarly, investigator found out that, qualification, experiences and age did not affect the content knowledge of science teachers, who teaches in the secondary school.

EDUCATIONAL IMPLICATIONS

⇒ Secondary science teachers need to learn a basic concept of science.

- ⇒ Secondary science teachers need a deep and robust understanding of the nature of science thinking and reflect on their experience as students what they have learned about the nature of science.
- ⇒ The government should arrange subject specific training program for secondary science teachers to develop content/ subject matter knowledge about science.
- ⇒ Government should prepare effective programs time to time for secondary science teachers require collaboration among science educator, science professor, and education faculty and science teacher.
- ⇒ Colleges and universities need to provide all prospective secondary science teachers with significant opportunities to learn how to teach conceptually the science subject at the secondary level.
- ⇒ College courses for prospective teachers should illustrate the way science is practiced.

SUGGESTIONS FOR FURTHER RESEARCH

- The similar study may be taken up on a large sample of secondary science teachers teaching science.
- The same study can be conducted between government science teachers and private science teachers and to compare the content knowledge.
- The study can be conducted on all subjects of teachers teaching at secondary level.
- The study can be conducted between rural science teachers and urban science teachers teaching at secondary level.

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