



Sunita Kathuria¹ and Prof. Sangeeta Chauhan²

¹Senior Research Fellow, Ph.D. Scholar, USE, GGSIPU & Indian Sign Language Interpreter, India.

²Professor, Former Dean, USE, GGSIPU, Dwarka, New Delhi, India.

Corresponding Author: Sunita Kathuria

Email: sunit.kath@gmail.com

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USAGE OF SIGN LANGUAGE IN DEVELOPING SCIENCE PRACTICAL SKILLS AMONG THE LEARNERS WITH HEARING IMPAIRMENT IN INCLUSIVE SCHOOLS

ABSTRACT

The current research explored the effectiveness of using Indian Sign Language (ISL) as an instructional medium for developing Science Practical skills among LwPHI. Methodologically, the research falls under the mixed-method research paradigm. This study had one group, pretest-post-test design and the sample was selected through purposive sampling. The data was collected from 10 Science teachers and 20 LwPHI studying at the upper primary stage in the Inclusive schools of Delhi, India. The researcher used interview schedule, rubrics, and Science practical lesson plans as the tools. The intervention phase was designed to develop the skills related to 4 important components of science practical i.e. procedural and manipulative skills, observational skills, drawing skills, and Interpretive & reporting skills. On analysis of the descriptive statistics, it was found that there was a mean gain difference of 14.95 between the pre-post test scores and 0.423 in the standard deviation. The hypothesis testing was done through Wilcoxon signed-rank test statistical analysis, Z: -3.936, P-value was less than 0.05 ($0.000 < 0.05$), indicated that there was a significant difference in the performance and hence, H_0 was rejected. The qualitative analysis of the rubrics and interview revealed that the LwPHI not only had limited ability to connect the science content taught in the classrooms to their daily life but also were less aware of science as a subject and had many misconceptions. And, due to the communication gap, this learning gap was widening. The analysis of data collected after the intervention indicated improved content understanding, a rise in science vocabulary, and awareness of scientific terminologies. The finding of this study is in coherence with the preceding researches and acknowledges that the curriculum objectives are better attained by learners if they are delivered in the respective learner's first language.

KEYWORDS

Science Practical Skills; Indian Sign Language; Learners with Profound Hearing Impairment; Inclusive Schools; Barriers and Science Education.

INTRODUCTION

“Visualise a science class wherein a science teacher is demonstrating with a verbal explanation about the “properties of acids and bases” to 35 students. Most of the students are listening and watching the experiment conducted by the teacher. One student who has a high degree of hearing loss looks confused as he struggles back and forth between the teacher’s lip movement and hand movement. Ultimately, end up understanding, almost nothing. On the same day, in the practical class, they are asked to perform the same experiment. Most of the students are in the position to perform it to some extent with no or little support from the teacher. The LwPHI tries to copy from the student next to him, somehow able to manage it to perform but with very little or no understanding.”

The similar real scenarios observed and reported in recent researches that highlight that despite having a normal, average, above average, and high intellectual competency, LwPHI exhibits low academic performance in schools (Andrews, Jean., 2017). Although, there is no match of their attentiveness and inquisitiveness, still, the outcome is found to be disappointing. Researchers (Lang and Albertni, 2001) found that there is a significant difference in the knowledge level and learning strategies of LwPHI and hearing learners. The statistical data (DISE, 2014-15) on enrolment drop out and pass percentage of hearing-impaired students studying in government schools reported low enrolment, high drop-out, and poor academic performance in school. LwPHI exhibit pronounced difficulties in the acquisition of new knowledge and application of the previously acquired concepts to the general setting. The low enrolment statistics of students with complete hearing loss in the science stream at the senior secondary stage in India indicate that there is something wrong with the system which requires a big transformation. One of the primary obstacles researched in the areas of ‘increased drop-out rates’ is the inability of the system to provide a language-rich environment to LwPHI, which leads to ‘LANGUAGE DEPRIVATION’.

Language Deprivation and its impact on Learning of Science concepts

With time, along with physical growth, the child develops cognitively and socio-emotionally. Language plays an important role in cognitive and socio-emotional development. The knowledge of the language and its appropriate usage is of utmost importance. In the context of children with hearing impairment, language development gets affected and delayed. It is observed that the deaf child brought up by deaf parents, grasps sign language as the natural/ primary/ first language and the growth of the child is found to be near to normal (Benson, C., & Kosonen, K., 2013). Research has shown that children’s first language is the optimal language for literacy and learning throughout the initial phase of life (UNESCO, 2008).

Education is a complex endeavor in itself (Koul R. et.al., 2019). Within the greater educational discussion, lies, the area of Science. Science is considered to be one of the difficult subjects, as it requires a lot of critical examination, exploration, reflection, analysis, the perspective of constructivism, inquiry-based approach, problem-solving skills, abstract thinking processes, independent thinking, hands-on, and presence of mind. Development of language, deeper understanding, students' contextual knowledge, greater integration, world-views, internalization, appropriate reasoning, and social skills, all contribute to preparing students to become scientifically literate citizens (Koul R., 2019). The malfunction in any of such areas results in negative consequences in learning. The lack of the usage of auditory and speech modalities creates difficulties in grasping complex information and interlinking new concepts with the old ones. Concepts of Science are never learned through textbooks. They are learned when the learner starts interacting with the objects, environment, other beings, etc. Such kind of interaction is said to be part of incidental learning. Due to the communication barrier, deaf learners are deprived of knowing science to its fullest. Sometimes, not only deprivation, but it also leads to the formation of misconceptions, as, they are not able to confirm the observations from others due to lack of access to the expression of thoughts (Kurz B. Kim et.al., 2015). So, communication issue is found to be the greatest barrier in teaching and learning science to deaf students as science requires most of the discussion, argumentation, brainstorming, agreement-disagreement, and experimentation. So, despite possessing adequate intellectual potential, deaf learners perform poorly in science and develop anxiety, stress, frustration, anger, and fear for the subject. This challenge can very well be addressed by providing the opportunity for accessibility of information through visual-tactile mode to deaf learners (Dirksen, H., & Bauman, L., 2004).

This study explored the learning experiences of LwPHI in the inclusive classrooms, focussing on the learning of Science (understanding of concepts and acquiring practical skills), and also attempted an experiment where the information was communicated through their first language Indian Sign Language (ISL), to find whether the language support brought a difference in the comprehension of the science concepts and gaining of practical skills.

ABOUT THE RESEARCH

1.1. Objectives of the Research:

The current study was conducted:

- To know the knowledge level of LwPHI and the challenges faced in understanding Science concepts and practical skills.

- To determine the effectiveness of using Indian Sign Language as an Instructional medium for developing Science Practical skills among LwPHI.

1.2. Hypothesis:

The hypothesis framed in the study was:-

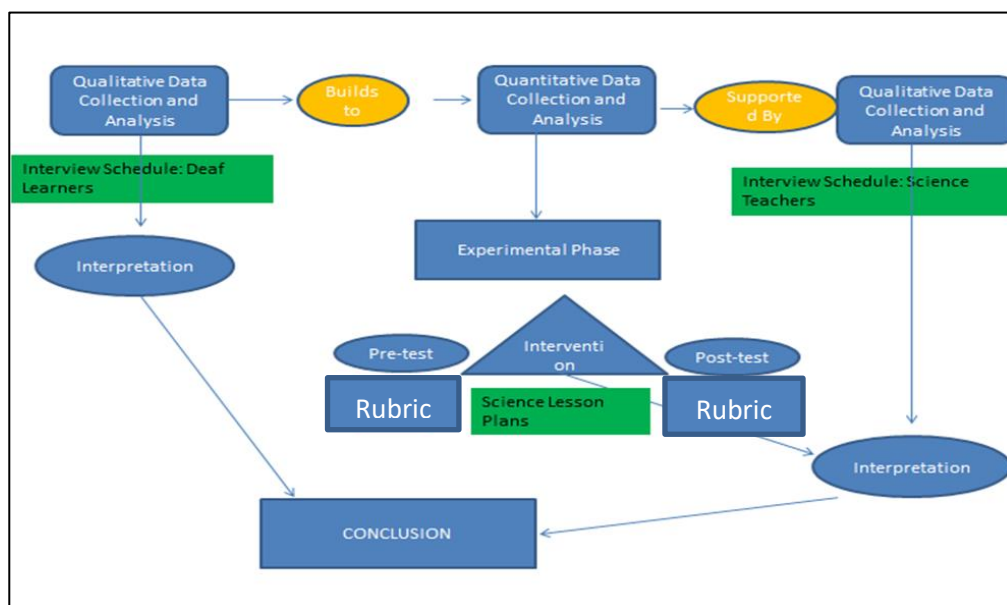
H₀₁: “There is no statistically significant difference in the pre-test and post-test scores of the rubrics (practical skill assessment tool) administered before and after the intervention”

1.3. Research Methodology:

Since, the research focused on exploring the way of mainstreaming LwPHI in inclusive school with equal attention towards the equity in academic opportunities, be it subject exposure or class activities, the researcher planned to move from experiential learning to abstract concept building of the students, so, chose to work firstly on the practical skill development.

Methodologically, the present study has a mixed-method research design (Exploratory Sequential Design) with a qualitative and quantitative approach for data collection and analysis (Figure 1). The data collected before and after the intervention was analyzed qualitatively through content analysis and quantitatively through the application of inferential statistics.

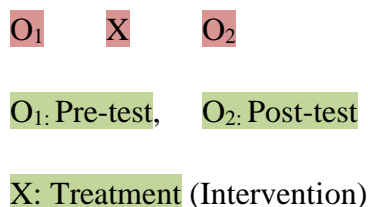
Figure 1: Diagrammatic representation of research design (Exploratory Sequential Design)



Population and Sample of the study:

In this study, the population was referred to, all the LwPHI of upper primary stage, studying in Government Inclusive schools of Delhi, India. The sample was selected through the purposive

sampling technique. The sample comprised of 10 Science teachers and 20 LwPHI. In the experimental phase of this study, the pre-experimental design was adopted (Best and Kahn, 2006) with one sample, a pretest-posttest design. Although, due to the lack of a control group or a failure to provide for the equivalence of a control group, this design is least preferred, due to the lack of availability (low enrolment) of students with profound hearing impairment in inclusive schools of Delhi and the nature of the research (experimental), the researcher had to choose the pre-experimental one group design.



The study had one independent variable and one dependent variable.

- Independent Variable: Teaching of science experiments through sign language.
- Dependent Variable: Skill acquired (science practical skills) by the LwPHI in performing science practical.

Tools used in the study:

1. *Interview Schedule*: There was two interview schedule prepared in the study. One was prepared to gather the data from science teachers and the other was prepared for the LwPHI. The researcher got the interview schedule validated by 4 experts.

a) Interview schedule for the LwPHI: The interview schedule was prepared on two dimensions, one was related to knowledge in science specifically (6 questions) and the other one was on challenges faced by LwPHI in understanding and acquiring skills related to science (6 questions). In all, there were 12 questions.

b) Interview schedule for the science teachers: This interview schedule had 6 questions on the interest, confidence, and performance of the LwPHI before and after the intervention.

2. *Rubric* (for objective 2): For assessing Science practical skills. The items were developed on 4 parameters (Refer Table 1.)

- procedural and manipulative skills (35% of the total items),
- observational skills (35% of the total items),
- drawing skills (15% of the total items) and

- Interpretive & reporting skills (15% of the total items).

The researchers got the rubric tool validated by 4 experts, as per the feedback, the tool was modified and the final version was prepared. The internal consistency of the final tool was found to be 0.79. Some of the items of the rubric used in the study:-

Table 1: *Items of the Rubrics*

Assessment Task	Performance indicators		
	Good/2	Satisfactory/ 1	Need Improvement
<i>Procedural and Manipulative Skills</i>			
Experimenting independently (following the procedure as described).	Able to carry out the whole experiment without any assistance.	Able to carry out the whole experiment individually but with little assistance	Not able to Experiment even with some assistance. (need help at every step)
<i>Observational Skills</i>			
Take observations carefully and in a systematic manner.	Able to take observations carefully and in a systematic manner.	Able to take observations carefully with some verbal assistance.	Not able to take observations independently even with some verbal assistance.
<i>Drawing Skills</i>			
To make and put data properly in observation tables.	Able to make and put data correctly in the observation tables.	Able to make and put data correctly to some extent in the observation tables.	Not able to make and put data correctly in the observation tables.
<i>Interpretive and Reporting Skills</i>			
Making a proper plan for recording the observations.	Able to make a proper plan for recording the observations with some verbal assistance in the first attempt.	Able to make a plan for recording the observations with some verbal assistance of the mentor after two or three attempts.	Not able to make a plan for recording the observations even with the involvement/ support of the mentor.

3. Science Lesson Plans:

The framework of the lesson plan was prepared to keep all three domains into consideration, the cognitive, psychomotor, and affective domains. The sub-objectives of the lesson plan were to enhance the skills related to 4 important components of science practical i.e. procedural and manipulative skills, observational skills, drawing skills, and Interpretive & reporting skills. One practical each of Biology, Chemistry, and Physics of VI-grade was prepared by the researcher, which was taught in ISL (Table 2).

Table 2: *Experiments taught during Intervention*

S.No.	Subject	Experiment
1.	Biology	Presence of Starch in different food items
2.	Physics	Electric Current and its' effects
3.	Chemistry	Separation of components of a mixture

PROCEDURE

The study started after seeking permission from the Principal. The objective and rationale of the research were explained to the Principal and the science teacher and the parents of LwPHI for cooperation at its best. A pre-test was administered to assess the entry-level knowledge on the practical skill of the LwPHI. The intervention phase was designed to develop the practical skills related to 4 important components of science practical i.e. procedural and manipulative skills, observational skills, drawing skills, and Interpretive & reporting skills. To develop the skills, in the intervention phase, the science practical and its related concepts were explained to LwPHI by the researcher in ISL. For this, lesson plans were prepared. Since the knowledge related to science and scientific concepts was found to be very low in LwPHI, one practical each of Biology, Chemistry, and Physics of VI-grade was taught to the students by the researcher in ISL. Though the experiments were of VI-grade, the lesson plans were prepared with the 'extended learning' approach and covered the related concepts of VII and VIII grade too. The whole intervention was given for six weeks. After the intervention of 6 weeks, a post-test was administered to assess the exit skill level in science practical.

ANALYSIS AND INTERPRETATION

Objective 1: To know the knowledge level of LwPHI and the challenges faced in understanding Science concepts and practical skills.

Tool: Interview of the LwPHI**Analysis and Findings:**

The interview was conducted in the first language (ISL) of the LwPHI. The data gathered through interviews revealed that the LwPHI not only had limited ability to connect the science concepts taught in classrooms to daily life but also were less aware of science as a subject and had many misunderstandings. And, due to the communication gap, the learning gap was widening. It was found that the LwPHI of the upper primary stage (VIII grade) has a basic knowledge level of science (1 to 4th grade). The students were not able to answer questions related to different components of food, three states of matter, organisms and environment, sound, electricity and circuits, plants and animals, shadows and reflections, magnetic property, measurement of distances, and the difference between synthetic and natural fiber. Though these topics were covered in VI, VII, and VIII grade NCERT books, LwPHI of VIII grade left 95% of the questions unanswered. The conceptual knowledge appears to be poorly interconnected. It was also found in the interview that the LwPHI deviates significantly in understanding the new scientific concepts. It was found that the LwPHI were not aware of scientifically informed language and developed lots of misinterpretations and confusions.

The verbatim of one of the learners with profound hearing impairment (as communicated in sign language during the interview):-

“I cannot understand what my teacher writes on board, what she explains, what she demonstrates in the class, as I can’t hear her. I try to lip-read her explanation but she speaks so fast that I cannot lip-read her even. Since no one understands my language; I am not able to ask them my queries. I just copy what is written on board and in my friend’s copy. I do not know what is the meaning of text I write in a notebook and how it would be useful to me in the future. I mostly fail in maths and science subjects. ”

(Verbatim of a LwPHI of VIII grade, Govt. school of West district of Delhi, rural area)

Some of the main themes identified in the interview; related to challenges faced by the LwPHI, in learning science in an inclusive classroom were as follows:-

- Rote learning behaviorist approach: Most of the LwPHI revealed that they were expected to just memorize the answers written in the notebooks and write them when asked in the exams. They were very less aware of the real-life application of these scientific concepts.
- The inability of the teachers in designing positive experiences: Most of the LwPHI acknowledged that they should be allowed to express and understand differently. They

have a different learning and expression style, which must be addressed and accommodated in the class and examination.

- Lack of Teacher-student relationship: Most of the LwPHI found the classroom environment to be authoritative and teacher-driven. It was revealed in the interview that most of the students fear from their science teacher and this subject too as they understand and score poor in this subject. Due to this, the students go through undesirable classroom experiences.
- Fear due to lack of understanding of even the basics of Science (poor basic knowledge). Risk of public embarrassment and fear of criticism on expressing the curiosity related to the subject.
- Abstract nature of Science: Science and its concepts are perceived as abstract by the LwPHI. When it comes to anything about theories, facts, and processes like analysis and interpretation; the students find it, out of their understanding.
- Too much emphasis on verbal approach (explanation)/ Traditional method of teaching Science: Science was taught through a reading a book method, underlining the important points, dictating the answers, or copying the answers from the blackboard and lecture method. Practical exposure was found to be very less at the upper primary stage.
- Lack of peer support: Since no one in the class except for two-three students (that too based on guesswork) understands their signs, the expectation of cooperation was quite difficult and next to impossible from hearing peers. There was a lack of connecting bridge of the friendship between hearing and LwPHI which ultimately impacts the learning growth of LwPHI.

Objective 2: To explore the effectiveness of using Indian Sign Language as an Instructional medium for developing Science Practical skills in LwPHI.

Tools: Rubrics, Interview schedule, and Science Practical Lesson plans

Analysis and Findings:

To explore 'If the LwPHI have been benefitted from the intervention when taught science practical in sign language, the mean of pre-test and post test scores were compared. Descriptive statistic (Table 3) indicates that there was a gain difference of 14.95 between the pre-post test scores and 0.423 in the standard deviation.

Table 3: Descriptive Statistic: Comparison of Pretest v/s Posttest scores

	N	Mean	Std.	Minimu	Maximu

			Deviation	m	m
Pre-test	20	4.35	5.985	0	17
Post-test	20	19.30	6.408	13	34

Interpretation: The data of Table 3, indicated that there was a gain difference between pre-test and post-test scores in each dimension. The maximum gain score was found to be in procedural and manipulative skills i.e. 6.2 and the gain in interpretive and reporting skills were found to be the minimum i.e. 1.05 (Table 4).

Table 4: Descriptive Statistics indicating the Gain scores in Each Dimension

Dimensions	Pre-Test Average	Post-test Average	Gain score
Procedural and manipulative skills	2.45	8.65	6.2
Observational Skills	1.1	5.5	4.4
Drawing Skills	0.65	3.95	3.3
Interpretive and Reporting Skills	0.15	1.2	1.05

The data of table 5 indicates that there were no negative scores and there was no decrease in scores after intervention. This means that the intervention did not work in a negative direction.

Table 5: Inferential Statistics: Wilcoxon Signed Ranks Test

		N	Mean Rank	Sum of Ranks
Posttest – Pretest	Negative Ranks	0 ^a	.00	.00
	Positive Ranks	20 ^b	10.50	210.00
	Ties	0 ^c		
	Total	20		
Posttest – Pretest				
Z			-3.936 ^b	
Asymp. Sig. (2-			.000	

tailed)	
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks.	

Interpretation: The hypothesis testing was done through Wilcoxon signed-rank test, the P-value was less than 0.05 ($0.000 < 0.05$), indicated that the H_{01} was rejected and hence a significant difference in the performance was found at the end of the intervention. The Z score was observed as -3.936, Asymp. Sig. (2-tailed): 0.000, indicated that there was a significant difference in the practical skills of the LwPHI gained after the intervention.

It was found through the qualitative analysis of the rubrics (administered after the intervention) that teaching the concepts of difficult subjects like science (as perceived and expressed by LwPHI in the initial phase of the study, in the interview) through sign language (the first language of the child), can be made accommodated under the reach of their understanding. In the final phase of the study, it was observed that 85% of the LwPHI were able to:-

- make a plan for recording the observations with some gestural assistance.
- record the observation/data/information with some degree of accuracy.
- generate a reasonable hypothesis of possible outcome based on observation with some help and assistance.
- write the performed steps on the practical file but not that accurately (grammatical errors due to language problem) and systematically.
- classify and categorize 50% of the things at the end, based on observations in the experiment
- collect data correctly either from measurement or observation with some help/ support.
- make and put data correctly to some extent in the observation tables.
- label and sketch the related diagram.
- arrange 50% of the apparatus/ experimental setup on their own,
- experiment with some degree of efficiency and accuracy.
- have basic knowledge of the concept related to the experiment done, its' use, and limitations of the apparatus or the material used in the experiment.
- are somewhat aware of the chemicals and quantity of the chemicals to be added in the experiment.
- apply precautionary measures while handling sensitive chemicals and apparatus but it is not much in practice.
- take observations carefully with some gestural/ verbal (lip reading) assistance.

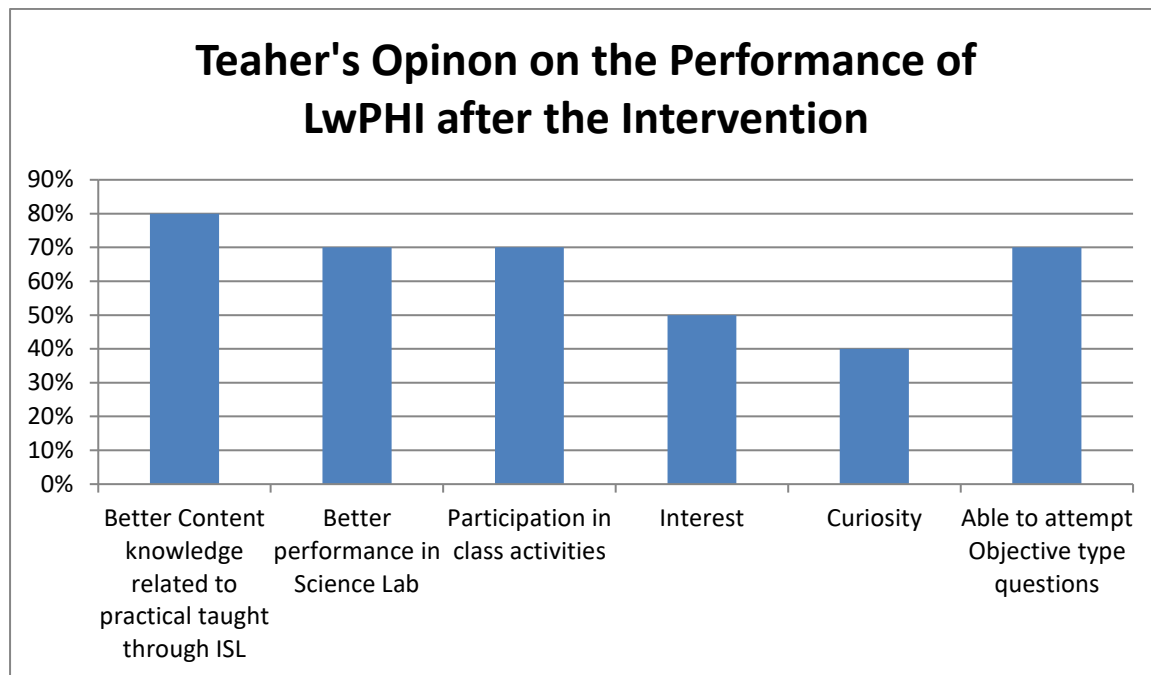
- track the pre and post changes in the experiment to some extent (color change, chemical reaction, the evolution of gases, formation of precipitates, etc.)

The results of the study indicated that the LwPHI who have received instructions in their first language i.e. ISL, performed better and acquired skills required for performing science practical.

Analysis of the Interview conducted with Science Teachers:-

The interview was conducted with the science teachers of the LwPHI to know the performance of the students in the science class after the completion of the research.

- 4/5th of the teachers (80%) of the teachers acknowledged that LwPHI showed improvement in a science subject.
- It was acknowledged by 7/10th (70%) of the teachers that the performance of LwPHI in science practical had improved. They try to complete the practical following the procedure and write down the observation accordingly.
- 1/5th (50%) of the teachers revealed that the students have developed a basic understanding of the science concepts which were related to practical performed during the intervention and had acknowledged the importance of interpretation of the instruction in Sign Language.
- 7/10th (70%) of the teachers opined that the LwPHI had started taking interest in the science class and also started raising questions in the classroom activities. The teacher observed a change in the behavior of the students. The teachers observed students with less anxiety, hesitation, and fear towards the subjects after the intervention.
- The curiosity to know more was observed by 2/5th of the teachers (40%), they stated that the students started asking questions in the classroom in the science period.
- 2/5th of the teachers (40%) revealed that the LwPHI participates in the practical classes and most of the time completes the experiment with confidence in the directed time.
- 7/10th of the teachers (70%) stated that there is a positive change in the approach of the LwPHI towards the subject but still the writing of answers (the expression on paper) was not up to the mark due to which they are not able to gain good marks in the assessments. Teachers also acknowledged that students performed better in objective-type questions and correctly attempted flow chart and diagram-based questions.

Figure 2: *Teacher's Opinion on the Performance of the LwPHI after the Intervention*

Interpretation: Figure 2 indicated that most of the teachers had observed a positive change in the learners after the intervention. 80% of the teachers acknowledged that the content understanding of those topics which were taught during the intervention had improved and 70% of the teachers said that the students were performing better in the laboratories and were showing interest in the subject. The plausible reason for such a positive response from the students could be that the students had started developing a liking towards the subjects as they started understanding it and relating it with their immediate environment. They found the science concepts very interesting and wanted to learn every topic of science through practical. Earlier, whatever was taught in the class, could not reach them due to a communication gap, but, when the topics were taught in sign language, the language which they knew, they started understanding it.

DISCUSSION

After the successful implementation of the Right to Education Act (2009) in Delhi, India, most of the students with different disabilities are being given admission in mainstream educational settings today. To achieve true inclusion, not only in words but in action, efforts are required from every corner. It is not less than an exploitation of the child with a disability if required and a sufficient amount of assistance is not provided in the schools. There has been ample research acknowledging the drop-out rate and poor academic performance of students with disabilities in inclusive schools. This study was conducted to know and assist the students with a high degree of hearing loss, in the best possible manner. The result revealed that there was an enhancement in learning and comprehension of science content by the LwPHI when taught through ISL. Not

only this, the LwPHI gained interest, the high internal motivation and confidence with respect to answering science questions and performing science practical. Before the intervention, it was found that the LwPHI viewed science subject in a negative light. It was also found that the LwPHI lack of early experience and prior knowledge, poor language base, the high disparity in cultural exposure, and also the need for kinaesthetic learning style must be addressed in the classrooms for inclusivity. The finding of this study was in coherence with the preceding researches and acknowledges that the curriculum objectives are better understood by the learners if they are delivered in the respective learner's first language (Mejia-Menendez, I., 2016, Toth, A. 2009 and Daniels, M., 2004). As professionals and parents, it is an obligation on us to provide opportunities from every corner and make education accessible to all.

CONCLUSION

There was an increase in the understanding of content knowledge and performance of the Laboratory experiment by the LwPHI, when the learners were exposed to instructions given in sign language, hence, it is concluded in the study that the communication gap in the classroom must be addressed by the teachers. The teachers must know the learning style and language needs of all the learners and arrange the learning experiences in the best possible manner.

EDUCATIONAL IMPLICATIONS

This study had indicated that the usage of sign language for content delivery is an effective instructional medium in classrooms. It not only supports the construction of knowledge but also makes the learners self-reliant. The educational implications of this study are as follows:

- At the formative stage, teaching and learning must take place in the child's mother tongue/ primary language/ natural language for children with benchmark disabilities, especially children with hearing and speech impairment. And, depending on the base of language acquisition, the second language shall be introduced.
- A strong language foundation and knowledge of the world must be provided to LwPHI through the usage of sign language in inclusive schools. The teacher must organize a successful educational experience for the learners.
- Teachers may use some technological tools like Indian Sign Language mobile applications or software or PowerPoint presentations with captioning or OLabs while delivering the content in the classroom so that the content can be made accessible to the learners as much as possible.

- The teachers may attempt to learn basic sign language skills mainly the fingerspelling signing, which can help the LwPHI and hearing students equally in the inclusive classroom (Mejia-Menendez, I., 2016, Toth, A. 2009 and Daniels, M., 2004).
- Teachers must use different defensible strategies in teaching-learning. The introduction of new techniques creates and maintains the interest of students towards learning. Teachers must believe in the students and their capabilities and their potential must not be underestimated on any ground.
- Indian Sign Language is a complete, natural language that has the same linguistic properties as spoken languages, with grammar that differs from English. So, it is suggested that it shall be adopted and offered as one of the language subjects in school education.
- Learning styles of all the students must be explored by the teachers so that the same can be catered well by the teachers for a healthy learning experience.
- Provision of placing a full-time sign language interpreter in schools must be taken seriously as per the norms quoted in UNCRPD, 2006 and RPwD Act, 2016.

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