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## TEACHING PHYSICAL SCIENCE THROUGH SUBJECT-SPECIFIC VOCABULARY FOR MEANING, TRANSFER, ACTIVE CLASSROOM ENGAGEMENT, AND DEVELOPING BIG IDEAS

1

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### PRESENT STATE OF TEACHING OF SCIENCE IN INDIA

Good science teaching requires student-involved activity. Gupta (2019) found that science learning is linked to various media such as photos, animated videos, maps, presentations, etc. that work as a bridge between the learner and the teacher for effective learning. The NCERT position paper emphasizes that higher secondary science should strongly emphasize problem-solving, awareness of conceptual pitfalls, and critical interrogation of different topics. In real science classrooms, the student-centered approaches are often led by lecture and note-taking methods that dissuade the curiosity of the learner and that is the main concern for students not inclined for science at the tertiary level. On the other hand, there exist many misconceptions in science by the learner. For example, as soon as the students enter secondary school they begin to think that science only happens in the science lab

and so, at 16+, they sometimes leave the science they've learned in school behind them– the science doesn't become part of their 'science capital' (Ross, 2019).

Therefore, in teaching science, we do not want students to simply parrot back the words we have said. We want them to be able to construct the essential meanings in their own words. Encourage them to relate the science we teach to the everyday happenings that are to be experienced by them. Similarly, Peter Borrows finds that 'Chemistry doesn't just happen in test tubes' but in the brick, walls and kitchen sinks of our daily lives. Hence the teaching of science should witness a paradigm shift in India to make science more lucrative to younger students right from primary to higher education.

### NEP 2020 EXPECTATION

- NEP-2020 envisages the development of Scientific Temper among students for which Subject teachers should

design learning/discussion of the more abstract concepts in each subject across the sciences, inculcate greater critical thinking, Promoting Critical and creative thinking aligned to the 21st century in classrooms.

- NEP- 2020 envisages augmenting student learning outcomes through Foundational Literacy and Numeracy. NIPUN Bharat is the flagship programme to promote FLN in which reading comprehension is one of the most important components. Accordingly Reading Comprehension means constructing meaning from a text and thinking critically about it. This will help learners in understanding texts and retrieving information from them, as well as interpreting texts.

## VOCABULARY INSTRUCTIONS

Language is a major barrier in learning science and language in science matters the most for understanding. Therefore, paying attention to the language of Science can help in improving the quality of learning in science (Osborne, 2001). Teaching students to use the specialized language of science in speaking, writing, and reasoning is essential to every goal of science education. Students should be required to be able to say anything in science in more than one way and be taught how to do so. Therefore, learning science involves learning a whole new language and it is important that you develop pupils' fluency in that language (Secondary Science Report, 2018). This method stresses the importance

of teaching science as a unified set of ideas and actions for creating a bigger understanding rather than a disconnected piece of information given for the test and then forgotten forever.

Research reveals that Print vocabulary comes to play an increasingly larger role in literacy than does oral vocabulary. The expansion and elaboration of vocabularies is something that extends across a lifetime. By keeping this in mind National Reading panel (2000) said that there is a need for direct instruction of vocabulary items required for a specific text. Repetition and multiple exposures to vocabulary items are important. In this context physics vocabularies need special attention owing to their complexity, abstractness, familiarity with daily life, and cognitive requirements.

## TEACHING PHYSICS AND BIG IDEAS

Big ideas are the central concepts of a lesson and it binds smaller concepts around them. These are the keys that unlock content areas for the broader acquisition of knowledge in Physics or any other subject area. Big ideas are the ideas that connect multiple concepts with a common binding plane. Also, Big ideas lead us to an enduring understanding of a concept deeply. For example studying the smallest (particles, atoms, and molecules) in the secondary classes will enable the student to connect with the origin of the Universe which is structured from its biggest scale such as galaxies, stars, planets, etc. Teaching



physics effectively is a complex task as it involves much understanding of concepts that are to be developed through a piece of Text, may it be a textbook or reference book. Therefore, content-laden physics should especially vocabularies be selected in such a way that it creates big ideas around the concepts with the help of proper pedagogy which should begin with effective vocabulary instruction.

### **RATIONALE**

- Effective vocabulary instruction is multifaceted, and it includes teaching individual words (i.e. giving students both definitional and contextual information means information about what a word means and about how it is used); extensive exposure to rich language, both oral and written; and building generative word knowledge. So that the child can connect the word deeply with the context and expand their understanding around it (Hiebert, et al, 2005).
- According to NRP (2000), Vocabulary learning is effective when it entails active engagement in learning tasks. When vocabulary items are derived from content learning materials, the learner will be better equipped to deal with the specific reading matter in content areas.
- Teaching science as a unified set of ideas and methods; and teachers are urged to teach science in an integrated way– exemplified by Twenty-First Century Science that

leads to creating Big Ideas in the subject (Ross, 2019).

### **ESSENTIAL QUESTIONS**

1. How can teachers deal with new scientific vocabulary teaching and facilitate vocabulary learning in the context of reading Science text?
2. How pupils should be taught with the help of effective strategies to read science with understanding, to locate and use the information, and to synthesize what they learned from their reading?

### **REVIEW OF RELATED LITERATURE**

*In Improving Secondary Science-The guidance report* (2018) Sir John Holman & Emily Yeomans stressed that 'There is a strong correlation between pupils' literacy skills and their success in learning science'. Students need to be explicitly taught new scientific vocabulary. It is familiar words used in unfamiliar contexts that cause most difficulty in learning Science. Therefore, teachers should judiciously select the vocabulary to teach and focus on the most tricky words, Show the links between words and their composite parts, Use activities to engage pupils with reading scientific text and help them to comprehend it, and Support pupils to develop their scientific writing skills.

### **METHODOLOGY**

In Physics, there are many abstract concepts and principles that students

find it many difficult to understand and retain for a longer period of time. Also in Physics, there are too many facts in the form of derivations, properties, formulae, equations, uses, hypotheses, etc. are presented which make it difficult for the student to grasp and assimilate the right perspective. The author suggests that some simple conceptual vocabulary in Physics can be used effectively to make students interact in class and retain their understanding of the subject longer. This method requires the teacher to identify

conceptual vocabulary from a given topic with the help of students and guide them to master those conceptual vocabularies with the help of vocabulary games in order to develop a 360° understanding of it. These conceptual vocabularies do not involve a quantitative problem but are simply a means for evoking the engaging discussion in the class, as opposed to presenting it as a lecture. Here are a few examples of Physics vocabularies and their pedagogical implications in table -1.

Vocabularies	Pedagogical Implications
General Academic Examples: analyze, cite, compare, determine, develop, recount, restate, summarize (e.g. laws of reflection of sound)	<ul style="list-style-type: none"> <li>• These words are aimed at cognitive action and are widely used, in the instructional process. Teachers need to explain those process-centric words to develop a wider understanding among students.</li> <li>• The words should be used in classroom activities, in-depth discussions, learning tasks, and tests to assist students to get a proper connection with the subject.</li> </ul>
Domain/Discipline Specific Science: formulate, hypothesis, observation	These words are associated with the 'How' part of Physics and should be used by the teachers to take students through Physics and arrive at independent understanding. These are critical for integrating Bloom's taxonomy in class to enable students to elicit their own thoughts on Physics.
Topic-Specific: (Sound): Vibrations, Frequency, Time Period, Amplitude, Wavelength, Crest, Trough	These words are critical to the comprehension and communication of information about Sound. So direct instruction and guided practice about how the words connect to the topic or concept would be necessary. Explaining these words with proper examples and making their connection with the topic helps the learner to develop a big picture around Sound.

In the present study, the researcher identified 25 Keywords from the chapter **Sound** from the class 8 and 9 Science Textbook by taking class 9 students to feedback on the difficulty in understanding during the academic year 2021-22. Students were asked to prepare 1) all about waves vocabulary table and 2) Acrostics, and 3) sorting of words into Naming, Process, and concept words, in groups. Peer teachers were invited

to observe the three performance tasks assigned by the researcher to students in their classes.

- 1) **All about Waves Vocabulary**-With the help of students the researcher compiled all 25 words with their *meaning and what it looks like*. It gave students a deeper peep at every word. The details of All about Waves Vocabulary are given in table-2.

**Table-2: All about Waves Vocabulary**

S. No.	Vocabulary Word	What it is?	What it is like?
1.	Vibrations	a) Mechanical property due to motion of any object/ substance. b) Rapid back and forth motion	1)Blowing air in two folds of paper 2) Plucking a rubber band
2.	Amplitude	Maximum displacement from the mean position	Beating of the drum and increasing its loudness
3.	Frequency	The number of oscillations per second	Playing the whistle
4.	Wavelength	Distance between corresponding crest or trough	Light has a visible wavelength that ranges from 380-750 nm.
5.	Time Period	Time taken to complete one oscillation is called the time period	Time is taken by Pendulum completing one oscillation
6.	Crest and Trough	The highest surface part of a wave is called the crest, and the lowest part is the trough.	The compressions and rarefactions are analogous to the crests and troughs of transverse wave
7.	Infrasonic & Ultrasonic	The sounds having a frequency range below 20 hertz are called infrasound and the sound waves having a frequency range above 20 kilohertz are called ultrasounds.	1) Waves occurring during earthquakes and sonography 2) The sounds which are inaudible

S. No.	Vocabulary Word	What it is?	What it is like?
8.	Medium	A path or material through which any wave can travel.	The conductor that helps in the propagation of sound
9.	Compression and Rarefaction	Compressions are regions in the medium where the particles are closer whereas rarefactions are regions in the medium where the particles are spread out.	The sound produced in the school bell
10.	Hertz	The SI unit of frequency is called hertz.	The unit that is multiples of 10 <sup>3</sup> i.e ( 10 <sup>3</sup> called kilohertz), Reciprocal of one second
11.	Communications	The imparting or exchanging of information by speaking, making special sounds	Roll number calling by a teacher in the class
12.	Satellite	A satellite is a machine that orbits around the planet	Satellite telephone
13.	Navigation	The activity of one's position and following a route.	GPS in car helps us in reaching the destination
14.	Longitudinal Wave	A wave which when travels through a medium, the particles of the medium vibrate in the same direction of wave motion	Sound waves
15.	Transverse Wave	A wave which when travels through a medium, the particles of the medium vibrate in the perpendicular direction of wave motion	Like lightwave
16.	Vacuum	Empty space in which there are no matter particles present	The insulating area between the glass walls of a thermos contains a vacuum.
17.	Oscillation	To and fro motion of an object repeated after regular intervals	Movement of pendulum
18.	Loudness	The relative amplitude of vibrations of a vibrating body.	Beating of drum

S. No.	Vocabulary Word	What it is?	What it is like?
19.	Shrillness or Pitch	The degree of highness or lowness of a tone depends on Frequency.	Sound of whistle and Sound of a whale
20.	Music	Music is a pleasant sound that has a clear pitch	Playing Harmonium
21.	Reverberation	The phenomenon of persistence of sound after it has been stopped because of multiple reflections from surfaces	Gong of church
22.	Voice Box	The sound is produced because of the vibration of the voice box called as larynx in humans	A piece of paper with a narrow slit and hold on between the fingers when blown through the slit produces a sound.
23.	Larynx	The hollow muscular organ forms an air passage to the lungs and holds the vocal cords in humans	Blowing air through stretched rubber bands.
24.	Wind Pipe	The tube that takes air from our throat to the lungs	Blowing wind through flute openings
25.	Eardrum	The membrane of the middle ear, which vibrates in response to sound waves	The vibration of cloth over a speaker during the playing of a song

2. **Acrostic Game:** Students in a group were assigned to prepare acrostics on all 25 words in groups which helped them to connect all words related to the topic to form a meaningful fun poem.

An acrostic is a form of a short poem in which the first letter of each line forms the word, which usually depicts the title of the poem. The acrostic techniques are an effective strategy to support the poetry writing skills of school-going students as they are learning science in the most abstract manner. *How to create acrostics?*

Following are the steps required to create Acrostics.

1. Decide what to write about (any topic/concept/sub-concept. (e.g. SOUND))
2. Write the word / Key concept down vertically
  - S- (any idea) (any connection to Sound)
  - O- (any word related to Sound)
  - U- (any clues)
  - N- (any word)

D-(any phrase related to sound)

3. Brainstorm words or phrases that describe your idea about the topic/ concept( SOUND)
4. Place your brainstormed words or phrases on the lines that begin with the same letters vertically (S-O-U-N-D).
5. Fill in the rest of the lines to create a poem. If possible give a picture for the line matching the theme/word/ phrase/concept under consideration.

Finally, it looks like-

S- Seemingly produced by vibrations made by

O- Objects mechanically,

U- Under the influence of any external force to produce

N- Noise and music that is due to

D- Displacement of a particle in the medium

3. **Sorting of Words:** Students were asked in the group to sort all 25 words into pre-identified four categories. Their sample sorted words are illustrated below.

**Naming words:** Denotes identifiable and observable entities, i.e. the child has seen those objects/entities like *Larynx, Voicebox, windpipe, eardrum, satellite, crest and trough,* etc. There are some words that the child has not seen earlier like: vibrations, infrasonic, ultrasonic,

medium, etc. which are not in the experience of the child.

**Process Words:** These are words that denote the process that happens in science like *Reverberation, Oscillation, compression, rarefaction, communication, navigation,* etc. which the child can verify and needs careful observations.

**Concept Words:** Denotes concepts in Science like- *Sound, Frequency, Intensity, Pitch, Amplitude, Time period, Loudness and pitch, Music,* etc. are not directly observable and hence it is difficult for students as they cannot be understood in isolation. Some of these words also form the foundation in theoretical constructs of concepts like *Vacuum* which is highly abstract in nature.

**Mathematical Words and symbols:** Highly abstract and it is not derived from the experience. For example Hz for Hertz, Kilo Hertz, MegaHertz, etc.

## DATA ANALYSIS AND INTERPRETATION

While students were performing three tasks on 25 words from the Sound chapter, they encountered the following issues.

- 1) In writing what it looks like and meaning it was observed that students with poor English language proficiency faced difficulty connecting the keywords with life situations and hence showed

withdrawal symptoms to learn the chapter 'Sound'.

- 2) **Acrostics:** Though making acrostic mostly happens in Languages (e.g English), the researcher asked the students to make fun poems on Sound and related words by following simple teacher-made acrostic rules. The most difficult part for students was Brainstorming words based on each alphabet selected for the acrostic with specific reference to Sound as they felt inadequacy of their vocabulary. However, they were allowed to use the dictionary and other reference books to gather some words and finally made them fit into the context. Another difficulty that was noted was to connect each line of the acrostic to make a meaningful poem though some students could make it.
- 3) **Sorting words into four groups:** They were asked in the group to sort all 25 words into pre-identified four categories such as naming words, Process words, Concept words, and Mathematical words/symbols. While doing this exercise few students find some difficulty in categorizing some words in two groups as they thought which was later on clarified by the teacher.
- 4) **Transfer:** While the chapter was under discussion and the teacher assigned the 'All about Waves Vocabulary' table, students started discussing among themselves 'what it is like' and started asking questions to themselves and friends to correlate vocabulary, its meaning, and daily life objects, incidents, and processes they undergo in various situations like in school assembly drum beating was one such point to connect for *amplitude, vibration, pitch, loudness, music, sound*, etc. which happened after series of discussions among themselves and finally teachers timely intervention. This shows the transfer of learning vocabulary, its meaning to a real-life context.
- 5) **Meaning:** All the students while writing vocabulary in terms of 'what it is' and 'What it is like, discussed among themselves for their meaning that is written in the table. The meaning of these 25 words is created by students with the help of their friends and teacher. It is to note that the meaning of what students wrote in the table is slightly different from the textbook. In some places, the teacher corrected them to arrive at the correct meaning of some conceptual and process vocabulary.
- 6) **Big Ideas:** By discussing and connecting through sorting of words in groups, students made 5 subthemes out of all 25 keywords. In each subthemes words were connected to create Big ideas like *Sound is a wave and it transfers energy through vibrations, Frequency is a measure of Pitch, Sound is responsible for vital communications and intensity makes loudness.*

## MAJOR FINDINGS

- It helped students connect to the concept “sound” and its sub-concepts and Big Ideas given in the content.
- It helped students in the amalgamation of multiple concepts through the content and inculcated sound comprehension skills in students.
- Conceptual words and Process words, their meaning helped learners to connect to Big ideas which helped in uncovering understandings of the topic.
- Students could be able to pronounce it properly, know the different meanings of vocabularies, and recognized it in the context in the textbook.
- Students could be able to assimilate the meaning of the word with the context it is used in the textbook.
- Students said ‘Everything comes together for us along with Physics. We don’t go to Chemistry and then Biology chapters separately and study something totally different. All the concepts’ come together”; “I’m learning more because there is a flow to what we are studying.
- It enabled them to use all 25 vocabularies correctly within a sentence in an appropriate grammatical form and generated several reports around it.

## PEER TEACHER OBSERVATION

- Acrostics is one of the effective ways to bring happiness and induce thinking in Science classrooms.
- It is a means to bend the thought process of learners and brought coherence within concepts of *Sound*.
- It is more of a self-expressive practice than traditional rote learning methods as many of the students took an active part during the ‘*Sound*’ acrostic session.
- It helped us nurture the thinking of learners and a feeling of ownership for their work through the topic *Sound*.
- It is an effective tool for deeper understanding and conceptual learning
- Students correlated these 25 conceptual keywords and generated word meanings by themselves and found interesting connections.
- Helped to understand the question better manner and responded effectively.
- Few students made subject-wise dictionaries by writing conceptual vocabularies and their meanings for their own reference.

## MOVING IDEAS FORWARD

- a) **Taxonomy of Words of Science:**  
Teachers should have the clarity



in Taxonomy of Words of Science i.e naming words, Process words, Concept words, and Mathematical words and symbols, then only they could guide students to understand scientific words properly. This has necessitated the inclusion of Taxonomy of Words of Science in the teacher training curricula in our country.

- b) **Research Practice:** There has always been a case for teachers to be aware of and use research to bring novelty in their Teaching learning practice. Hence, there is a strong need for teachers to work with researchers, professional developers, teacher educators, and the EEF Improving Secondary Science (Gittner, et al. 2019).
- c) **Professional Development at School Level:** The school academic leadership should show genuine interest to offer deep understanding to teachers about scientific vocabulary learning, instructional planning for science vocabulary teaching through professional development sessions.
- d) **Development of Big Ideas in Science (Physics):** Science especially Physics requires the cultivation of Big ideas by students. A big idea is built on the premise of the understanding, essential question, and transfer task which should be internalized by the teachers. Only when we help the

learner see firsthand that an idea is an inference, and it empowers the learner to provide meaning and transfer then only it become a “big idea.” Therefore, teachers should find the correlation between covering facts vs uncovering understandings and should think of avoiding the temptation to treat all scientific ideas as facts. Also, they mustn’t compare a *big idea* with a concept taught as a fact or definition.

### CLOSING REMARK

Many a time students write answers without actually knowing the meaning of the words. Many words related to the concept of *Sound* were found completely strange to students. Therefore, early scientific literacy, vocabulary learning matters the most for which teachers need to design teaching-learning practices accordingly. Through ‘*acrostics*’ and ‘*all About Waves Vocabulary Tables*’, students were deeply engaged with the topic. Therefore, by teaching words that matter the most in science, the teacher not only is able to give meaning, transfer the associated connections but also lead the learners for the big idea around the concept of *Sound*. By emphasizing the naming words, process words, concepts word the learning of Science was made more enjoyable and student-centric.

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## A STUDY ON ADJUSTMENT AND WELL-BEING AMONG TEACHER TRAINEES

2

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### INTRODUCTION

Education in changing scenario meets the requirements for development of a country. Education is the media for all round development of human personality. Education is not only limited to teaching of students according to the prescribed syllabus at a specific school level. It has broader objectives and involves much wider concept. Education is the process to train the students for adjustment in the life situations. Main concern of teachers is to develop the capacity among the students for adjusting in home, school, college, and in the society. The adjustment is a life long process and continues till the end of life (Aggarwal, 1990). The adjustment of an individual affects his well-being in every aspect of life. Well-being is an ongoing process not an intermittent prescription. It is based on individual's active interaction in a complex world. World Health Organization (1948) defined health as physical, mental and social well-

being not merely absence of any disease. Keys (2002) defined well-being as the quality of life of an individual or other social unit. According to Ryff (2005) well-being contributes to an individual's positive relationship with others. Sharma and Sarika (2011) viewed well-being as a feeling of having achieved something with one's life. An individual learns to adjust with the needs of himself and environment with the help of education. Adjustment is a state that is condition of harmony attained by a person whom we call well-adjusted.

### ADJUSTMENT

A balanced personality is the outcome of proper adjustment of an individual with his environment. It is a continuous process by which a person varies his behavior to produce a more harmonious relationship between himself and his environment. The direction of his effort may be toward modifying his own behavior and attitudes toward changing the environment. Adjustment

can be defined as a process of altering one behavior to reach a harmonious relationship with their environment. This is typically a response brought about by some type change that has taken place. The stress of this change causes one to try to reach a new type of balance or homeostasis between the individual and with their environment. Adjustment depends upon external and internal demands. These are social, psychological and physiological needs of an individual. Simon (1987) stated that a person is said to be adjusted when he is relatively happy, efficient and has some degree of social feeling. In simple words adjustment is all inclusive term meaning relationship between an individual and his environment through which his needs are satisfied in accordance with social demand. Generally there are three types of adjustment.

- Biological Adjustment
- Social Adjustment
- Adjustment to the Self

Each type has its own impact on the life of an individual. Lack of adjustment in any form of adjustment affects the balanced growth and development of personality.

## **WELL-BEING**

Well-being is multifaceted concept. Well-being is feeling of perception of life as functioning smoothly and joyfully. Well-being is related to life experience that they are beyond the ordinary day to day material and rational existence and derived from values of spiritual quality.

Well-being means different things to different people. For some people financial well-being is most important, for some physical well-being and still other desire well-being in relationship and family affairs. Freedom is important to well-being, i.e. freedom from fear, worry and anger and freedom to pursue one's dreams and mission of life. Pavis et al. (1996) stated that well-being emerged from mental health. Well-being is a very comprehensive concept which involves physical, psychological, social and economic betterment so that it enhances overall quality of life. We can also add environmental richness and equilibrium to be necessary to increase quality of any situation so that well-being of people can be ensured. Aggarwal (1990) defined that well-being is not only an absence of illness. Well-being and healthy living go hand in hand. Healthy living goes beyond eating a balanced diet taking regular exercise and avoiding illness. It also reflects the mental, emotional and social aspects of an individual's life. The key aspects of healthy living can be broken down in to the following elements our body, our diet, our daily routine and our environment.

## **REVIEW OF RELATED LITERATURE**

Mehta et al. (1996) explored the effect of achievement motivation, self-confidence and assertiveness upon adjustment of 400 higher secondary female students. They found that there was no significant difference between

girls having high and low achievement motivation, with regard to their level of adjustment in different areas. Secondly they found adjustment in all areas under study was positively affected by the self-confidence. Dutta et al. (1998) explored that there was not much difference in adjustment aspects between the girls and the boys. Razia (2016) studied adjustment of pupil teachers in relation to well-being. For the purpose of conducting the study, sample comprising 120 pupil teachers (B.Ed. students) was selected from the department of education, Aligarh Muslim University and two private colleges in Aligarh. Standardized tools were administered to draw information. Results showed that male and female pupil teachers were similar in their adjustment but difference existed in relation to well-being. The study further brought into light that emotional intelligence has positive and significant relationship with overall well-being of pupil teachers.

Bruke et al. (1995) studied work and career experiences, and emotional well-being of managerial and professional women. Four groups of predictor variables were considered, includes personal demographic variables organizational and situational characteristic, work experience associated with job, career satisfaction and work outcomes. Work experience and work outcomes were fairly, consistently and significantly related to self-reported emotional well-being.

Altermann et. al (2007) studied the well-being of teacher in Flanders by using

a reliable and validated questionnaire on a representative sample of 2000 teachers in Belgium and found that lower pressure of work was related to higher levels of well-being. They also found the elementary school level female teachers had higher well-being than men. The research also found years of experience was an important predictor of well-being: older teacher had a lower sense of well-being than younger teacher. Kaur (2007) found average level of happiness was a positive inductor of well-being among university students and it was also found that there is no significant mean difference in well-being among high and low stress group of university students. Rani (2018) studied wellbeing of 164 students of Punjabi University, Patiala. She found female students are significantly better in their wellbeing than male students belonging to arts faculty whereas male students are significantly better in their well-being than female students belonging to science faculty. She also found that no personal variable has any effect on well being of university students. Yadav et. al., (2012) found that yoga practices significantly decreased in both state and trait anxiety levels and positive change in the subjective well-being of students. Kalia et. al., (2010) studied general well-being in relation to gender, birth order and academic achievement. The result showed that gender had no effect of gender on the general well-being of student. Women with higher well-being were found to be significantly happier than women having low well-being. Perez (2012) studied gender difference in

psychological well-being among college students in Philippines and found that gender differences were found in term of daily spiritual experience, father relationship, peer relationship, autonomy, positive relations with other and purpose in life. No gender differences were found in the aspects of positive affect negative affect mother relationship, teacher relationship, environment mastery, personal growth and self-acceptance.

- There is no significant difference in adjustment of male and female teacher trainees.
- The level of well-being of teacher trainees is moderate.
- There is no significant difference in well-being of male and female teacher trainees.
- There is no significant relationship between adjustment and well-being of teacher trainees.

### OBJECTIVES

- To study the level of adjustment of teacher trainees.
- To study the difference in adjustment of teacher trainees in the relation to their gender.
- To study level of well-being of teacher trainees.
- To study the difference in well-being of teacher trainees in relation to their gender.
- To study relationship between adjustment and well-being of teacher trainees.

### HYPOTHESES

- The level of adjustment of teacher trainees is moderate.

### METHODOLOGY

The study is carried out by survey method. The variables of the study included adjustment and well-being. The population of the study included all teacher trainees and the sample included 200 teacher trainees selected from Sangrur and Barnala disthas been choose randomly. The researched has adapted research tools namely Revised Adjustment Inventory (RAI) by Lalita Sharma in the year 1988 and Well-being Scale (WBS) by Singh and Gupta in the year 2001. The tools were administered among the sample and data were collected. For the analysis of data Descriptive and Differential analyses were applied.

### ANALYSIS AND INTERPRETATION OF DATA

**Table 1: Mean Score Difference in Adjustment between Male and Female Teacher Trainees**

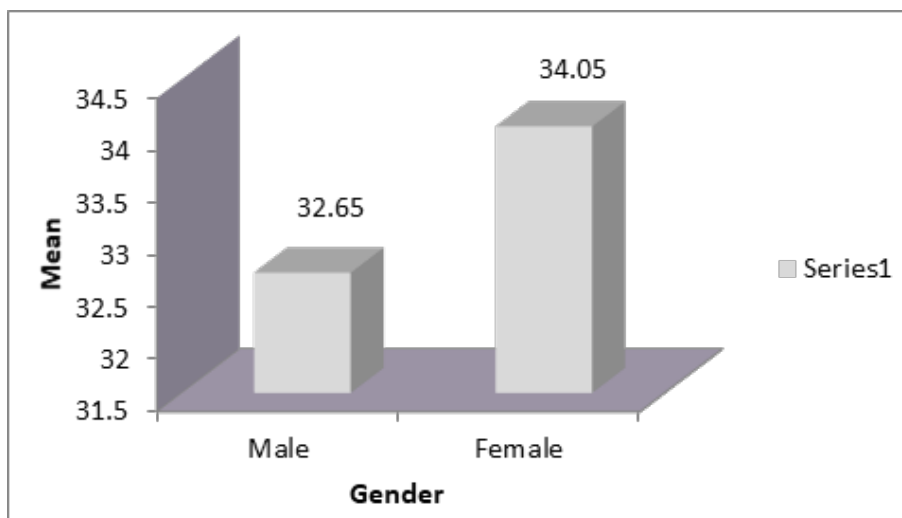
Gender	N	Mean Max = 60	SD	t-ratio
Male	100	32.65	8.16	1.01 NS
Female	100	34.05	8.52	

Gender	N	Mean Max = 60	SD	t-ratio
Overall	200	33.35	8.36	

NS = Not significant

Table 1 showed the mean score difference in the level of adjustment among the teacher trainees. The overall mean value (33.35) showed that the teacher trainees had moderate level of adjustment. The mean score of adjustment of male teacher trainees is 32.65 whereas the mean score of adjustment of female teacher trainees is 34.05. The calculated t-value 1.01 is lesser than the table value at 0.05 level of significance. Hence it is stated that there is no significant difference between male and female teacher trainees in their adjustment.

**Figure 1 : Mean Score Difference in Adjustment between Male and Female Teacher Trainees**



**Table 2: Mean Score Difference in well-being between Male and Female Teacher Trainees**

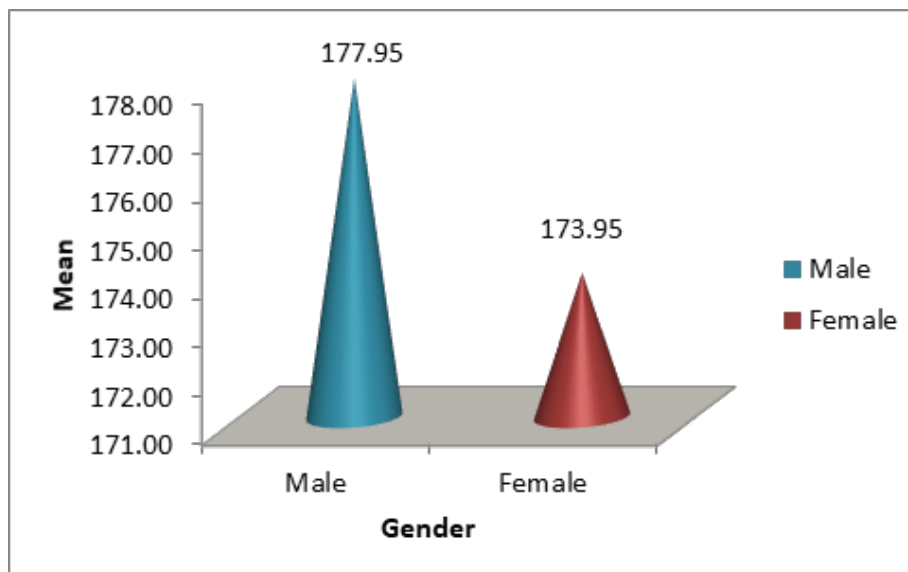
Gender	N	Mean Max= 250	SD	t-ratio
Male	100	177.95	15.80	1.86 NS
Female	100	173.95	14.50	
Overall	200	175.95	15.16	

NS = Not significant

Table 2 showed the mean score difference in the level of well-being among the teacher trainees. The overall mean value (175.95) showed that the level of well-being among teacher trainees is above average. The mean score of well-being among male teacher trainees is 177.95 whereas the mean score of well-

being among female teacher trainees is 173.95. The calculated t-value 1.86 is lesser than the table value at 0.05 level of significance. Hence it is stated that there is no significant difference between male and female teacher trainees in their well-being.

**Figure 2 : Mean Score Difference in Well-being between Male and Female Teacher Trainees**



**Table 3: Relationship between Adjustment and Well-being of Teacher Trainees**

Variables	N	Coefficient of Correlation (r)
Adjustment and Well-being	200	-0.2829 <sub>NS</sub>

NS = Not significant

Table 3 showed the relationship between Adjustment and Well-being among the teacher trainees. The correlation value ( $r = -0.2829$ ) disclosed that there is a negative correlation existed between the variables.

## FINDINGS AND CONCLUSION

- Analysis based on adjustment of teacher trainees disclosed that they had moderate level of adjustment and there is no significant difference



between male and female teacher trainees in their adjustment.

- Analysis based on well-being of teacher trainees revealed that had above average level of well-being and there is no significant difference between male and female teacher trainees in their level of well-being.
- The correlation analysis revealed that there is a negative correlation existed between the variables adjustment and well-being among the teacher trainees.

Based on the results it is concluded that though the level of adjustment and well-being are moderate and above average, the variable adjustment had negative impact on well-being of the teacher trainees in this study. Also gender had not influence the variables adjustment and well-being. Based on the results it is suggested that teacher trainees should be provided counseling sessions in order to maintain a high level of well-being and adjustment.

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## SURFACING THREATS IN E-WASTE MANAGEMENT IN INDIA AND SIGNPOSTS IN CURBING THE MENACE

**3**

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### INTRODUCTION

Man and environment are considered inter related entities and their interdependence is everlasting. The awareness of resource depletion, the degradation of natural system and the danger of pollute substance have increased markedly in the recent decades. These worsening conditions are started destroying the eco systems, displacing living beings, and increasing threat to the safe and healthy environment. In every effort of saving the Globe, the surfacing threats with e-waste makes us worrying as those of other environmental pollutions. E-waste is generated when electronic and electrical equipment become useless for their originally intended use or surpassed the expiry date. Growth in the IT and telecommunication sectors has enhanced use of electronic equipment exponentially. Faster up-gradation of electronic product forces consumers to discard old electronic products quickly, leading to e-waste accumulation. The

growing problem of e-waste calls for greater emphasis on recycling and managing e-waste. This paper focuses on the issues related to e-waste management and disposal, and possibly suggests few observations to overcome the same.

### E-WASTE – MEANING AND NATURE

E-waste is a popular, informal name for electronic products nearing the end of their “useful life.” In other words, E-wastes or Waste Electrical and Electronic Equipment (WEEE) are loosely discarded, surplus, obsolete, broken, electrical or electronic devices. The European Directive 2002/96/EC Article I (a), defines “waste” as “any substance or object which the holder discards or is required to discard in compliance with the national legislative provisions”. The Organization for Economic Co-operation and Development (OECD) (2006) defines e-waste as, “Any household appliance consuming electricity and

reaching its life cycle end". Some of the e-waste consists of valuable covering or materials inside which can be reused or recycled. Whereas some of the e-waste may contain hazardous chemical materials which should be disposed of carefully without causing harm to nature.

### **CAUSES FOR E-WASTE IN INDIA**

India generates about 3 million tonnes of e-waste annually and ranks third among e-waste producing countries next to China and the United States. In India most of the waste electronic items are kept without any use at households as people do not know the way of discarding them. One more reason for this growing menace is that India has become a dumping yard to import e-wastes from many developed countries. This has led to an exponential increase in e-waste generation.

India is one of the fastest growing economies of the world and the domestic demand for consumer durables has been skyrocketing. Data suggests that two out of five Indians replace their smart phones every year. These electronic gadgets get fast replaced with newer models due to rapid technological up-gradation and production of newer equipment. People tend to switch over to the newer models and the life of products has also been decreased. Rapid technology change, planned obsolescence and attracting low initial cost have resulted in enhancing the production of e-waste all over the world. Another report estimated that in India, business and individual

households make approximately 1.38 million personal computers obsolete every year, accelerating the rate of e-waste generation, which is around 10%, annually going to affect environmental health indicators. The global e-waste production is estimated to increase due to the economic growth and the available technologies since increased purchasing of electronic goods and eventually to increased e-waste production.

According to a survey, 78 per cent respondents agreed with the statement that COVID-19 caused unnecessary short-term investment in technological equipments, leaving them at the risk of data being stored on a wide range of devices. As many as 92 per cent of enterprises agreed with the statement that the manufacturers had to take a serious view on ensuring all devices used to equip the workforce throughout the COVID-19 pandemic were appropriately stored and disposed of. With rapid urbanization, this problem of managing e-waste will multiply considerably alarming the contemporary society reasonably. The ever-increasing amount of e-waste and the lack of awareness in managing the e-waste are worsening the problem.

### **THREATS IN MANAGING E-WASTE**

The presence of toxic substances and heavy metals even in minute quantities pose a significant threat to the environment and living beings as well. E-waste releases harmful chemicals, such as lead, on burning, which adversely impacts human blood, kidney and the

peripheral nervous system. When it is thrown in landfills, the chemicals seep into the ground water affecting both land and sea animals. Decomposing of e-waste is an expensive process and not practical to developing countries like India. Nevertheless, the unscientific practices in the process of recycling e-waste also lead to several environmental and health hazards. Thus the disposal of e-waste is an emerging global environmental and public health issue.

E-waste is both valuable as source for secondary raw materials, and toxic if treated and discarded improperly. Improper dismantling and processing of e-waste materials result in perilous problems to human health and our environment in general. It is necessary to review the need of proper e-waste management lessening public health risks and appropriate strategies must be thought of to combat this growing menace. Also a large number of unskilled workers are involved in crude dismantling of these electronic waste items for their livelihood and their health is at risk. Hence there is an urgent need to implement a preventive strategy with regard to health hazards of these workers in India.

### **RECENT TRENDS TO CURB E-WASTE IN INDIA**

India's e-waste regulations, employing the EPR approach, came into effect in May 2012, with further amendments in 2016. EPR, one of the more widely used approaches for regulating e-waste

globally, places the responsibility of the end-of-life management of products on the manufacturers or the producers. Early evaluation of these rules showed that while they may have created demand for new formal dismantling and recycling centres, the rules have largely been ineffective in improving the existing practices.

Initiatives such as Extended Producer Responsibility (EPR); Design for Environment (DfE); Reduce, Reuse, Recycle (3Rs), technology platform for linking the market facilitating a circular economy aim to encourage consumers to correctly dispose their e-waste, with increased reuse and recycling rates, and adopt sustainable consumer habits are the need of the hour not only to developing countries but also to developed countries.

### **PUBLIC VIEW TO CURB THE MENACE**

It is a compulsion that every individual must initiate the goodwill to protect the environment from all the hazards from every possible angle. The people of India should never look for someone to begin such reforms from the efforts of government or private organizations. The public, the manufacturers, the traders and the centres involved in the e-waste collection and recycling must also put forth their efforts in minimizing the present menace of e-waste.

- People should be made aware of efficient use of electronic devices by regularly maintaining them. By getting devices serviced timely,

- they can prolong the life of these electronic devices.
- It is better to reevaluate our choices and use one multi-purpose device. One can also extend the life of electronics by keeping the device clean and avoiding overcharging.
  - Yet another unique solution to the problem can be offered that the tech giants, through conditional selling, mandate their customers to buy new technological devices only after exchanging old electronic products.
  - Hardware stores and companies should offer incentives to customers who are ready to exchange their old electronic devices. Tech companies and sellers should collaborate with e-waste disposal companies for their proper disposal.
  - They should also adopt smart ways to refurbish their old products into new ones by outsourcing contracts with e-waste disposal companies.
  - These activities can be approved of by enactment of laws wherein they can provide companies tax benefits for recycling of e-waste.
  - The Government of India, in addition to the efforts taken, should have an Apex body at National level and Implementation Committees at State level for controlling unauthorized disposal of e-waste from foreign countries, and the collection, recycling and disposal of e-waste from different parts of our Nation by strictly enumerating the data on segregated waste materials.
  - The State Governments, in turn, organize the collection centres and recycle units calculating the source of e-waste, reusability and safe disposal with zero problems to living organisms and Nature.
  - For e-waste management many technical solutions are available, but to be adopted in the management system, prerequisite conditions such as legislation, collection system, logistics, and manpower should be prepared. This may require operational research and evaluation studies.
  - The State Governments may form a separate Welfare Board to protect the welfare and the health issues of the workers involved in the e-waste management in general.
  - The UGC may involve all the Higher Education Councils namely AICTE, ICMR, ICAR, NCTE, NCVT, etc., to take part in studying the impact of e-waste and the benefit of reusing them considerably by setting up a new National School of Inter-disciplinary nature.

## **SUGGESTIONS FOR OVERCOMING THE PROBLEMS**

E-waste recycling in the non- formal sector by primitive methods can damage the environment. Following are some of the recommendations to be followed to manage the threats of e-waste in our country:

- The Department of Science and Technology may fund more research grants and sensitization programmes throughout the year considering the volume and intensity of e-waste from every region.
- The Universities besides introducing greater awareness programmes should have separate centre for the e-waste from educational Institutions with eye on reducing waste and channelizing the disposal by statutory implementations and voluntary efforts as well.
- Similar ideas may be adopted exclusively for every government departments and Industrial sectors in association with State government e-waste centres.
- Existing businessmen in the arena may be regulated by formal registration and tie-up with local authorities for easy logistics and early disposal. Required information should be provided to the workers regarding safe handling of e-waste and personal protection.
- An exclusive Laboratory at an International Standard may be set up to study the components of e-waste collection and the possible impact on health hazard of man, animal, cultivable lands and water resources.
- Every student in degree/diploma is awarded with grade/marks based on the compulsory component

of contribution to the e-waste management by involving them in different activities. In addition to the regular activities of NCC, NSS, and other student wings, every student enrolled in a school or college must contribute for the e-waste reduction or e-waste recycling from home and neighbourhoods.

## CONCLUSION

Williams (2005) observed that despite significant attention from the media and enactment of some national level trade bans, the problem is apparently worsening. Therefore, the health risk assessments are also required for the analysis of the consequences and the effective management of end-of-life electronic wastes is to be attended with utmost care in developing countries.

In most parts of hill stations and other places, the ban on plastics is imposed, and the use of plastics has been reduced drastically because of the efforts of the Government of Tamil Nadu. It is also possible to succeed in the attempt of managing e-waste by promoting aforesaid activities. Similarly, the workers involved in the field of segregating the e-waste may be periodically involved in medical check-up after identifying and enumerating them under the category of unorganised sector of notable workers. If the government, NGOs and the media join together, we may positively win over the war of fighting the menace of e-waste to a considerable extent.

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## A STUDY ON FACEBOOK ADDICTION AMONG PROSPECTIVE TEACHERS

4

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### INTRODUCTION

Facebook is one of the most popular social networks in the world. It has an impact on every day routine of people particularly youthful adults. Facebook make the world more entertainment and spending time. In education, facebook take its vital role to share the materials and so on. It helps to search peoples and transmit information from one person to another through e-devices. It creates the pupil to remain in touch with the teachers. Everyone in world can create his or her facebook account without a website or blog. The aim of the present study is to explore the facebook addiction among Prospective Teachers.

### SIGNIFICANCE OF THE STUDY

Facebook directly come into the life of the people and it has befallen one of the most important day-to-day practices of the people, particularly adolescent. It fulfils many sociological and psychological desires of learners. This causes serious use of the Facebook

and creates some challenging issues like addiction to it. Consequently, there is an escalating curiosity among the learner to know their friends' activities. In this research the researcher, identify the facebook addiction among Prospective Teachers in Kanyakumari district.

### FACEBOOK OVERVIEW

Facebook is an online social networking service. Mark Zuckerberg and his fellow teammates have founded Facebook in 2004 and they had initially limited the website's membership to Harvard students, but later expanded it to colleges in the Boston area, the Ivy League, and Stanford University. It became famous and come into regular usage. Using the friend searching option one can search his/her friends through the social network Facebook.

### ADDICTION

Addiction is a neuropsychological disorder distinguished by importunate use of a drug, despite extensive harm and

other negative consequences. Repetitive drug use often alters brain function in ways that perpetuate craving, and self-control. As *addicere* and *addictus* evolved in the Middle and Late Roman Republic, the notion of enslavement, a secondary derivation from its legal usage, persisted as descriptive and no longer literal. In the Early Modern period, the verb *addict* meant simply 'to attach (Rosenthal & Faris, 2019). In this study, the researcher deal with the Facebook addiction among the prospective teachers. Thus, the study makes conscious with the prospective teachers.

### **FACEBOOK ADDICTION**

“Facebook addiction” is a term coined by researchers that is applied to individuals who engage in excessive, compulsive Facebook use for the purposes of mood alteration, with negative personal outcomes (Chakraborty, 2017). Speedy augment extensive of the World Wide Web, (www) around the world, leads to the manifestation of the word Internet Addiction. Addiction separates the Substance Related Addiction and Non-Substance Related Addiction. The Internet related addiction considered as non-substance related addiction. An individual is spending their most of their time in facebook is known as Facebook Addiction.

### **PROSPECTIVE TEACHERS**

The Prospective Teachers are the graduates who are studying Bachelor of Education in College of Education.

### **SOCIAL MEDIA**

Social Media is the application in the electronic devices like Mobile Phone, Laptop, Computer, Tablet and so on. Some of the Social Media applications are skype, facebook, team Viewer, Google Hangouts, GoToMeeting, Webex, Tango, Intercall, Twitter and Whatsapp (Olson, 2013). The social media have overriding in all the human beings particularly among learners. Majority of the learners are making use of facebook in their education by sending materials. Reluctantly they follow their friends and become addict in the facebook. Therefore, the present study is very necessary in this scenario.

### **REVIEW OF RELATED LITERATURE**

Moreno (2020) examined the influence of facebook addiction on study habits of the second year Bachelor of Science in Office Administration students of North Luzon Philippines State College, Candon City. Results showed that the respondents have a moderate degree of facebook addiction that had significant effect on study habits. Correlation analysis showed that the dimensions of facebook addiction, namely: salience, tolerance, mood modification, relapse, withdrawal, and conflict are significantly correlated with overall study habits. Khan (2018) conducted a study on facebook addiction and its association with academic performance among undergraduates. It was found that high (51%) prevalence of face book addiction

among undergraduate students and also facebook addiction had adverse effect on academic performance and their social lives.

Nizami, Naeem, Arzoo and Ismail (2017) studied the impact of facebook addiction on academic performance among 150 undergraduate students. It was found that 55.33% participants were facebook addicted, whereas 44.67% participants were not addicted to facebook. There was a significant association between facebook addiction with academic performance of students according to their GPA ( $p = 0.00$ ), with IQ level ( $p = 0.00$ ), and with self-esteem level ( $p = 0.00$ ) of students. Frequent use of facebook makes them addicted, that affects their academic performance and self-esteem as well. Vashishtha, Ahuja and Sharma (2017) studied the impact of facebook addiction disorder on study habits and academic achievement of adolescents. It was found that there is a significant negative impact of Facebook Addiction Disorder (FAD) on study habits and academic achievement of adolescents. The major implication derived is that the higher the addiction to Facebook the study habit becomes poor and academic achievement decreases resulting in lower grades.

## OBJECTIVES

- To study the difference between Hindu and Christian Prospective Teachers in their facebook addiction.

- To study the difference between Prospective Teachers in Nuclear and Joint family in their facebook addiction.
- To study the difference in the facebook addiction among Prospective Teachers based on their fathers' education.
- To study the difference in the facebook addiction among Prospective Teachers based on their mothers' education.
- To study the difference in the facebook addiction among Prospective Teachers based on their family income.

## HYPOTHESES

- There is no significant difference between Hindu and Christian prospective teachers in their facebook addiction.
- There is no significant difference between prospective teachers in nuclear and joint family in their facebook addiction.
- There is no significant difference in the facebook addiction among prospective teachers based on their fathers' education.
- There is no significant difference in the facebook addiction among prospective teachers based on their mothers' education.
- There is no significant difference in the facebook addiction among prospective teachers based on their family income.

## METHODOLOGY

The investigator used the survey method to conduct this study and to find out the facebook addiction among the Prospective Teachers. The population of the present study include all the prospective teachers who are studying Bachelor of Education Course in College of Education in Kanniyakumari District. The investigator selected a sample of 60 Prospective Teachers from Christian College of Education, Marthandam in Kanniyakumari District. Stratified sampling technique was used to select the sample for this study. In order to collect the data the researcher has constructed a Facebook Addiction Scale and administered among the sample. Validity of a tool was established by using content validity procedure. It used to determine whether the inferences about test scores

are accurate (Santrock, 2006., & Garrett, 2005). For establishing the content validity, the tool was given to English graduate to check the content. Thus, the content validity was established. In order to establish the reliability of the tool test retest method was applied. The reliability of the tool was found to be 0.71. The final tool of facebook addiction scale consisted of 33 statements. The tool was administered to the Prospective Teachers to record their opinion. The statistical techniques applied included descriptive and differential analyses.

## ANALYSIS AND INTERPRETATION

### Hypothesis 1:

There is no significant difference between Hindu and Christian Prospective Teachers in their facebook addiction.

**Table 1: Facebook Addiction - Comparison of Hindu and Christian Prospective Teachers**

Groups	Sample	Mean	SD	t-value	Level of Significance
Hindu	10	105.1	51.17	2.172	0.05
Christian	50	130.18	28.89		

Table 1 indicated that 10 Hindu and 50 Christian Prospective Teachers were compared to identify the level of facebook addiction using t-test. The mean and standard deviation obtained by Prospective Teachers belonging Hindu were 105.1 and 51.17 and the corresponding values obtained

for Christian were 130.18 and 28.89 respectively. The obtained t-value 2.172 is greater that the table value 2.00 at 0.05 level. Hence it is stated that there is a significant difference existed between Hindu and Christian Prospective Teachers in their facebook addiction and null hypothesis was rejected.

### Hypothesis 2:

There is no significant difference between prospective teachers in nuclear and joint family in their facebook addiction.

**Table 2: Facebook Addiction - Comparison between Prospective Teachers from Nuclear and Joint family**

Groups	Sample	Mean	SD	t-value	Level of Significance
Nuclear Family	52	126.69	32.41	0.395	0.05
Joint Family	8	121.5	47.72		

Table 2 indicated that 52 Nuclear family Prospective Teachers and 08 Joint family Prospective Teachers were compared to identify the level of facebook addiction using t-test. The mean and standard deviation obtained by prospective teachers from nuclear family was 126.692 and 32.41 and the corresponding values obtained for Joint family Prospective Teachers were 121.5 and 47.72 respectively. The obtained t-value 0.395 is lower than the table

value at 0.05 level. Hence it is state that, there is no significant difference between Prospective Teachers from Nuclear and Joint family in their facebook addiction, and the null hypothesis is accepted.

### Hypothesis 3:

There is no significant difference in the facebook addiction among prospective teachers based on their fathers' education.

**Table 3: Facebook Addiction – Comparison among Prospective Teachers based on Fathers' Education**

Source	SS	DF	MS	F	Level of Significance
Between groups	3343.080	4	835.770	0.693	0.05
Within groups	66368.920	55	1206.708		

The above Table 3 revealed that the obtained F-value 0.693 is lesser than the table value (2.50) at 0.05 level of significance. Hence it is stated that there is no significant difference existed among prospective teachers based on their fathers' Education. Hence the null hypothesis is accepted.

### Hypothesis 4:

There is no significant difference in the facebook addiction among prospective teachers based on their mothers' education.

**Table 4: Facebook Addiction - Comparison among Prospective Teachers based on Mothers' Education**

Source	SS	DF	MS	F	Level of significance
Between groups	9927.389	4	2481.847	2.283	0.05
Within groups	59784.611	55	1086.993		

The above Table 4 revealed that the obtained F-value 2.283 is lesser than the table value (2.50) at 0.05 level of significance. Hence it is stated that there is no significant difference existed among prospective teachers based on their mothers' Education. Hence the null hypothesis is accepted.

#### **Hypothesis: 5**

There is no significant difference in the facebook addiction among prospective teachers based on their family income.

**Table 5: Facebook Addiction - Comparison among Prospective Teachers based on Monthly Income of the Family**

Source	SS	DF	MS	F	Level of significance
Between groups	3074.674	2	1537.337	1.315	0.05
Within groups	66637.326	57	1169.076		

The above Table 5 revealed that the obtained F-value 1.315 is lesser than the table value (2.50) at 0.05 level of significance. Hence it is stated that there is no significant difference existed among prospective teachers based on the monthly income of the family. Hence the null hypothesis is accepted.

facebook addiction, and the null hypothesis is accepted.

- There is no significant difference existed among prospective teachers based on their fathers' Education.
- there is no significant difference existed among prospective teachers based on their mothers' Education.
- There is no significant difference existed among prospective teachers based on the monthly income of the family

#### **FINDINGS OF THE STUDY**

- There is significant difference between Hindu and Christian prospective teachers in their facebook addiction.
- There is no significant difference between prospective teachers from nuclear and joint family in their

#### **CONCLUSION**

The study revealed that there is a significant difference existed between Hindu and Christian prospective

teachers in their facebook addiction. It may be due to the culture, tradition and other practices of the prospective teachers. Whereas significant difference not existed among the prospective teachers based on their family, parents' education and monthly income. Hence it is concluded that parents' education, monthly income and family type had no influence on facebook addiction whereas religion may influence on the internet usage and addiction among the prospective teachers.

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## ANALYTICAL THINKING SKILLS OF HIGHER SECONDARY SCHOOL STUDENTS WITH REFERENCE TO GENDER AND SUBJECT OF SEPCIALISATION

**5**

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### INTRODUCTION

The Greeks are generally regarded as the earliest teachers of thinking (Mc Gregor, 2010). From an educational perspective, there are many diverse views about what constitutes thinking. Thinking is defined in many ways by various educators. Dewey (1933) defines it as a sense of thoughts that originates from some perplexity, confusion or doubt. With regard to the role of schools in thinking, Dewey says that all which the schools can or need do for pupils is to develop their ability to think. Bloom (1956) have extensively categorized cognitive abilities.

Analytical thinking skill is higher-order thinking skill (Permana et al., 2019), and become high demands of human resources in the 21st century. Analytical thinking skill triggers student ability to solve the problems of their daily lives (Schumacher & Ifenthaler, 2018). Furthermore, it is crucial to improve the students' analytical thinking

skills; to understand information comprehensively and be able to associate between components (Brookhart, 2010; Yilmaz & Saribay, 2017), and to explain problems into smaller pieces and understand the interrelationships between these components (Yulina et al., 2019). It is a part of the problem-solving process which is considered essential for providing the skills required to prepare children for a more complex life and work environment in 21st century (Thaneerananon, Triampo, & Nokkaew, 2016). As economic and technological changes shape the occupational outlook of today's students, schools and colleges have begun to embrace the need of higher order thinking (Mainali, 2012) in the pedagogical process. Analytical thinking involves a further element of inquiry and situations with less well-defined parameters and outcomes and its necessary when an ambiguous situation requires the learner to identify or create a problem to solve (Robbins, 2011). Analytical thinking skill was very

necessary to be used in working as well as daily life in the 21st century by students (Paziotopoulos & Kroll, 2004).

## **THEORETICAL OVERVIEW**

Analysis is the process of breaking down of any material into its constituent parts and detection of the relationship between the parts, and of the way they are organised and connected (Bloom, 1956). According to Bloom (1969) analysis comprise of Analysis of elements, Analysis of relationships and Analysis of organizational principles. (1) Analysis of elements is the ability to classify and analyze significant elements, i.e. to find a summary of content and to differentiate facts and opinions, similarities and differences and causes and effects; (2) Analysis of relationships is the ability to relate concepts and reasons, i.e. to compare and analyze consistent and/or contrary or irrational information, and; (3) Analysis of organizational principles is the ability to search for principles of relationships between elements of information, i.e. to identify key matters by taking into account relevant stories and being able to summarize the relevant information into one concept.

Analytical thinking involves abilities to (1) take apart a problem and understand its parts, (2) explain the functioning of a system, the reasons why something happens, or the procedures of solving a problem, (3) compare and contrast two or more things, or (4) evaluate and critique the characteristics of something (Sternberg, 2006).

Analytical thinking provides ability to determine, organize, and the purpose behind relevant information. Components of analytical thinking skills are differentiating, attributing, and organizing (Anderson, 2001). According to Marzano and Kendall (2008), there are five components of analytical thinking, namely matching, classifying, analysing error, generalizing, and detailing. In the present study the components of analytical thinking skill as proposed by Anderson, and Marzano and Kendall are considered for developing the tool for measuring analytical thinking skills of school students. Components of Analytical thinking skill as derived by the investigators for the present study consists of five components: matching, differentiating, attributing, categorising and organizing. These components were used by investigators for developing the research tool ie, the Analytical Thinking Skill Test.

## **REVIEW OF RELATED STUDIES**

A study conducted in Indonesia among grade XI students (Irwanto, Eli Rohaeti, Endang Widjajanti, *et al*, 2017) reveals that the measurement of all aspects in analytical thinking ability is low with the percentage of 30.67%. This result indicates that the teacher has not fully optimized the students' analytical thinking ability in the learning process.

Researchers recommend that lecturers should be promote the importance of student's analytical thinking skills in facing the challenges

of the 21st century (Suyatman, Saputro, S., Sunarno, W., & Sukarmin, 2021). The results of comparison of the pre-test and post-test scores between the experimental class and the control class showed a significant difference in the matching indicator, classifying indicator, organizing indicator, and attributing indicator as indicators of analytical thinking skills.

Perdana, Jumadi & Rosana (2019) asserted that the scientific argumentation levels and analytical thinking skill of the university students in Indonesia are rather low. To enhance these skills, teachers can use alternative teaching strategies in the classroom. The results of research conducted among 111 students in Indonesia (Prawita, Prayitno and Sugiyarto (2019) showed that percentages of students belonging to various category of analytical thinking skills were: very poor 49%, poor 42%, fair 9%, and no student obtained a good or excellent score of analytical thinking skills. Achievement of students' analytical thinking skills indicators: Interpretation 34.97%, Identifying 41.89%, Generating Hypothesis 11.15%, and Inference 18.24%. In conclusion the analytical thinking skills of students are relatively low. Based on this research, it is suggested that the students need practice to answer analytical questions or teacher efforts are needed for using the right strategies that can foster students' analytical thinking skills.

The above research studies revealed that the analytical thinking skills of

the students at secondary and higher secondary level varies and the teachers have to use appropriate teaching strategies in classroom to enhance these skills in the learners. The higher secondary school students choose different subjects of study like science, commerce and humanities. For the present study the sample selection is delimited to science and commerce students. The analytical thinking skills of each of this group should be measured through appropriate research instruments. To incorporate various teaching strategies, it is important to diagnose the analytical thinking skill of students studying at higher secondary level based on gender, locale, subject of specialisation etc and hence the present research is relevant. This is an important step to improve and equip students with various skills and abilities needed in the 21st century.

## OBJECTIVES

- To find out the level of analytical thinking skills and its components of higher secondary school students for the total sample and relevant subsamples.
- To find out whether there is any significant difference in the analytical thinking skill and its components of higher secondary school students classified on the basis of gender.
- To find out whether there is any significant difference in the analytical thinking skills and its components of higher secondary school students classified on the basis of subject of specialisation.

## **HYPOTHESES**

- There is significant difference in the analytical thinking skill and its components of higher secondary school students classified on the basis of gender.
- There is significant difference in the analytical thinking skill and its components of higher secondary school students classified on the basis of subject of specialisation.

## **METHODOLOGY**

### **Sample of Research**

The study was conducted in a sample of 72 higher secondary school students of Kerala, India, at the end of the of academic year 2021-2022 using the survey method. The survey involved two classes which consists of 72 XI standard students with commerce and science as their optional subject of study as the participants. Of the total sample, 31 students were from science optional subject and 41 students were from commerce optional subject. Of the total sample 40 students were male and 30 students were female. This study was conducted to find out the analytical thinking skills of students at higher secondary school level with respect to gender and subject of specialisation.

### **Tool and Procedure of Data Collection**

Analytical Thinking Skill Test (ATST) is the data collection instrument used for the present study. The ATST developed by the investigators included

the items for the components of analytical thinking skills: matching, differentiating, attributing, categorising and organizing. ATST that consisted 50 items in the form of multiple-choice type questions with four alternatives from A to D was used for the present study. The test includes 11 items for the component skill of matching, 9 items for the component skill of differentiating, 10 items for the component skill of attributing, 9 items for the component skill of categorising and 11 items for the component skill of organising. The time allocation for the test was 60 minutes. There was no negative marking. The score given for each correct answer is 1 and the maximum score of the test is 50. The test was administered to the sample and the response sheets were scored. Data was analysed using descriptive statistics and test of significance of difference between means of two large independent groups (t-test).

## **ANALYSIS OF DATA AND RESULTS OF THE STUDY**

The 72 students were classified into three groups with high, average and low analytical thinking skills. Students score greater than 66.7% (score 33.35) belong to high group, those with score between 33.3-66.7% (score 33.35-16.65) belong to average group and those having score less than 33.3% (score 16.65) belong to low group. Table 1 shows the number of higher secondary school students belonging to each of these three groups.

**Table 1: Number of Higher Secondary School Students belonging to High, Average and Low Level of Analytical Thinking skill**

Level of Analytical Thinking Skill	Number of Students	Percentage of Students
High	36	50.00%
Average	24	33.33%
Low	12	16.67%

Table 1 indicates that 50% of the sample possess high level of analytical thinking skill, 33.33% belongs to the average level and only 16.6 % to the low level.

### **Descriptive Statistics**

The details of mean and standard deviation of analytical thinking skill and its components were calculated and the details are given in Table 2.

**Table 2: Mean and Standard Deviation of Analytical Thinking Skill and its Components**

Variable	Sample Size	Mean	Standard Deviation
Matching	72	7.75	3.28
Differentiating	72	5.79	2.66
Attributing	72	7.26	3.43
Categorising	72	5.94	2.73
Organising	72	7.36	2.84
Analytical Thinking skill	72	33.44	13.60

From Table 2 it is seen that all the components of analytical thinking skills of higher secondary school students are average or above average.

### **Comparison of Analytical Thinking Skill and its Components with respect to Gender and Subject of Specialisation.**

The data collected were analysed with respect to the objectives and

hypotheses of the present study using test of significance of difference between means of two independent samples.

### **HYPOTHESIS 1:**

There is significant difference in the analytical thinking skill and its components of higher secondary school students classified on the basis of gender.

The data pertaining to analytical thinking skills of higher secondary school

students were analysed using t-test for the subsamples based on gender and the details regarding sample size (N), Mean and standard deviation, and the t-value calculated are given in Table 3.

**Table 3: Test of Significance of Difference between Mean Scores of Analytical Thinking Skill and its Components of Male and Female Higher Secondary School Students**

Variable	Male			Female			t-value
	N	Mean	SD	N	Mean	SD	
Matching	40	6.55	3.551	32	9.25	2.140	3.99**
Differentiating	40	4.98	2.722	32	6.81	2.235	3.14**
Attributing	40	6.10	3.615	32	8.72	2.568	3.59**
Categorising	40	5.13	2.980	32	6.97	1.992	3.13**
Organising	40	6.35	2.842	32	8.63	2.311	3.74**
Analytical Thinking skill	40	28.53	14.362	32	39.59	9.678	3.89**

\*\* significant at 0.01 level

From Table 3, it can be seen that Analytical Thinking skill of male higher secondary school students differ significantly at 0.01 level as the t-value calculated (3.89) is greater than 2.58; the table value set at 0.01 level of significance. It can also be seen that higher mean of Analytical Thinking skill is associated with female higher secondary school students (M = 39.59) when compared with that of male higher secondary school students (M = 28.53).

The Matching skill of male higher secondary school students differ significantly at 0.01 level as the t-value calculated (3.99) is greater than 2.58; the table value set at 0.01 level of significance. It can also be seen that higher mean of Matching skill is associated with female higher secondary school students (M = 9.25) when compared with that of male

higher secondary school students (M = 6.55).

The Differentiating skill of male higher secondary school students differ significantly at 0.01 level as the t-value calculated (3.14) is greater than 2.58; the table value set at 0.01 level of significance. The higher mean of Differentiating skill is associated with female higher secondary school students (M = 6.81) when compared with that of male higher secondary school students (M = 4.98).

The Attributing skill of male higher secondary school students differ significantly at 0.01 level as the t-value calculated (3.59) is greater than 2.58 the table value set at 0.01 level of significance. The higher mean of Attributing skill is associated with female higher secondary school students (M = 8.72) when

compared with that of male higher secondary school students (M = 6.10).

The Categorising skill of male higher secondary school students differ significantly at 0.01 level as the t-value calculated (3.74) is greater than 2.58; the table value set at 0.01 level of significance. The higher mean of Categorising skill is associated with female higher secondary school students (M = 8.63) when compared with that of male higher secondary school students (M = 6.35).

The Organisation skill of male higher secondary school students differ significantly at 0.01 level as the t-value calculated (3.74) is greater than 2.58; the table value set at 0.01 level of significance. The higher mean of Organisation skill is associated with female higher secondary school students (M = 8.63) when compared with that of male higher secondary school students (M = 6.35).

Hence the formulated hypothesis “there is significant difference in the analytical thinking skill and its components of higher secondary school students classified on the basis of gender” is accepted.

### HYPOTHESIS: 2

There is significant difference in the analytical thinking skill and its components of higher secondary school students classified on the basis of subject of specialisation.

The data pertaining to analytical thinking skills of higher secondary school students were analysed using t-test for the subsamples based on subject of specialisation and the details regarding sample size (N), Mean and standard deviation, and the t-value calculated are given in Table 4.

**Table 4: Test of Significance of Difference between Mean Scores of Analytical Thinking Skill and its Components of Higher Secondary School Students Studying Commerce and Science as Subjects of Specialisation**

Variable	Science			Commerce			t-value
	N	Mean	SD	N	Mean	SD	
Matching	31	9.84	1.985	41	6.17	3.193	5.984**
Differentiating	31	7.74	1.914	41	4.32	2.161	7.108**
Attributing	31	9.84	1.594	41	5.32	3.158	7.930**
Categorising	31	8.00	1.592	41	4.39	2.365	7.728**
Organising	31	9.52	1.964	41	5.73	2.259	7.586**
Analytical Thinking skill	31	44.06	8.016	41	25.41	11.245	8.212**

\*\* significant at 0.01 level

From Table 4 it can be seen that Analytical Thinking skill of higher secondary school students studying commerce as optional subject differ significantly at 0.01 level as the t-value calculated (8.212) is greater than 2.58; the table value set at 0.01 level of significance. It can also be seen that higher mean of Analytical Thinking skill is associated with higher secondary school students studying science as optional subject (M = 44.06) when compared with that of higher secondary school students studying commerce as optional subject (M = 25.41).

The Matching skill of higher secondary school students studying commerce as optional subject differ significantly at 0.01 level as the t-value calculated (5.98) is greater than 2.58; the table value set at 0.01 level of significance. The higher mean of Matching skill is associated with higher secondary school students studying science as optional subject (M = 9.84) when compared with that of higher secondary school students studying commerce as optional subject (M = 6.17).

The Differentiating skill of higher secondary school students studying commerce as optional subject differ significantly at 0.01 level as the t-value calculated (7.108) is greater than 2.58; the table value set at 0.01 level of significance. The higher mean of Differentiating skill is associated with higher secondary school students studying science as optional subject (M = 7.74) when compared with that of higher secondary school students

studying commerce as optional subject (M = 4.32).

The Attributing skill of higher secondary school students studying commerce as optional subject differ significantly at 0.01 level as the t-value calculated (7.93) is greater than 2.58 the table value set at 0.01 level of significance. The higher mean of Attributing skill is associated with higher secondary school students studying science as optional subject (M = 9.84) when compared with that of higher secondary school students studying commerce as optional subject (M = 5.32).

The Categorising skill of higher secondary school students studying commerce as optional subject differ significantly at 0.01 level as the t-value calculated (7.728) is greater than 2.58; the table value set at 0.01 level of significance. The higher mean of Categorising skill is associated with higher secondary school students studying science as optional subject (M = 8.00) when compared with that of higher secondary school students studying commerce as optional subject (M = 4.39).

The Organisation skill of male higher secondary school students differ significantly at 0.01 level as the t-value calculated (7.586) is greater than 2.58; the table value set at 0.01 level of significance. The higher mean of Organisation skill is associated with higher secondary school students studying science as optional subject (M = 9.52) when compared with that of higher secondary school students



studying commerce as optional subject (M =5.73).

Hence the formulated hypothesis “there is significant difference in the analytical thinking skill and its components of higher secondary school students classified on the basis of subject of specialisation” is accepted.

## DISCUSSION OF RESULTS

From the present study it is evident that majority of higher secondary school students possess average or above average analytical thinking skill. The curriculum and transaction process of higher secondary schools may be helpful in developing the analytical thinking abilities of the students. Areesophonpichet (2013) found that research-based learning with concept mapping, can help students to develop their analytical skills to a higher level. Moreover, the design of teaching plans and the sequencing of assignment plans both have effects upon the development processes of students’ analytical thinking skills.

The case study conducted by Sheri Stover and Sean Pollock, (2014) redesigned the traditional curricular program offered by the university as a synchronous online course that provided students with opportunities to work collaboratively to build a community of inquiry and to develop the analytical skills needed to understand course materials and compete in the 21st-century workforce.

The results of the study (Fitriyana, Marfuatuna., & Priyambodo, 2019) conducted among senior high school students indicates that there was significant effect of systemic learning approach on students’ analytical thinking skills.

The present study also revealed that male and female higher secondary students differ significantly in the analytical thinking skills in all of the component skills. In all of the component skills female students were found to be better than male students. The female higher secondary students actively engage in the teaching learning process and their academic achievement is high. This may be helpful in developing the analytical thinking skills of female higher secondary school students.

Prakash (2003) found that girls were better than boys in Mathematics achievement at intermediate level. Anice and Marice (2004) investigated the influence of academic stress on the achievement of XI standard students and found a significant difference between boys and girls. Girls performed better than boys in their level of achievement and lowered in the level of academic stress.

The results of the present study revealed that the higher secondary school students studying commerce and science as subjects of specialisation differ significantly in the analytical thinking skill in all of its component skills. In all of the component skills the science students were found to be better than the

commerce students. In the state of Kerala, most of the students who choose science as their subject of specialisation are meritorious than the commerce students. The higher order thinking skills required for learning the science subjects might have an impact on the high analytical thinking ability of science students.

## CONCLUSION AND SUGGESTIONS

The level of analytical thinking skill and its components vary for the total sample and the subsamples based on gender and subject of specialisation. In general, the curriculum and the transaction strategies of higher secondary school students in the state of Kerala are suitable for developing the analytical thinking skill of the students. Appropriate instructional strategies should be adopted for the students who possess low level analytical thinking skills. The students with high analytical thinking skills can be provided with

enrichment activities. As the analytical thinking ability of commerce are low when compared to science students the curriculum and transaction strategies need to be redesigned to develop higher order thinking skills in commerce students. With regard to gender, analytical thinking skills of male students are low when to compared to female students. The reasons for this difference need thorough investigation.

As the higher secondary school education paves way to higher education the enhancement of higher order thinking skills is highly relevant for the students. Based on this research it has been suggested that the Analytical Thinking Skills of Higher secondary School students need to be enhanced. Irrespective of gender and subject of specialisation the school education system should provide opportunity to enhance analytical thinking skills.

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## ATTENTION TO AUTHORS

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