



Multidisciplinary Research in Academics: The Way Forward



Multidisciplinary Research in Academics:
The Way Forward



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**Research and Development Cell
Institution's Innovation Council
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of

Women's Christian College, Chennai

A two-day International Conference on "*Global Perspectives on Transforming Academics through Research and Innovative Strategies*" was held on 26th and 27th July, 2023 at Women's Christian College, Chennai. This was an attempt to explore the current trends in collaborative research across all disciplines, and its impact on academic progress and the community at large.

Various papers on multidisciplinary aspects were presented at the conference and selected for publication in the book after scrutiny. The papers presented included research-based articles on topics related to Arts and Humanities, Social Sciences, Community-based Research, Green Initiatives, Science and Technology.

This book is thus an attempt to bring together various research articles undertaken as projects/studies in different disciplines under one umbrella of multidisciplinary research. We hope that this book will be the way forward to enhance the research culture in Institutions, and contribute to a holistic teaching-learning process.



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INSTITUTION'S INNOVATION COUNCIL
INFORMATION RESOURCE CENTRE
INTERNAL QUALITY ASSURANCE CELL
of
WOMEN'S CHRISTIAN COLLEGE, CHENNAI**

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on
“GLOBAL PERSPECTIVES ON TRANSFORMING ACADEMICS
THROUGH RESEARCH AND INNOVATIVE STRATEGIES”

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Foreword

The shifting sands of higher education warrant that we need to keep ourselves abreast of the latest developments in our domain areas. Apart from this, it is imperative that teachers employ the latest techniques and technology for teaching. It is important to combine both with the vision and ethos of our respective institutions that give us a distinct flavour. With this in mind, the International Conference "Global Perspectives on Transforming Academics through Research and Innovative Strategies" organized by the college will pave a pathway for deliberations and discussions which will help in the transformation of higher education into a meaningful endeavour for all concerned.

Research and Innovation are two important factors that both teachers and students have to involve themselves in to make education application-oriented and experiential. I am sure that a book which has research material on this topic of great relevance will be of use to educationists and students alike.

Dr. Lilian I Jasper

Principal and Secretary
Women's Christian College, Chennai

Acknowledgements

It is with a feeling of tremendous gratitude that we thank our Principal Dr. Lilian I. Jasper, College Management, and the Bursar for encouraging us to convene an International Conference and supporting us in every way possible, and especially towards providing us with financial support towards this Book publication. This Book titled *Multidisciplinary Research in Academics: The Way Forward* is a compilation of research articles based on projects/studies conducted by scholars and faculty belonging to different disciplines.

We would like to thank the students, faculty, and research scholars who have presented their work at the conference, and translated this into a publication, which was included as Chapters in this Book. Our heartfelt gratitude is also due to the Resource persons who have given their valuable time, ideas and a brief description of their presentation.

We wish to thank Mr. Olivannan of Emerald Publishers for the help rendered in publishing the book. Above all, we would like to thank God Almighty for the abundant grace bestowed on us.

THE EDITORIAL TEAM

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Introduction

The International Conference on “*Global Perspectives on Transforming Academics through Research and Innovative Strategies*” on July 26th and 27th, 2023, was an attempt to explore the current trends in collaborative research across all disciplines, and its impact on academic progress and the community at large. Research is an integral part of the teaching learning process, and in all Higher Education Institutions, research-based activities stimulate the young minds to think beyond the classrooms, and paves the way for innovation and entrepreneurial ventures. Thus, to enhance the research culture on campus through engagement with innovative developments in various disciplines and facilitate the teaching-learning process, the *Research and Development Cell*, *Information Resource Centre (Library)*, *Institution’s Innovation Council*, and the *Internal Quality Assurance Cell* of the college jointly organized this conference.

In the global context, high-quality research is critical not just to maintain a sustainable academic environment, but also translate knowledge into an impactful outcome for the betterment of society. Collaborative research focusing on good communication skills, critical thinking and creative innovations help academic institutions cultivate a holistic environment for acquiring knowledge, and provide the necessary platform for catering to

the changes in education and technology at the global level. With this in mind, the objectives for the conference included exploring evidence-based research in various disciplines related to the Sciences, Technology related courses, Social Sciences, Arts and Humanities, and also deliberating on innovations in the teaching and learning process.

The main themes of the conference included Research and Innovations in Science and Technology, Social Sciences, Arts and Humanities, Green Initiatives, Social Reforms, Academia-industry partnership, Innovations in Teaching and Learning, Digitalization in Education, Community-based research, Innovative strategies to build a sustainable future, preserve, conserve, and promote heritage, tradition and culture.

Many eminent resource persons from abroad and India were invited for this conference to deliberate on issues concerned with the focus areas. While a few speakers from the United States and United Kingdom did online presentations, the speakers from Malaysia, Saudi Arabia and India delivered lectures on campus. Student participation from across colleges in Chennai contributed to the success of this conference. Various papers on multidisciplinary aspects were presented at the conference and selected for publication in the book after scrutiny. The papers presented included research-based articles on topics related to History, Management Studies, Social-sciences, Community-based Research, Green Initiatives, Sciences and Technology.

This book is thus an attempt to bring together various research articles undertaken as projects/studies in different disciplines under one umbrella of multidisciplinary research. We hope that this book will throw light on different aspects of research that has emerged from creative ideas discussed in a classroom setting, and which can be translated into major projects, policies or developing skill sets necessary for entrepreneurial ventures.

A Brief Write-up from the Resource Persons

Dr. Suresh Ramanathan

Dean & Principal
Great Lakes Institute of Management
Chennai

Topic: *Cultivating Curiosity: Nurturing Academic Growth through Research*

The power of academia lies in an active sense of curiosity in discovering answers to questions about a variety of phenomena. Very often, we struggle to make sense of why things happen or may have multiple explanations for the same that we are unable to reconcile. Some of the biggest questions in the world have been answered by leading academics at various universities. In my speech, I will attempt to talk about how academia in India needs to harness our natural inclination to be curious, and be at the forefront of knowledge creation that can benefit a wide variety of stakeholders - industry, government, students in our classrooms, and society at large. Creating impact through high quality research will not only benefit all these stakeholders, but will also help catapult India into the big league in academia.

Dr. Hassan Basri Jahubar Sathik

Director, Academic Affairs
University of Cyberjaya,
Malaysia

Topic: Innovation for Impact: Unleashing the Power of SDGs in Building a Sustainable Future

In today's rapidly changing world, the need for innovative strategies to tackle global challenges and foster sustainability has never been more urgent. This presentation aims to explore the transformative potential of innovation and its role in building a sustainable future aligned with the United Nations Sustainable Development Goals (SDGs). Innovation has become the driving force behind transformative change across various sectors, and academia plays a pivotal role in shaping a sustainable future. I will share insights, research findings, and practical examples that highlight the transformative power of innovative strategies in achieving the SDGs. My talk will touch upon key themes such as fostering collaboration between academia, industry, and government to drive sustainable development, leveraging emerging technologies for sustainable solutions, integrating the SDGs into curriculum design, and promoting interdisciplinary research.

Key Topics:

1. The significance of innovation in academia and its potential for transformative change.
2. Enabling a culture of innovation within academic institutions to promote sustainability.
3. Fostering collaboration between academia, industry, and government to accelerate progress towards the SDGs.
4. Integrating emerging technologies and interdisciplinary approaches to drive sustainable solutions.

Dr. Gayathri Deepak

Founder/Director
CHETANA EDUCATION
Saudi Arabia

Topic: PBL as a Mainstay Approach for Making Learning in HEIs Holistic, Authentic and Relevant

This short talk will outline the appropriate methodology of doing PBL and drive home the message of making PBL a mainstay learning approach for all disciplines in our Higher Educational Institutions.

What is the most comprehensive learning method that can make learning engaging, relevant and also prepare college students ready to face the real world in the 21st century? Collaboration, communication skills, critical thinking, learner agency and engagement are all ensured through Project Based Learning (PBL). Besides being adaptable to this modern era of digital learning, it is the only approach that allows assessments to be seamlessly integrated into the learning process, making assessments relevant, meaningful and authentic. This is the only approach that can also easily allow for multi-pronged, interdisciplinary work, allowing collaboration between departments, Universities and even research teams across countries, to address Sustainable Development Goals to tackle real world issues, inspiring quality studies with far reaching scientific as well as social impact. All this drives home the point that PBL should be the mainstay approach in our HEIs.

Dr. Glyn Thomas Gowing

Professor of Computer Science
Chair, Non-Traditional
Computer Science Program
LeTourneau University
Longview Hall 114

Topic: *Hands-on Experience in an Academic Environment (Online)*

Traditional university education in the United States is largely academic and theoretical, typically following the European university model, equipping students with vast theoretical knowledge but little practical, hands-on experience. Technical schools, typically two-year programs, focus more on hands-on experience but their graduates lack the in-depth theoretical background. LeTourneau University is unusual in its approach that combines the theoretical background expected in a university education with extensive hands-on experience, producing graduates who are ready to enter their fields immediately instead of requiring several months of additional on-the-job training to learn to use equipment needed on the job. This presentation will describe how this highly successful approach (in terms of student job placement and high-profile companies coming to a tiny Christian university seeking students over students from top-tier universities) is implemented without sacrificing the theoretical background one expects from a university education.

**Dr. M. Isabella Cavalcanti
Junqueira**

Full Professor of Entrepreneurship
& Marketing
LeTourneau University
LeTourneau School of Business
Longview, TX 75605

Topic: Developing An Entrepreneurial Mindset & New Markets (Online)

An entrepreneurial mindset and new markets are interconnected concepts critical for success in today's dynamic and rapidly changing business environment. The entrepreneurial mindset involves seeing opportunities where others see challenges, taking calculated risks, and being resourceful in achieving one's goals. On the other hand, new market opportunities refer to untapped or underdeveloped market segments within a particular context that presents opportunities for growth and expansion.

In this presentation, Dr. Cavalcanti Junqueira will share case study research focusing on the development of a local vineyard. Marginal attention has been devoted to exploring the approach and rationale winemakers in the new world pursue to establish a winery in a region with no tradition or history of winemaking. Finding suitable land conditions for vineyards or the desirable consumer market in East Texas, USA, can become challenging. Hence, Dr. Cavalcanti Junqueira's research generates insights into how market actors can effectively work across social and economic boundaries to design real-world solutions and valuable innovative goods and services. We know little about the micro, firm-level practices underpinning business models and their market strategies. Hence, we need to understand more about

the decision-making process of market vision, business strategy and regional development. This integration can encapsulate their business model into localized, contextualized, and enacted market practices. Against this background, there is the understanding that entrepreneurship happens and adapts to places and regions. Therefore, this research contributes to understanding the development of new markets in East Texas, USA, while offering insights into the dynamic interplay of entrepreneurship and regional development.

Dr. Shyam K. Sriram

Assistant Professor
Department of Political Science
Canisius College,
Buffalo, NY, USA

Topic: Effective Strategies at Applying Research Skills to the Job Market (Online)

This online presentation will engage with the crucial question of turning your quantitative and qualitative graduate training into the kind of skills sought out by employers. The presentation will discuss how to brand yourself, what to emphasize in your resume or CV, and concrete examples of cover letters and mock interview questions.

Dr. Yesan Sellan

Assistant Professor,
PG and Research Department of
Library and Information Science
Bishop Heber College,
Tiruchirappalli,
Tamil Nadu, INDIA

Topic: Empowering Academic Excellence: The Vital Role of Libraries in Research Support, Collaboration and Innovative Strategies

Libraries play a pivotal role in supporting and enhancing the research pursuits of academia and the importance of libraries remains undiminished even in the digital age. Research support services and collaborative spaces offered by libraries are indispensable for enhancing the scholarly productivity of faculty members. Provision of scholarly resources, research support services, collaborative spaces, preservation efforts, and information literacy initiatives of libraries significantly contribute to the success and advancement of scholarly communication. Introduction of innovative strategies and research in academics contribute to the growth of academic institution. Collaboration of faculty members and librarians are key to the growth and development of academic institutions. The integration of technology has changed the dynamics of learning and teaching tasks of academic fraternity. This presentation highlights the role of academic library.

Dr. Kezia Sasitharan

Research Associate-Energy
Research group of Dr Marina Freitag,
Newcastle University, UK

Topic: *CREATIVE RESEARCH – Can being creative boost critical thinking and problem- solving abilities in academics? (Online)*

Developing creativity is core to our personal and professional development. While it is common to associate creativity with arts, it is equally vital to scientific and technological endeavour. Research often requires methodical preparation, repetitive data collection and rigorous analysis, delivered within strict budgets and tight time-frames. It is understandable then, that some researchers wonder where being creative fits into the picture. However, academic creativity is essential to help us stand out. Being creative is key to innovation, stimulates original ideas which can lead to new discoveries and inventions. In addition to developing our own intellectual curiosity and sense of adventure, creativity can enable us to push the frontiers of our own knowledge as well as the wider knowledge in our subject area. STEM (Science, Technology, Engineering and Mathematics) researchers use creativity to develop and explore new problems and re-examine, re-articulate or solve existing ones in novel ways. Despite the centrality of creativity to STEM research, there is usually very little importance given on how to incorporate it into our day-to-day research. In addition, structural pressures like competition for scarce resources and an increased focus on the economic or social impact of research projects can mean that ‘safe’, measurable results are prioritised over original ideas and processes.

So, how can you build creativity into your day-today routine? In my talk, we will explore key findings from teams that have studied the role of creative research and discuss tools and techniques to help make academic research a more creative experience. As our understanding of creativity develops, so does our appreciation that an individual's skills, talents and knowledge are not the only factors that influence their ability to think and work creatively. The physical, social, and intellectual environments in which we work are also significant to our levels of creativity. My talk will also explore the environmental factors that have been found to be significant in stimulating the creativity of academic researchers, including some practical guidance on how you can change your research environment to make it a more creativity-friendly place to work.

Dr. Kalpana Sankar

Managing Director of
Belstar Microfinance Limited,
Managing Trustee,
Hand in Hand India

Topic: *Role of Research and Academics in the development sector*

India has seen a rapid expansion in the higher education sector since 2001. There has been a dramatic rise in the number of higher education institutions (HEI) and enrolment has increased four-fold. The Indian higher education system is now one of the largest in the world with 49,964 institutions. Despite the increased access to higher education in India, challenges remain: poor quality of education, complex regulatory norms, low employability of graduates, and lack of integration between the industry and the

HEI. As the global economy undergoes structural transformation, there will be a need for sophisticated researchers, innovators, and knowledge workers. Although the IITs and IISc have figured among the best Indian institutions for research much needs to be done for India to be recognized as world class.

Why Invest in R&D? Research and Development (R&D) is primarily undertaken by companies and government in India to foster innovation but the role of education institutions is limited except for work done by IITs and IISc. The Government of India has provided an impetus to investments in R&D by way of various tax incentives. These incentives are available with respect to revenue and capital expenditures incurred by entities for carrying out R&D activities in relation to their businesses, including their contributions to various institutions for carrying out scientific research.



**Research and Innovation
pertaining to Arts,
Humanities and Culture**



Multidisciplinary Interfaces of Environmental Sciences used in Archaeological Research

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Abstract

It's impossible to assess long-term human activities without taking the environment and its sciences into consideration. Environmental changes are intricately tied to a variety of historical crescendos, including social structures, economic situations, political systems, cultural and religious traditions, and so on. All these phenomena are entwined with a variety of ecological and environmental details. To understand the long humanoid history, it is essential to understand the environmental sciences as a multidisciplinary approach. Through many methodological discoveries made on environmental sciences over the course of 300 years, this study has steadily grown into the area of archaeology and history in recent years. This paper will discuss and highlight the contributions of academics and intellectuals of environmental science findings and theories that have aided archaeological and historical research to understand and reconstruct the past.

Keywords: *Archaeology, Climate, Dating techniques, Environmental sciences, Human evolution, Multidisciplinary*

Introduction

Environmental science is an interdisciplinary branch of study that combines physical, biological, and information sciences. Ecology, biology, geology, soil sciences, botany, atmospheric science, physics, zoology, and chemistry are all included in the environmental science field. Because it is such a broad field of study, there has been a huge amount of research and discoveries in the field over many centuries. In their own mode, these disciplines have evolved with a variety of concepts and approaches with numerous scientific principles and methodologies. History and archaeology on other hand is a scholarly study to reconstruct the human past. To evaluate the various traits of archaeological and historical analysis several principles and research methodologies are employed in the study. These features have evolved over time, particularly with the help of environmental scientists. Using new scientific findings in the realm of environmental sciences, cultural and historical perspectives on early human lifestyles and activities have become increasingly well-defined in recent years. Some of these significant scientific breakthroughs and their discoverers that have assisted in the field of archaeology and history are highlighted here.

Geoarchaeology

Geology is a branch of environmental science that focuses on the Earth's physical properties and the study of the planet's history. The study of a planet's history is one of the sub-fields in geology known as historical geology. For a very long period, people relied on religious inspired stories rather than scientific investigations to explain the earth's beginning. Nicolaus Steno (1638-1687 CE), a Danish geologist studied old rock layers and pioneered a new geological concept called "Law of Superimposition" or "Law of Stratigraphy". This law describes the pattern in which rock or soil

layer deposited, revealing details about the earth's history. Even though this notion amended and improved throughout time, it was not until 1830 that this geological principle began to be utilized in archaeology. The study of layered materials (strata) that were deposited throughout time is known as stratigraphy. Using this typology techniques, an archaeologist can trace the structures and artefacts on a site back through time by excavation. Human activities could affect soil, allowing archaeologists to examine and reconstruct historical landscapes and circumstances through its layers (strata). This principle of stratigraphy practically used in all archaeological investigations at present, it became a foundation for the relative dating technique based on the rule of superposition. Stratigraphy is also important for reconstructing the landscape of habitation and historical conditions, as well as for understanding the processes of site development, known as Site formation processes. Werner Kasig created the phrase archaeological geology in 1980's. It's a branch of geology that highlights the importance of earth components for human survival. This became an integral sub-filed specialization in archaeology in recent times.

Geomorphology on other hand is a concept in geology to study the evolution of land formation. The study of the deposits provides profuse data about how landforms have changed through time. This approach aids archaeologists in determining whether deposits in a strata (soil layer) were generated by weathering of underlying strata or were transported by natural factors such as wind, water, or humans who lived there.

Evolutionary Biology

The theory of evolution is founded on the idea that all species are connected and evolve over time. After witnessing numerous species with adaptation adjustments to their surroundings,

which gave them a greater capacity to live and prosper in that environment, Charles Darwin (1809 – 1882 CE) developed the concept of natural selection and along with many of his findings, he published the book “The Origin of Species” in 1859. Evolutionary biology provides the key to understanding the principles governing the origin and extinction of species. This field relates itself with archaeobotany and archaeozoology and bioarchaeology. The research and natural principles established by several evolutionary biologists, particularly in terms of human evolutions, aided much during the study of prehistoric times for an archaeologist. When there are no written documents to examine, stone tools, together with evolutionary conceptions of humans and their adaptation to paleoenvironments, play a critical role in gaining a better understanding of human ancient civilization. At present evolutionary archaeology and behavioral ecology are the two primary techniques now employed to evaluate archaeological remains from an evolutionary perspective. Evolutionary archaeology is one of the sub-field, which examines the morphology, physiology, genetics, ecology, behavior, and cognition of humans and non-human primates from an evolutionary viewpoint to answer issues about human nature, paleoenvironment and evolution.

Absolute dating

In archaeology and geology, absolute dating is the method of identifying an age based on a certain chronology. Scientists found measuring absolute age or exact date to be a problematic and challenging task during early times. However, discovering natural mechanisms that happen at a steady pace and records in the radioactive decay of elements helped in obtaining the absolute age. The principle of absolute dating incorporates atmospheric sciences, physics, chemistry, and geology. Few instances are shown below,

Willard Libby suggested a novel method for dating organic materials in 1946 by carbon-14 concentration, a recently found radioactive isotope of carbon. Radiocarbon dating is a method of determining the age of an object by measuring the amount of carbon in it during its decay process.

Scientists at Simon Fraser University in Canada established conventional thermoluminescence dating (TL dating) methodologies in the 1970s and 1980s. It is a stimulated emission process occurring when the thermally excited emission of light follows the previous absorption of energy from radiation. This dating is mainly used for ceramic age study.

K-Ar dating also known as potassium argon dating developed in the 1950s is particularly effective for identifying the age of lavas and it was significant in formulating the idea of plate tectonics and calibrating the geologic time scale.

Dendrochronology (or tree-ring dating) is a scientific method for determining the precise year that tree rings (also known as growth rings) were produced. Astronomer Andrew Ellicott Douglass and archaeologist Clark Wissler devised it in the early 20th century. Based on the examination of tree rings, the paleoclimates and climatic changes are determined in this analysis.

● Ice – Core Records

Ice core analysis has been utilized and studied since the early twentieth century to better understand past environmental and climatic shifts. These ice core samples are drilled and extracted from glaciers in pristine areas such as the Arctic and Antarctic regions. These ices originate from the continuous accumulation of yearly layers of snow, which provide archived data for the reconstruction of past climates and ecosystems. The ice-core

research is comparable to the stratigraphical study in that it is a vertical column of ice sheet strata. These ice cores are subjected to numerous assessments in order to obtain diverse historical data that are critical for the reconstruction of Paleoenvironments. To gain information about the past environment, numerous dating techniques are employed to the ice core. Radiocarbon dating is used on the carbons found in ice cores, which are in the form of carbon dioxide. Potassium argon dating is used to date and evaluate volcanic tephra contained in portions of the ice core. Aside from that, the ice core study aids scientists in understanding the geomagnetic reversal event. Thus, ice core dating and analysis aid in establishing a critical chronological timeline for previous climatic and environmental data.

● **Otoliths Analysis**

Otoliths, additionally referred to as “earstones,” are hard, calcium carbonate formations found just behind the brain of bony fishes. This calcium carbonate structure expand throughout time during a fish’s life, comparable to tree ring formation. The otoliths fluctuate with the seasons and environment, displaying thick or thin rings. An archaeological specimen of a 4500 year old otolith was discovered in Dholavira (Indus Valley Civilisation site), and the study of the otolith assemblages aids in comprehending the ancient temperature and the environment.

Similar research was conducted on the oxygen isotope discovered in snail shells at the same site. This archaeo-zoological examination aids in understanding the nature of the fauna as well as the environment in which it existed, as these snails are only found in the mangrove zone.

Conclusion

As we progress in the realm of sciences, several advanced concepts and methodologies are developed and employed periodically in the science field. Slowly from the 19th century onwards several science principles and methods began to aid other fields as a result of the multidisciplinary approach. Archaeology was once related with the arts and thought to be a historical study of human history based on artefacts recovered from the past. However, it is today described as a scientific and systematic study of recreating human history, with the addition of many environmental science disciplines into its research. This paper elucidated about the usage and influences of various environmental sciences in archaeological research.

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Solutions to Restore and Sustain the Reading Habit in Learners of the English Language

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Abstract

2020 COVID-related lockdown negatively impacted the reading habit of students requiring solutions of reading spaces and context-based reading materials. The experimental research to test these solutions in the Department of English, Women's Christian College, Chennai, for Basic Proficiency Level students of Part-II English from July to November 2022 aimed to develop comprehension, vocabulary, creative and imaginative thinking to the delimited target group with specific methods for active reading. The Control Group (CG) and Experimental Group (EG) of 19 students with same mean value for Pre-Test showed significant increase for EG in the Post-Test assessed through independent and paired T-Tests. The findings/solutions of Reading Spaces and Context-based Reading Materials may be recommended as future directions assessing same/different cohorts.

Key words: *Active Reading, Reading Spaces, Contextual Reading Materials, Experiment*

Assessments

The habit of active reading was negatively impacted as educational institutions in India resorted to the online mode of classes during the Covid-19 lockdown in March 2020. A journal article titled “Impact of Covid-19 Pandemic on Study: Assessing Reading Habits of University Students in Bangladesh (2021)” confirmed that the reading habits of university students, be it a physical book or e-reading, had decreased significantly during the time of the pandemic (Jahan et al. 327,328). To ascertain this premise, the students admitted to the Liberal Arts and Science Degree Programme in 2022 were administered a questionnaire regarding their active reading habits. 44 students in the Basic Proficiency Level in English of the Part II -English course “English for Communication Skills”, at Women’s Christian College, responded to the questionnaire. Analysing the responses showed that 57% read comics, short stories of Tamil culture and history, novels, magazines, and newspapers of regional languages while 11% read nothing. 5% read books in English occasionally while 66% watched English movies and shows regularly. This led the researcher into seeking solutions to restore the active reading habits to enhance English Language competence by establishing cognitive connections to comprehend meaning, intention, implication, and, by developing critical and analytical thinking skills to create new synapses in language learning.

A theoretical framework of Reading Theories was designed to work out the procedural aspects of the methodology. The Top-Down reading theory, first coined by Richard Gregory says “Top-Down processing is perceiving the world around us by drawing from what we already know in order to interpret new information” (qtd. Rousay). Therefore, external influences, personal connections,

beliefs, and prior knowledge to process the context and overall understanding of the text would help in restoring active reading. As per teachingenglish.org.uk, the Bottom-Up reading theory is used when new words and grammatical structures are learnt and applied to the text (“Bottom Up”). The Interactive Approach includes the two theories of reading and understanding (Top-Down) and new words within the text (Bottom-Up) (Roldan).

Thus, the methodology for the intervention titled ‘Reading Spaces’ was defined by the study as a conducive physical, contextual, and cognitive environment to facilitate active reading. The physical reading space meant a calm environment to help absorb information better (Tampubolon and Kusuma 1), the contextual reading spaces would relate to the text for purposes of leisure or pleasure and functional or academic while the cognitive reading space would use visual elements to trigger memories that correlate with the words thereby building ‘cognitive maps’ for comprehension (Shi et al. 2). With this focus, an intervention module ‘Reading Space’ was designed for students to read contextually familiar texts in English so that cognitive connections between the text and their social, cultural, and historical realities developed comprehension, creative and imaginative thinking, and vocabulary. Based on the analysis of the questionnaire, a quantitative research design of a Pre-test and Post-test to determine the percentage of actual active reading for language learning was drawn up. A Control Group (CG) and an Experimental Group (EG) of 20 students each were created based on random selection. Both groups took the Pre-test and Post-test after which independent and paired t-tests were done to obtain the results. The Pre-test, a comprehension passage on Pongal given to both groups of 19 students each, was to be submitted on a single day,

answered independently and honestly. 38 papers were submitted on 30.9.2023 and were assessed. The average marks between the groups had a difference of 1%. To prove this further, independent t-tests were conducted. The alpha value was set to 0.05. The mean values were similar. The p one-tailed value was 0.46 which indicated no significant difference between the groups and were similar at the start of the intervention.

The intervention module was designed with 45 minutes to an hour of reading every day for a period of over 5.5 weeks from 23 September to 31 October 2022. The delimitation of this study includes choosing first-year undergraduate students of Basic Proficiency Level English as the cohort, using Reading Spaces as defined by the student researcher and its types with texts of a regional context and lastly, enhancing comprehension, vocabulary, creative and imaginative thinking as factors to increase the habit of active reading. The sessions through Google Meet/phone calls with a game or an interactive conversation saw new vocabulary, ideas and questions discussed online and in the classroom. The EG's first Guided Reading passage on 4.10.2022 on 'Kamarajar' tested 'comprehension', 'vocabulary' and 'creative and imaginative thinking'. The EG built their contextual and cognitive reading spaces through Kamarajar, a familiar Tamil icon. Together with simplified explanation and use of bilingual instructions, 60% guessed the meanings with various interpretations. The Bottom-Up theory was applied when meanings of words were understood within the context. The Interactive Theory was applied when students used some of these new words in their answers, demonstrating a growing vocabulary. 98% gave compelling reasons on what they would do as a leader of India. Personal connections intertwined with background knowledge led

to independent thinking to expand their cognitive and contextual reading spaces. 95% of the students used silent rooms to work as they focused better.

The second passage ‘Marina Beach’ was given on 13.10.2022. The average marks increased by 23%. The students’ personal experiences of the physical (Marina Beach) and contextual space (being on a beach) helped the cognitive reading space (memories). New words and their meanings based on the context proved the use of an active cognitive space (recollection of memory). The students’ creative and imaginative thinking ignited with discussions on beach cleaning as civic responsibility. 95% answers proved self and social awareness as the relatability to the situation and reliance on memories encouraged independent ideas honing their contextual and cognitive reading spaces. The Self-Reading Intervention required students to analyse the extracts from the translated versions of Chapters 1 and 2 of the Tamil historical fiction novel, ‘Ponniyin Selvan’ by Kalki Krishnamurthy and two short stories of a regional context (Tamil Nadu). The average marks and percentage were higher than the Pre-test and Guided-Reading intervention. The students summarised the texts, identified new words, framed new sentences, and also improvised story endings. Although some found the exercise challenging, many attempted as the given novel and short stories were relatable due to the regional (Tamil culture and language) and historical context (Chera, Chola, Pandya dynasties). To further prove and strengthen the intervention’s success, a Post-test was held on 30.10.2022 for both groups. The Pre-test passage used with an additional 5 questions showed that the difference between the average scores was 0.54. The overall percentage difference was 10%. The EG showed a notable increase in scores. To analyse the effect of the intervention, an independent t-test was administered to both groups. The mean

values were compared, and the p value was 0.03, showing a significant difference, as the EG gained better comprehension, vocabulary, creative and imaginative thinking. Comparisons were made between the EG's Pre-test and Post-test scores. The average score had doubled, representing a 28% increase. A paired t-test was conducted for the EG to analyse the intervention's effects. The mean values were compared, and the p value was found to be ~ 0.000046 which showed significant improvement in the EG with respect to their reading habits.

Qualitative feedback at the end of the intervention revealed that 37% enjoyed the entire learning process and 58% agreed that the intervention restored the reading habit. 47% agreed that familiar contexts in reading materials sustained their cognitive thinking. 37% said their vocabulary had increased to a large extent and 52% to a reasonable extent. The preferred physical reading space for 68% were silent rooms while 10.5% agreed on a classroom and the outdoors for active reading. On a scale of 1-10, 5.26% agreed that their creative and imaginative thinking had developed to a 10 (highest), 63% confirmed 6-9 (somewhat high), 31.5% confirmed 2-5 (medium). As an outcome of this study, recommendations include using Reading Spaces to analyse the active reading habits for purposes of English Language Learning to question, express their views, and contribute to discussions in the classroom.

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**கல்வராயன் மலைப்பகுதி சேராப்பட்டு
கிராமத்தில் வாழும் காட்டு நாயக்கர்களின்
வாழ்வியல் பின்புலம் - ஓர் ஆய்வு**

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முன்னுரை

தமிழரின் ஜவகை நிலங்களாக போற்றப்பட்ட குறிஞ்சி, முல்லை, மருதம், நெய்தல், பாலை முதலானவற்றில் மலையும் மலை சார்ந்த நிலமான குறிஞ்சி நிலப்பகுதியில் பழங்குடியின மக்கள் காலம் காலமாக வாழ்ந்து வருகின்றனர். மலைப்பகுதிகளில் வாழும் மக்கள் பழங்குடியினர் என்று அழைக்கப்படுகின்றனர். தமிழகத்தைச் சுற்றியுள்ள பல்வேறு மலைகளில் பல்லாயிரத்திற்கும் மேற்பட்ட மக்கள் வசித்து வருகின்றனர். இவர்களின் வாழ்வாதாரம் முழுவதும் மலைகளின் வளங்களைச் சார்ந்தே உள்ளன. தமிழ்நாட்டின் கள்ளக்குறிச்சி மாவட்டத்தில் உள்ள கல்வராயன் மலை வட்டாரத்தில் அமைந்துள்ள சேராப்பட்டு கிராமத்தில் வாழும் காட்டு நாயக்கர் மக்களின் வாழ்வு முறைகளை ஆராய்ந்து, இன்று அவர்களின் வாழ்வின் முன்னேற்றம் குறித்தும், தேவைகள் குறித்தும் கள ஆய்வு செய்து பெறப்பட்ட தரவுகளின் அடிப்படையில் இக்கட்டுரை எழுதப்பட்டுள்ளது.

பழங்குடியினர்

பழங்குடியினர் என்பவர் பன்னெடுங்காலமாக ஒரு குறிப்பிட்ட நிலப்பகுதியில் வாழ்ந்து வருபவர்கள். இவர்கள் தாங்கள் வசிக்கும் நிலப்பகுதியைச் சார்ந்து தன்னிறைவோடு வாழ்பவர்கள்.

தங்களுக்கென்று தனிப்பட்ட பழக்க வழக்கங்களும், மொழியும், நிலமும் சார்ந்த செடி, கொடி, மரம், விலங்குகளைக் கொண்டு தங்கள் வாழ்க்கையைத் தன்னிறைவோடு வாழ்பவர்கள். இவர்கள் தங்களுக்கென தனி கலைகளும் கடவுள், சமயம், மற்றும் உலகம் பற்றிய கொள்கைகளும் கொண்டிருப்பர். தனி மனித வாழ்க்கையிலும், உறவு முறைகளிலும், சமூகமாக வாழ்வதிலும் தங்களுக்கென தனிப்பட்ட முறைகள் கொண்டவர்கள். பிற மக்களிடம் அதிகம் பழகாமலும், பணத்தை அடிப்படையாகக் கொண்ட பொருளாதாரம் இல்லாமலும், தற்கால தொழில் வளர்ச்சி பெற்ற புதிய பொருட்கள், வசதிகள் எதையும் பெரிதாக ஏற்றுக் கொள்ளாதவர்களுமாக இருக்கிறார்கள்.

பழங்குடிகள் பட்டியல் இனத்தவர்கள்

பட்டியல் இனத்தவர்கள் மற்றும் பட்டியல் பழங்குடி இனத்தவர்கள் என்ற சமூகத்தவர்கள் கல்வி, பொருளாதாரம், தொழில், சமூகம் மற்றும் அரசியல் தகுதிகளில் வரலாற்று ரீதியாக பாதிக்கப்பட்டவர்கள். இந்தியாவில் இவர்களை ஒடுக்கப்பட்ட மக்கள் (Depressed Class) என்று வகைப்படுத்தி, அவர்களது பொருளாதார மேம்பாட்டிற்கு பஞ்சமி நிலங்கள் ஒதுக்கப்பட்டன. பஞ்சமி நிலம் (Depressed Class Land) என்பது நிலமற்ற பட்டியல் இன ஏழை மக்களின் பொருளாதார முன்னேற்றத்திற்காக, 1892 ஆம் ஆண்டில் ஆங்கிலேயரின் ஆட்சி காலத்தில் இந்திய அரசால் ஒதுக்கப்பட்ட வேளாண் விளைநிலங்கள் ஆகும்.

பழங்குடியினர் வசிக்கும் இடங்கள்

மேற்குத் தொடர்ச்சி மலைப்பகுதிகளில் பழங்குடியினரில் பெரும்பான்மையினர் வசித்து வருகின்றனர். சில பழங்குடியினர் தமிழகம் மற்றும் கேரளம், கர்நாடகப் பகுதிகளிலும் வசித்து வருகின்றனர். இரூளர், ஊராளி, எரவாளர், கசவர், காடர், காட்டு நாயக்கர், காணிக்காரர், காவினையர், குரும்பர், குன்றவர் கோட்டர், கோத்தர், கோரக்கர், சோழ நாயக்கர், சோளகர், தொதுவர், தோடர், பணியர், பத்தி நாயக்கர், பளியர், மலசர், மலைக்குறவர், மாவலியர், முதுவர், வேடர், வேட்டுவர் எனப் பழங்குடியினர் அட்டவணைப் பட்டியல் நீண்டு கொண்டே போகிறது. இந்திய அரசாங்கம் பழங்குடி இனத்தவரை

மிகவும் பழமை மிக்க பழங்குடியினர் என்று வரையறுத்துள்ளது. எழுதப்படாக்கும் திறனுள்ள மக்கள் ஐந்து விழுக்காட்டிற்கும் குறைவாகவும், விவசாய நாகரிகத்திற்கும் முற்பட்டதான வாழ்வியல் நடவடிக்கைகளைக் கொண்டவர்கள் என்ற அடிப்படையில் மிகவும் பழமை மிக்க பழங்குடியினராக இவர்கள் வகைப்படுத்தப்படுகிறார்கள். மிகவும் பழமைமிக்க பழங்குடியினராக கோரக்கர், காட்டு நாயக்கன், சோல நாயக்கன், குரும்பர்கள், காடர்கள் ஆகிய ஐந்து பழங்குடியினர் கருதப்படுகிறார்கள். இவர்கள் எண்ணிக்கையில் இருபதாயிரத்திற்கும் குறைவானவர்கள். அத்துடன் கலாச்சாரம், பண்பாடு ஆகியவற்றில் ஒருவருக்கொருவர் வேறு பட்டவர்கள்.

பழங்குடிகளுக்கான வரைவிலக்கணம்

பழங்குடிகள் என்போர், தங்களுக்கென்று ஒரே பண்பாட்டுக்கு உரியவர்களாகவும், ஒரே மொழியை அல்லது கிளைமொழியைப் பேசுபவர்களாகவும், பொது வரலாற்றைக் கொண்டவர்கள் என்ற உணர்வு கொண்டவர்களாகவும், மையப்படுத்திய அதிகார அமைப்பு இல்லாதவர்களாகவும் உள்ள ஒரு குழுவினர் என்று வரையறுக்கப்படுகின்றனர்.

கல்வராயன் மலை

கல்வராயன் மலைகள் தமிழ்நாட்டின் கள்ளக்குறிச்சி மாவட்டத்திற்குட்பட்ட கல்வராயன்மலை வட்டத்தில் உள்ளது. இம்மலைகள் கீழ்க்குத் தொடர்ச்சி மலைத்தொடரின் ஒரு பகுதி ஆகும். பச்சைமலை, ஜவ்வாது மலைகள், சேர்வராயன் மலைகள் ஆகிய இவை காவிரி ஆற்று வடிநிலத்தை பாலாற்றின் வடிநிலத்திலிருந்து பிரிக்கும் எல்லையாக அமைந்துள்ளன. 1095 சதுர கீமீ பரப்பளவுள்ள இம்மலைகள் 2000 முதல் 3000 அடி வரை உயரமானவை.

சேராப்பட்டுக் கிராமம்

சேராப்பட்டு கிராமம் தமிழ்நாட்டின் கள்ளக்குறிச்சி மாவட்டத்தில் உள்ள கல்வராயன் மலை வட்டாரத்தில் அமைந்துள்ளது. இந்த ஊராட்சி, சங்கராபுரம் சட்டமன்றத் தொகுதிக்கும், கள்ளக்குறிச்சி

மக்களவைத் தொகுதிக்கும் உட்பட்டதாகும். 2011 ஆம் ஆண்டு இந்திய மக்கள் தொகை கணக்கெடுப்பின்படி, இந்த கிராமத்தின் மொத்த மக்கள் தொகை 3629 ஆகும். இவர்களில் பெண்கள் 1717 என்றும், ஆண்கள் 1912 என்றும் கணக்கிடப்பட்டுள்ளது.

காட்டு நாயக்கர்

காட்டு நாயக்கர் எனப்படுவோர் இந்திய மாநிலமான கேரளா, கர்நாடகா, ஆந்திரா, தமிழ்நாடு மற்றும் மேற்கு தொடர்ச்சி மலைப்பகுதிகளில் வாழுகின்ற பூர்வ பழங்குடியினர் ஆவர். காட்டு நாயக்கர் என்ற சொல்லுக்கு தமிழ் மொழி மற்றும் மலையாள மொழிகளில் காட்டின் ராஜா என்று பொருள்படும். இவர்கள் மேற்குத் தொடர்ச்சி மலைப் பகுதிகளில் வாழும் ஒரு மூத்தப்பழங்குடி மக்கள் ஆவர். இவர்கள் தமிழ்நாட்டில் உள்ள நீலகிரி மாவட்டத்தில், முதுமலை, மேற்கு தொடர்ச்சி மலை ஓட்டிய தென் தமிழ்நாடு திருநெல்வேலி, தென்காசி, கன்னியாகுமரி மற்றும் வட தமிழ்நாட்டுப் பகுதிகளில் குறைந்த அளவில் வசித்து வருகின்றனர். இவர்களை காட்டுக் குறும்பர் எனவும் அழைப்பர்.

காட்டு நாயக்கர் என்ற பழங்குடியினர் “ஜேனு குறாமன், ‘தேன் குறும்பர்’ ‘காட்டு நாயக்கன்,’ ‘களத்து நாயக்கன், ‘நாயக்கன், ‘ஜேனு கொய்யோ,’ சோல நாயக்கன்;’ என்ற பெயர்களில் அழைக்கப்படுகின்றனர்.. இவர்கள் தொல் பழங்குடியின வகையைச் சார்ந்தவர்.

காட்டு நாயக்கர்பழங்குடியினரில் சோழ நாயக்கன், பத்தி நாயக்கன் என்ற இரு பிரிவினர் உள்ளனர். சோழ நாயக்கர்கள் மலையின் உயர்ந்த பகுதிகளிலும், பத்தி நாயக்கர்கள் பள்ளத்தாக்கின் மலையடிவாரக் காடுகளிலும் வசிக்கிறார்கள்.

காட்டு நாயக்கரின் சமூகப்பின்புலம்

குடியிருப்பு

காட்டு நாயக்கர்கள் குடியிருப்பு “குடி” என்று அழைக்கப்படுகிறது. அடித்தளமற்ற, எளிய குடிசையின் சுவர்கள் மூங்கில்களால் அமைக்கப்பட்டு, மண் குழைத்துப் பூசப்படும், புல்லால் கூரை வேயப்படும் இருக்கும்.

தொழில்

இவர்கள் உணவு தேடுவது, சேகரிப்பது, காட்டு வேலை, தோட்ட வேலை, சிறு விவசாயக் கூலி வேலை போன்றவற்றில் ஈடுபடுவார்கள். அம்பையும் வில்லையும் பயன்படுத்தி காட்டில் உள்ள ஆடுகளையும் கிளிகளையும் வேட்டையாடுகின்றனர். முறம் முடைதல் தொழிலையும் மேற்கொள்கின்றனர். தேன் சேகரிப்பது, காட்டில் வேட்டையாடுவது இவர்களுடைய முக்கியத் தொழிலாகும்.

திருமணமுறை

தங்கள் இனத்திற்குள் மட்டுமே திருமண உறவு முறை கொள்வதும், குழுவிற்குத் தலைவனை “மூப்பன்” என்றழைப்பதும் இவர்களது வழக்கம். மூப்பனே மதச்சடங்குகளை முன்னின்று நடத்தி வைப்பார். 1990களுக்கு முன்னர் குழந்தை திருமணங்கள் செய்து வந்தனர். ஆனால் தற்போது பெண்கள் பருவ வயதை அடைந்த பிறகு திருமணம் செய்கிறார்கள். காட்டு நாயக்கர் சமூகத்தினரிடையே ஒருதுணை மணம் என்பது பொதுவான விதியாகும்.

வழிபாட்டுமுறை

இவர்கள் மூதாதையர்களை வணங்குவதுடன், நிலவு, சூரியன், இந்துக்கடவுள்கள் சிலரையும் வணங்குகிறார்கள். தங்கள் குடியில் “தெய்வ மண்” என்ற என்ற ஓரிடத்தை வழிபாட்டிற்காக ஒதுக்குகிறார்கள். காட்டு நாயக்கர்கள் இந்து மதத்தைப் பின்பற்றுகின்றனர். கோத்திரத்தின் முக்கிய தெய்வங்களான சிவன், விஷ்ணு மற்றும் குலதெய்வமாக காளியம்மன், மாரியம்மன் மற்றும் பைரவர் முதலான கடவுளரை வழிபடுகின்றனர். இவர்களும் மற்ற இந்துக்களைப் போல விலங்குகள், பறவைகள், மரங்கள், பாறை மலைகள் மற்றும் பாம்புகளையும் வணங்குகிறார்கள்.

சொத்துரிமை

நாடோடிகளாக வாழ்வதால் சொத்துரிமை போன்றவை இவர்கள் வழக்கில்லை. மூப்பன் தலைவராகவும், அவரில்லாத பொழுது

அவரது இளைய சகோதரரும் தலைமைப் பொறுப்பை ஏற்கிறார்கள். இளைய சகோதரரும் இல்லாத பொழுது வாரிசரிமை மூப்பனின் மூத்த மகனுக்குப் போகிறது. இவர்களுடையது தந்தை வழிச்சமூக அமைப்பாகும்.

கல்வி

இருபது விழுக்காட்டினர் எழுதப்படிக்க தெரிந்தவர்களாக இருந்தாலும் பெரும்பாலோர், குறிப்பாக காட்டின் உட்பகுதியில் வசிப்பவர்களாக உள்ளனர்.

மொழி

இவர்கள் தமிழோடு தெலுங்கு மற்றும் கன்னடம் கலந்த மொழி பேசுகின்றனர். இவர்கள் ஓரிடத்திலும் நிலையாக இருப்பதில்லை. ஓரிடத்தில் தங்கி, அங்குள்ள பொருட்கள் தீர்ந்தால், கூட்டம் கூட்டமாய் இடம் பெயர்கின்றனர்.

உணவு

இவர்கள் தேனையும், காட்டுக்கிழங்குகளையும், காய்களையும், சிறு தானியங்களையும் உண்கின்றனர். இறைச்சியும் சாப்பிடுகின்றனர். இவர்கள் தங்கள் உணவாகக் விலங்குகள் மாமிசத்தை உண்கின்றனர். காட்டு நாயக்கர்கள் அசைவ உணவு உண்பவர்கள்.

உடை

இந்த சமூகத்தினர் கறுப்புத்தோல் உடையவர்களாகவும், ஆண்கள் சிறிய அளவில் வேட்டி மற்றும் அரை சட்டைகளை அணிவார்கள். பெண்கள் தங்கள் உடலை கழுத்துக்குக் கீழே ஒரு நீண்ட ஒற்றை துணியால் இணைத்து, தோள்களையும் கைகளையும் வெறுமனே விட்டு விடுகிறார்கள்.

பொழுதுபோக்கு

இசை, பாடல்கள் மற்றும் நடனம் ஆகியவற்றை விரும்புகிறார்கள்.

சேராப்பட்டு காட்டு நாயக்கர்களின் தற்கால வாழ்வியல்

சேராப்பட்டு ஊராட்சி ஒன்றியத்தில் காட்டு நாயக்கர்களில் ஐம்பது குடும்பங்கள் இங்கு வசிக்கின்றனர். மலைவாழ் மக்களினமான இவர்கள் மலைகளில் வசிப்பதைப் பெரிதும் விரும்புகின்றனர். இன்றைய வாழ்வியலுக்கேற்ப இயல்பான உடை, அணிகலன், உணவுமுறை, பழக்கவழக்கங்களை மேற்கொண்டு வாழ்கின்றனர். இங்குள்ள காட்டு நாயக்கர் சமுதாயம் இந்து மலையாளி, தொட்டி நாயக்கர், இந்து கவரா, வேத கால நாயக்கர் என்ற பெயர்களில் அழைக்கப்படுகின்றனர்.

பெயர்கள்

சின்னப்பொன்னு, ரங்கநாதன், வீரம்மாள், கண்ணன், சரோஜா போன்ற நவீன கால தமிழ்ப்பெயர்களைப் பயன்படுத்துகின்றனர்.

வழிபடும் தெய்வங்கள்

கரிய ராமர், சோலையம்மா, முனியப்பன், மாரியாயி, பெரியாயி, செங்கம், பச்சையம்மா, அங்காளப் பரமேஸ்வரி, திரௌபதி அம்மன் முதலான பெயர்களில் வழிபடும் தெய்வங்களை அழைக்கின்றனர். மாரியம்மன் திருவிழா, கரிய ராமர் திருவிழா முதலானவை மே, ஜீன் மாதங்களில் நடைபெறுகிறது.

திருமணமுறை

இவர்கள் வேறு சாதியில் திருமணம் செய்வது கிடையாது. இவர்கள் சமுதாயத்தில் விவாகரத்து அதிகம் கிடையாது. நூற்றுக்கு இரண்டு சதவீதம் மட்டுமே உள்ளது. திருமணத்தில் வரதட்சிணை வாங்கும் பழக்கம் கிடையாது. திருமணச்சடங்கின் போது தேங்காய் மூடி போல இருக்கும் பொட்டுத்தாலி போடும் வழக்கம் உள்ளது. திருமணத்தில் தாலி கட்டும் நேரத்தில் பெண் மாப்பிள்ளைக்கிடையே திரை போட்டு பெண் மாப்பிள்ளையின் கட்டை விரலை மிதித்துப் பிறகு தாலி கட்டச் செய்வார்கள். திருமண முறையில் முறை ஒப்புதல், நிச்சயம், வெற்றிலை தாம்புலம், புதுப்பட்டு முதலான வழக்கங்களைப்

பின்பற்றுகின்றனர். வீட்டு வாசலில் பந்தல் போட்டு தீருமணம் நடத்தப்படுகிறது. குடும்ப வாழ்வில் பெண்களுக்கு சம உரிமை கொடுக்கப்படுகிறது.

உணவு முறை

கம்பு, கேழ்வரகு, சோளம், சாமை, வரகு, ரெல், குச்சிக்கிழங்கு முதலான பயிர்கள் பயிரிடப்பட்டு உணவாக எடுத்துக்கொள்கின்றனர். இறைச்சியில் மாட்டிறைச்சியை உண்பதில்லை. பிற அசைவ உணவு வகைகளை விரும்பி உண்கின்றனர்.

தொழில் முறை

முக்கியத் தொழில் விவசாயம். மூங்கில் அறுத்து முறம் முடைதல், தாங்கர, பஞ்சாரம், விசிறி முதலான பொருட்களை செய்து மலைக்குக் கீழுள்ள கடைகளிலும், வீடுகள் தோறும் சென்று விற்பனை செய்கின்றனர். மொத்த வியாபாரமாகவும் விற்பனை செய்கின்றனர். மலைகளில் இறங்கி மூங்கில் வெட்ட வனத்துறை அதிகாரிகள் அனுமதி தருவது கிடையாது.

எதிர்கொள்ளும் பிரச்சினைகள்

காட்டு நாயக்கர் இன மக்கள் பட்டியலின பழங்குடியினராக இருந்தும் அதற்கான சாதிச்சான்றிதழ் அவர்களுக்குக் கிடைக்கவில்லை. பிற பழங்குடியினருக்குக் கிடைக்கின்ற சலுகைகள் தங்களுக்குக் கிடைக்க வில்லை என்ற ஆதங்கம் அவர்களுக்கு உண்டு. நிலத்தை பயன்படுத்த வனத்துறை அதிகாரிகள் அனுமதி தருவது கிடையாது.

முடிவுரை

பன்னெடுங்காலமாக மலைகளில் வாழும் காட்டு நாயக்கர் சமுதாயம் தங்கள் வாழ்வியல் முறைகளை மலைகளின் வாழ்வாதாரத்தை வைத்தே அமைத்துள்ளனர். அவர்கள் சமுதாயத்தில் பொருளாதார அடிப்படையில் மதிப்பளிக்கப்படுகிறது. கல்வி நிலையில் உயர்ந்து வருகின்றனர். மேற்படிப்புக்கும் பிள்ளைகள் படிக்க அனுமதிக்கப்பட்டு

செல்கின்றனர். இவர்கள் சமூகத்தில் இறந்தால் எரிக்கப்படுவதில்லை. புதைக்கப்படுகின்றனர். பெண்களுக்கான சம உரிமை அவர்கள் சமூகத்தில் வழங்கப்படுகிறது. கை வைத்தியம், மூலிகை வைத்தியம், சிகிச்சை முறைக்குப் பயன்படுத்தப்படுகிறது. இவர்கள் மலைகளில் வாழ்வதையே பெரிதும் விரும்புகின்றனர். இவர்களுக்குப் பட்டியலின பழங்குடியினர் என்ற சாதீச்சான்றிதழ் கிடைக்கவில்லை என்ற ஆதங்கம் உள்ளது.

துணை நூற்பட்டியல்

1. மெக்கன்சி சுவடிகளில் தமிழகப் பழங்குடி மக்கள் ம.இராசேந்திரன்
2. தொல்குடி வேளிர் வேந்தர் ர.புங்குன்றன்
3. அடித்தள மக்கள் வரலாறு ஆ.சிவ சுப்பிரமணியன்

Archives and Libraries: An Index to Digital Humanities

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Abstract

The purpose of this article is to give importance in setting up and maintaining archives in educational institutions and its contribution to digital humanities. In this study, the authors insist on distinguished contributions by library professionals and their notable role as archivists in curating quality collection and building up knowledge repositories. Library and information science and digital humanities are the two sides of the coin that frames a rich collection of digital knowledge treasures of our nation. This study focuses on the initiative in maintaining archives in institutions that support extending its access to interdisciplinary research, teaching, learning and in academic progression. In specific, the systematic collection, evaluation, organization, preservation, implementation and customization of the resources and provision of online access hone and phenomenally impact the library collection. The article states about the best practices involved in seeking support through crowdsourcing. Knowing-how in instituting a sustainable digital archive for the community that would leverage access of century old literature and history in a jiffy and aid in research.

Keywords: Archives, Digitization, Crowdsourcing, Women's Christian College, College Magazine, Digital Exhibition

Introduction

Libraries are havens of idea, thought, knowledge, life and culture of the entire universe. It is indeed a great and a Holy place. In this busy world, we focus on providing access to digital resources and intangible resources for easy, multiple, 24x7 remote. We aim and concentrate towards building digital collections, e-books, e-journals and e-repositories. Certainly, these resources provide the right information to the right user at the right time instantly. It apparently fulfills the law of the library 'Save the time of the User'. The focus is being lost track moving towards modernity and sophistication by side lining the very heritage and the culture which had been built piece by piece for several decades in our nation. Hence, it is felt that the need for proposing this study on preserving and safeguarding the special moments, the history, the legacy of our century plus old institution by forming the special focus 'The Heritage Centre'. History of the Heritage Centre of Women's Christian College (WCC) records that the first seed of thought fell on the noble land of WCC when its 13th Principal Dr. Lilian I Jasper found an original photograph with the signature of Rabindranath Tagore in one of the hostel rooms. That was the light which set the radiance in instituting a special location in the premises. The search for knowledge thus began. The Heritage Centre of the campus rightly got its position inside the library of the college. The collective ideas of the creative and passionate people have put in to begin the journey.

Literature Review

Kanisorn Wongsrichanalai (2022) identified how archives, historical societies and libraries from the past and present help researchers, in order to travel back in time to their research era 230 years later, scholars visit research institutes, archives, and

libraries around the nation. Researchers are under more pressure as a result of this transition, and historical institutions are now considering what types of research support they can provide. And also, he concluded that historical organisations, research institutions, and libraries are more crucial than ever because they keep bridging geography, the academic and popular worlds, and the past, present, and future.

Shiri Ali & Villanueva Emily (2021) has focused on digital heritage archive, he used to analyse Tefko Saracevic's digital library evaluation framework empirical studies in order to find models, frameworks and procedures in the literature and classify previous evaluative methods. They intend to create a set of suggestions for the future assessment of cultural heritage digital libraries and archives through the classification and critique of evaluative types and trends.

Objectives of the Study

- To collect and organize century old institution's resources, tradition and culture
- To provide access to historical evidences and literature to the society
- To serve as repository for humanities-based digital collections
- To contribute to digital archiving and digital humanities projects through libraries

Collection development

The pursuit of collection development began within the library and to choose the resources, material, maps, books, photographs, magazines that reflects the tradition and history of the campus.

Support of every department in the campus was sought after. The thrill and joy of identifying old items and resources as a new entry into the Heritage Centre is a never stopping quench thereafter. Books, photographs, maps, manuscripts, apparatus, letters, lamp, paintings, cutleries, glass and ceramic large jars, rare books, and the college magazines etc. have been identified and placed rightly in the Heritage room with a proper tagging. In tune with the print records and tangible items, non-book materials like CD-ROMs of digital collections of the College Magazine and the 17th Century Johnson Samuel's Dictionary have crowned the collection. The heritage Centre not only supports the internal faculty members but also the alumna who search for information, authors who look for points to be added on to their upcoming books, the researchers to collect the documented ideas have seemingly increased. The Heritage Centre also has a specific collection of books authored by WCC alumna, faculty and students and safeguarded in the Author's Corner of the room.

Serving the purpose

The visits to the heritage room by many externals, alumnae, faculty and students have spread many notable historical and worthy facts to add on. Finding archival information about the buildings, thoughts, documents, and people from the Heritage Centre's collection has lifted the importance of the library further. The heritage centre not only supports the internal faculty members but also the alumna who search for information, authors who look for points to be added on to their upcoming books, the researchers to collect the documented ideas have seemingly increased. To name a few the heritage collection of college's old magazines helped in finding information about the notable alumnae Dr. EK Janaki Ammal, a pioneering botanist and cytogeneticist and Ms Anna

Mani, an Indian physicist and meteorologist. The rich tradition and culture of the century old college is well preserved and further cascaded to the society. It is certainly a boon to the library portal as a gatekeeper of traditional humanities work in and in establishing literary canons.

Historical documents - the index to digital humanities

Alex H Poole (2017) discusses in his work “A greatly unexplored area”: Digital curation and innovation in digital humanities that digital curation encourages reuse of digital data, provokes new research questions, and aids in wider reachability. Digital curation, the process of managing a trusted body of information for current and future use, helps maximize the value of research in digital humanities. In WCC, the college magazine ‘Sunflower’ an annual publication is collected and preserved from the year 1915. The right attempt is made by digitizing the contents using Java CDS/ISIS. The documents are classified into two groups, Sunflower (full-text) and Sunflower Index. The digitized contents and the service are utilized very well using the CDS/ISIS database access made available as part of the library service. 17th Century Samuel Johnson’s Dictionary was also digitized by experts of Roja Muthiah Library and the same was funded by the alumnae of the college. The original dictionary is well preserved using traditional organic pest control methods. It is truly the reflection of a techno-social or techno-cultural interface to connect the dots. The rare photographs, books and manuscripts are carefully segregated, cleaned through fumigation, subjected to the deacidification process of restoration. Indexing and digitizing the rare photographs are in continual process.

Nostalgic excerpts from Sunflower

“As is usual with him he sat down and addressed his eager audience in words which we hope will never be forgotten by anyone who was present there. He said that his travels in the country had shown him the great advance made in female education, especially in Bengal and Travancore, the latter of which had been a perfect eye-opener to him. The problem now was what to do with these modern girls. He then pointed out to us that the education we get does not correspond with the life around us, is not of the villages, but of the cities. The real India was not seen in her few cities but in her thousands of villages. The question was whether we, the educated, had any message for our illiterate sisters. Unless women worked side by side with men there could be no salvation for India either economically, politically or spiritually...”
Reminiscences from Sunflower 1947: Time was fleeting by, and the fifteenth of August dawned—the long awaited day of India’s Political Freedom. The students played their part as they ushered in that great day with national songs of the Tamil poets, followed by a special service of dedication in the Chapel, and the hoisting of the tricolour flag over the Science Building.

Discussion and Conclusion

According to Michel Foucault (1969) the archive is not a place where history is found and historical knowledge is preserved, but a lot more and exactly the opposite. The best practices followed at WCC are identifying alumna, visitors, faculty and students who would support in collection development by their valuable contributions in terms of funding or sending across artefacts. It is ensured that every significant visitor of the college is accompanied by the Head of the Institution to the archives. Their valuable feedback is collected. This has paved a great source of

crowdsourcing in terms of idea generation, funding, contribution of artefacts, sharing of digital pictures of others who are/were associated with the college leading to a sustainable digital archive. The students who work as volunteers in the library are given the opportunity to learn about the way the archive is maintained. The volunteers are also trained to classify, index and digitize the documents.

Svensson (2009) suggests that this is highly essential in a discipline which sees one of its main features in curating and making knowledge accessible through archival work on the internet, as it is the case in the digital humanities according to many of the practitioners in the field. In this context, the future plan is to link the archive's digital index to the college's website and to create a digital exhibition of the artefacts available for a wider reach. So that it helps transcend obstacles to accessibility of factual information to the researchers. It is certainly essential that documentation is vital to historical processes and their sustenance is vital in social development. The authors leave this forum open, specifically to the young library professionals to explore in collecting artefacts and to set up archives in their libraries. Hence, it is essential to initiate establishing archives that can accommodate the new modes of publishing and knowledge production that are arising through digital humanities.

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Research and Innovation in Science and Technology



Odd Gracefulness of Cycle With Coconut Trees

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Abstract

A tree is a connected acyclic graph. An odd graceful labeling [3] is an injection f from $V(G)$ to $\{0, 1, 2, \dots, (2q-1)\}$ such that when each edge xy is assigned the label or weight $|f(x)-f(y)|$, the resulting edge labels are $\{1, 3, 5, \dots, (2q-1)\}$. In this paper, the odd gracefulness of cycle with coconut trees is proved to be odd graceful.

Keywords: *Odd Graceful Labeling, tree, coconut trees.*

Introduction

Gnanajothi (1991) introduced the odd graceful labelling and has shown a variety of graphs as odd graceful. These include paths P_n , even cycles C_n , complete bipartite graphs $K_{m,n}$, combs $P_n \odot K_1$ (graphs obtained by joining a single pendant edge to each vertex of P_n), books $B_m = S_m \times P_2$, the disjoint union of copies of C_4 , crowns $C_n \odot K_1$ (graphs obtained by joining a single pendant edge to each vertex of C_n), if and only if n is even. Gnanajothi (1991) has conjectured that all trees are odd graceful and has proved the conjecture for all trees with order upto 10. Graphs such as lobster (a tree in which the removal of all one degree vertices results in a caterpillar), banana tree (a tree obtained by

connecting a vertex v to one leaf of each of any number of stars, where v is not in any of the stars), regular bamboo tree (a rooted tree consisting of branches of equal length, the end points of which are identified with end points of stars of equal size) were proved to be odd graceful by Sekar [2002]. Seoud, Diab and Elsakhawi [1998] have established that a connected complete r -partite graph is odd graceful if and only if $r = 2$ and that the join of any two connected graphs is not odd graceful. Comprehensive results on odd graceful labeling can be fetched from the dynamic survey on graph labeling by Gallian (2015).

Cycle with coconut trees

The coconut tree $CT(r,n)$ (Gallian J.A.,2015) is the graph obtained from a path P_n by appending r pendant edges at one end vertex of P_n . The other end vertex of P_n is called the root of the coconut tree and it is denoted by c_n . The vertices of the path P_n in $CT(r,n)$ are denoted by $c_1, c_2, c_3, \dots, c_n$ and the pendant vertices of the appended r pendant edges in $CT(r,n)$ are denoted as $t_1, t_2, t_3, t_4, \dots, t_r$.

The cycle with coconut tree is obtained as the rooted product graph G_{CO} , by identifying the root c_n of the coconut tree $CT(r, n)$ with each vertex of the cycle C_d . The graph $G_{CO} = C_d \circ CT(r, n)$ when $d \equiv 0 \pmod{4}$ is proved to be odd graceful.

Theorem

The graph G_{CO} , the cycle with coconut tree is odd graceful, when the length of the cycle is a multiple of four.

Proof:

Let $CT(r,n)$ be the coconut tree with root vertex c_n . Let C_d be the cycle on d vertices with $d \equiv 0 \pmod{4}$. Let $CT^1, CT^2, CT^3, \dots, CT^d$ be d copies of the coconut tree $CT(r,n)$ with root vertices as $c_n^1, c_n^2, c_n^3, \dots, c_n^d$ respectively. These root vertices are identified with the vertices of the cycle C_d to obtain the rooted product graph G_{CO} . In the graph G_{CO} , the pendant vertices are denoted as t_j^k and the internal vertices are denoted by c_i^k for $1 \leq k \leq d$, $1 \leq j \leq r$, $1 \leq i \leq n$. The graph G_{CO} has p vertices and q edges where $p=q=d(n+r)$.

The vertices of G_{CO} are labeled based on the parameter n as follows.

Case 1: When n is even

Define

$$f(c_{2i-1}^{2k-1}) = 2i - 2 + 2(k-1)(n+r),$$

$$\text{for } 1 \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq \left(\frac{n}{2}\right)$$

$$f(c_{2i}^{2k-1}) = \begin{cases} 2q - 2r - 2i - 2(k-1)(n+r) + 1, \\ \text{for } 1 \leq k \leq \left(\frac{d}{4}\right), \quad 1 \leq i \leq \left(\frac{n}{2}\right) \\ \square \\ 2q - 2r - 2i - 2(k-1)(n+r) - 1, \\ \text{for } \left(\frac{d}{4} + 1\right) \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq \left(\frac{n}{2}\right) \end{cases}$$

$$f(c_{2i-1}^{2k}) = \begin{cases} 2q - 1 - 2(r+n-1) + (2i-2) - 2(k-1)(n+r), \\ \text{for } 1 \leq k \leq \left(\frac{d}{4}\right), \quad 1 \leq i \leq \left(\frac{n}{2}\right) \\ \square \\ 2q - 3 - 2(r+n-1) + (2i-2) - 2(k-1)(n+r), \\ \text{for } \left(\frac{d}{4} + 1\right) \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq \left(\frac{n}{2}\right) \end{cases}$$

$$f(c_{2i}^{2k}) = (2n-2) - (2i-2) + 2(k-1)(n+r),$$

$$\text{for } 1 \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq \left(\frac{n}{2}\right)$$

$$f(t_j^{2k-1}) = \begin{cases} 2q - 1 - (2j - 2) - 2(k - 1)(n + r), \\ \quad \text{for } 1 \leq k \leq \left(\frac{d}{4}\right), \quad 1 \leq j \leq r \\ \quad \square \\ 2q - 3 - (2j - 2) - 2(k - 1)(n + r), \\ \quad \text{for } \left(\frac{d}{4} + 1\right) \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq j \leq r \end{cases}$$

$$f(t_j^{2k}) = 2n + (2j - 2) + 2(k - 1)(n + r),$$

$$\text{for } 1 \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq j \leq r$$

Case 2: When n is odd

Define

$$f(c_{2i-1}^{2k-1}) = 2i - 2 + 2(k - 1)(n + r),$$

$$\text{for } 1 \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq \left(\frac{n+1}{2}\right)$$

$$f(c_{2i}^{2k-1}) = \begin{cases} 2q - 2r - (2i - 2) - 2(k - 1)(n + r) - 1, \\ \quad \text{for } 1 \leq k \leq \left(\frac{d}{4}\right), \quad 1 \leq i \leq \left(\frac{n-1}{2}\right) \\ \quad \square \\ 2q - 2r - 2i - 2(k - 1)(n + r) - 1, \\ \quad \text{for } \left(\frac{d}{4} + 1\right) \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq \left(\frac{n-1}{2}\right) \end{cases}$$

$$f(c_{2i-1}^{2k}) = \begin{cases} 2q - 1 - 2(r + n - 1) + (2i - 2) - 2(k - 1)(n + r), \\ \quad \text{for } 1 \leq k \leq \left(\frac{d}{4}\right), \quad 1 \leq i \leq \left(\frac{n-1}{2}\right) \\ \quad \square \\ 2q - 3 - 2(r + n - 1) + (2i - 2) - 2(k - 1)(n + r), \\ \quad \text{for } \left(\frac{d}{4} + 1\right) \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq \left(\frac{n+1}{2}\right) \end{cases}$$

$$f(c_{2i}^{2k}) = (2n - 2) - (2i - 2) + 2(k - 1)(n + r),$$

$$\text{for } 1 \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq \left(\frac{n-1}{2}\right)$$

$$f(t_j^{2k}) = 2n + (2j - 2) + 2(k - 1)(n + r),$$

$$\text{for } 1 \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq i \leq r$$

$$f(t_j^{2k-1}) = \begin{cases} 2q - 1 - (2j - 2) - 2(k - 1)(n + r), \\ \quad \text{for } 1 \leq k \leq \left(\frac{d}{4}\right), \quad 1 \leq j \leq r \\ \quad \square \\ 2q - 3 - (2j - 2) - 2(k - 1)(n + r), \\ \quad \text{for } \left(\frac{d}{4} + 1\right) \leq k \leq \left(\frac{d}{2}\right), \quad 1 \leq j \leq r \end{cases}$$

It is observed from the above equations that the vertex labels are distinct. The edges labels can be computed and are found to be odd and distinct. Thus, the cycle with coconut trees has been proved to be odd graceful.

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Some Graphs on Edge Even Graceful Labeling

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Abstract

In 2017, Elsonbaty and Daoud introduced the concept of edge even graceful labeling. A graph G with p vertices and q edges is called edge even graceful, if there is a bijection f from $E(G)$ to $\{2, 4, \dots, 2q\}$ such that the induced map f^ from $V(G)$ to $\{0, 2, 4, \dots, 2k - 2\}$ given by $f^*(u) = (\sum_{uv \in E(G)} f(uv)) \bmod(2k)$ is an injection, where $k = \max(p, q)$. In this paper, we prove that generalized friendship graph and torch graph admit edge even graceful labeling.*

Keywords: Edge-even graceful labeling, generalized friendship graph, torch graph.

2020 Mathematics Subject classification: 05C78

Introduction

Graph labeling is the assignment of integers, to vertices or edges or both under certain conditions. It has a wide application in the areas of coding theory, astronomy, radar, x-ray crystallography and so on (Gallian, 2022). Let G be a graph with p vertices and q edges. The first graph labeling of G called as the β - valuation was introduced by Rosa (Rosa, 1967). It is the injection $f : V(G) \rightarrow \{0, 1, 2, \dots, q\}$ such that when each edge $e = uv$ is assigned to the label $|f(u) - f(v)|$, the resulting edge labels are distinct.

Later, Solomon. W. Golomb (Golomb, 1972) called it as graceful labeling.

In 1985, Lo (Lo, 1985) introduced edge graceful labeling. A graph G is said to be edge graceful, if there exist a bijection $f : E(G) \rightarrow \{1, 2, \dots, q\}$ such that the induced map $f^* (u) : V (G) \rightarrow \{0, 1, 2, \dots, p - 1\}$ given by $f^* (u) = (\sum_{(uv) \in E(G)} f(uv)) \bmod (p)$ is a bijection. Edge even graceful labeling was introduced by Elsonbaty and Daoud (Elsonbaty et al., 2017), which is a bijection $f : E(G) \rightarrow \{2, 4, \dots, 2q\}$ such that the induced map $f^* : V (G) \rightarrow \{0, 2, 4, \dots, 2k - 2\}$, where $k = \max(p, q)$ given by $f^* (u) = (\sum_{(uv) \in E(G)} f(uv)) \bmod (2k)$ is an injection.

Daoud and Elsayw (Daoud et al., 2019), proved that double fan graph ($F_{2,n}$), quadrilateral friendship graph (Fr_n^4) and butterfly graph (B_n) admit edge even graceful labeling. Daoud and Saleh (Daoud et al., 2020), proved that torus grid graph ($T_{p,q}$) is an edge even graceful graph. Mohamed et al. (Mohamed et al., 2020), proved that join of two graphs such as $K_1 + W_n$, $K_1 + sf_n$, $\overline{K}_2 + K_{1,n}$, $\overline{K}_2 + W_n$, $\overline{K}_2 + C_n$ are edge even graceful. In 2021, Jayantara et al have shown that corona of graphs $P_2 \odot P_n$, $(S_n \odot K_1) - v_0$ are edge even graceful (Jayantara et al., 2021). In this paper, we prove that generalized friendship graph and torch graph admit edge even graceful labeling.

Generalized Friendship Graph

Generalized friendship graph ($F_{m,n}$) is defined as a collection of n cycles C_m with a common vertex. The vertices and edges of generalized friendship graph ($F_{m,n}$) are defined as follows, $V(F_{m,n}) = \{v_0, v_i^j ; 1 \leq i \leq m - 1, 1 \leq j \leq n\}$, $E(F_{m,n}) = \{v_0 v_{m-1}^j, v_0 v_1^j, v_i^j v_{i+1}^j ; 1 \leq i \leq m - 2, 1 \leq j \leq n\}$ (Ikhsanul et al., 2021),

Theorem 2.1

For $n \geq 1$ & $m \geq 3$ where n, m are odd, then generalized friendship graph $(F_{m,n})$ is an edge even graceful graph.

Proof:

Let G be a generalized friendship graph $F_{(m,n)}$ and let the apex vertex of $F_{(m,n)}$ be v_0 . We denote the vertices of the first copy of the cycle C_m by $v_1^1, v_2^1, v_3^1, \dots, v_{(m-2)}^1, v_{(m-1)}^1$, the vertices of the second copy of the cycle C_m by $v_1^2, v_2^2, v_3^2, \dots, v_{m-2}^2, v_{m-1}^2$ and the vertices of the n th copy of the cycle C_m by $v_1^n, v_2^n, v_3^n, \dots, v_{m-2}^n, v_{m-1}^n$. The number of vertices and edges of a graph G be $p = |V(G)| = mn - n + 1$ and $q = |E(G)| = mn$ respectively and $k = \max(p, q) = mn$.

We define the mapping $f: E(F_{m,n}) \rightarrow \{2, 4, \dots, 4n + 6\}$ as follows:

$$\begin{aligned}
 f(v_0 v_1^j) &= (2j - 1)m + 1 \quad ; 1 \leq j \leq n \\
 f(v_0 v_{m-1}^j) &= \begin{cases} (2j + 1)m - 1 & ; 1 \leq j \leq n - 1 \\ m - 1 & ; j = n \end{cases} \\
 f(v_i^j v_{i+1}^j) &= \begin{cases} (2j - 1)m + 2i + 1 & ; 1 \leq i \leq m - 2, 1 \leq j \leq n - 1 \\ (2j - 1)m + 2i + 1 & ; 1 \leq i \leq \frac{m-1}{2}, j = n \\ 2i - m + 1 & ; \frac{m+1}{2} \leq i \leq m - 2, j = n \end{cases} \quad (3.1)
 \end{aligned}$$

Then the induced vertex labels of $F_{m,n}$ are,

$$\begin{aligned}
 f^*(v_0) &= (2n^2 m) \pmod{2k} \\
 f^*(v_i^j) &= ((4j - 2)m + 4i) \pmod{2k}; 1 \leq i \leq m - 1, 1 \leq j \leq n \quad (3.2)
 \end{aligned}$$

It is clear that from equations 3.1 and 3.2 all the edge and vertex labels are distinct. Thus, the generalized friendship graph $F_{m,n}$ is an edge even graceful graph.

Torch Graph

The torch graph is O_n is defined by the vertex set $V(O_n) = \{v_i \mid 1 \leq i \leq n+4\}$ and the edge set $E(O_n) = \{v_i v_{n+1} \mid 2 \leq i \leq n-2\} \cup \{v_i v_{n+3} \mid 2 \leq i \leq n-2\} \cup \{v_1 v_i \mid n \leq i \leq n+4\} \cup \{v_{n-1} v_n, v_n v_{n+2}, v_n v_{n+4}, v_{n+1} v_{n+3}\}$ (Jona et al., 2018).

Theorem 3.1

The torch graph O_n is an edge even graceful graph when n is odd.

Proof:

Let G be a torch graph O_n for $(n \geq 5)$. The number of vertices of O_n is $p = n+4$ and the number of edges of O_n is $q = 2n+3$. It is clear that from equations 3.3 and 3.4 all the edge and vertex labels are distinct. Thus, the torch graph O_n is an edge even graceful graph when n is odd.

We define the mapping $f: E(O_n) \rightarrow \{2, 4, \dots, 4n+6\}$ as follows:

$$\begin{aligned}
 f(v_{n-1}v_n) &= 2 \\
 f(v_1v_{n+4}) &= 4 \\
 f(v_1v_{n+3}) &= 6 \\
 f(v_nv_{n+4}) &= 2q \\
 f(v_1v_n) &= 2q - 2 \\
 f(v_nv_{n+2}) &= 2q - 4 \\
 f(v_{n+1}v_{n+3}) &= 2q - 6 \\
 f(v_1v_{n+1}) &= 2q - 8 \\
 f(v_1v_{n+2}) &= 2q - 10 \\
 f(v_iv_{n+1}) &= 4i + 2 \quad \text{for } 2 \leq i \leq n-2 \\
 f(v_iv_{n+3}) &= 4i \quad \text{for } 2 \leq i \leq n-2
 \end{aligned} \tag{3.3}$$

Then the induced vertex labels of \mathcal{O}_n are,

$$\begin{aligned}
 f^*(v_{n-1}) &= 2 \\
 f^*(v_{n+4}) &= 4 \\
 f^*(v_n) &= 4n + 2 \\
 f^*(v_{n+2}) &= 4n - 8 \\
 f^*(v_1) &= 4n - 4 \\
 f^*(v_{n+3}) &= n + 15 \\
 f^*(v_{n+1}) &= 3n - 5 \\
 f^*(v_i) &= 8i + 2 \text{ for } 2 \leq i \leq \lfloor \frac{n}{2} \rfloor \\
 f^*(v_i) &= (8i + 2)(\text{mod } 2k) \text{ for } \lfloor \frac{n}{2} \rfloor + 1 \leq i \leq n - 2
 \end{aligned} \tag{3.4}$$

Conclusion

In this paper, we have proved that the generalized friendship graph and torch graph admit edge even graceful labeling. Further we intend to prove that split graphs are edge even graceful.

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Is Artificial Intelligence Eliminating the Exploitation of Auto Fare?

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Abstract

Day-to-day tasks are easily manageable by computers and it is playing a vital role in every field. No business is run without computers. Nowadays computers are primarily used for automation, and transaction of processes and they are faster and more accurate. People use computers to analyse their investments, profit, control their sales, and many other aspects of their business. The simulation of human intelligence processed by machines, especially by computers, is called Artificial Intelligence. Human intelligence based on each activity is processed as an individual or a combined activity by computers through artificial intelligence. This reduces time, gives more accuracy, reduces manpower, etc. In business, a revolution happened through artificial intelligence and we can now buy and sell books online. Through online markets such as Amazon and Flipkart, we can purchase several thousand materials online. In India, auto is commonly used as a rental transport for a short distance. The public hires autos for their local traveling. The auto fare is not fixed and drivers exploit the users by collecting the fares in an unfair manner.

Nowadays most of the autos are run by companies such as OLA & Uber and are connected through artificial intelligence. The fare is uniform and very fair to everyone alike. In this study, we looked at how artificial intelligence eliminates the exploitation of auto drivers while collecting fares and the ways in which uniform fares are implemented for all.

Keywords: *Artificial intelligence, OLA, Uber, Fare, Price*

Introduction

The transport sector is essential for all people. There is a general need for people to use transport to go to schools, colleges, offices, shops, tourist places, etc. After the revolution of digitalization, transportation booking has become a much easier task. Previously many middle-class people used public transport mostly because of unfair fares and exploitation by private cab drivers. When Ola and Uber (Rental service providers) entered the market, they connected all taxis and provided quick and best rental service for people through artificial intelligence. If a person wants to book a taxi, through the app he can book a taxi on the spot and get uniform fares. There is no bargaining on the fares.

In this study, we have collected the opinions of a few Ola customers in Chennai

Origin of OLA

Ola is India's first cab aggregator company which makes it easy to hire a cab. ANI Technologies PVT. LTD owns the company. Ola was founded by Bhavish Aggarwal and Ankit Bhati in 2010. One day Bhavish had taken a rental cab to go to Bandipore from Bangalore with agreed fares. In the middle of the trip, the driver stopped the cab and demanded huge extra money despite the

agreement previously made. Bhavish got disappointed and tried to convince the driver to collect the agreed fares. But the cab driver could not be persuaded and refused to move further. Bhavish was not willing to pay the extra money and he cancelled the trip then and there. He returned back to Bangalore by another cab. This incident induced Bhavish to start a rental cab service and he started a company in the name of Ola.

Review of Literature

Amitachaurasia (2019) identified the cheaper price, safety, easy booking, and punctuality as the reasons to choose Ola and Uber. Senthilvel Murugan et.al (2019) investigated in their study on why people choose app-based taxis. They found that people prefer the price, comfort, and safety measures taken in these apps as fair and better than the others. Ashisavinash Khadee. al (2018) found the motivational factors for choosing app-based taxis are Price, Safety, Comfort, Quality of service, and Convenience of seeking taxis. Rupali Rajesh (2021) investigates the reasons for choosing Apps based on taxis. The findings indicated that Ola and Uber services are more convenient and faster, and provide good cab services at a very effective cost.

Objectives of the study

1. To find why people choose App based cabs (artificial intelligence)
2. To find out the problems which the people faced
3. To give suggestions in order to improve the app-based cabs

Research Methodology

In this study, we have used a convenient sampling method and the sample size is 100. Two types of data are used in the study 1. Primary data 2. Secondary data.

Primary Data is collected through a structured questionnaire. The study is conducted along with Ola customers in the Chennai area. Based on the collected data, we analysed the data and interpreted the results.

Reasons for choosing app-based cabs

REASONS CHOOSING BASED CAB ^a		Responses		Percent of Cases
		N	Percent	
	FORLOWER PRICE	50	50.0%	100.0%
	APPNO BARGAINING	25	25.0%	50.0%
	EASYACCESS	5	5.0%	10.0%
	TIME	5	5.0%	10.0%
	CONVENIENT	5	5.0%	10.0%
	CUSTOMER SERVICE	5	5.0%	10.0%
	WIDE AVAILABILITY OF RIDES	5	5.0%	10.0%
Total		100	100.0%	200.0%

a. Dichotomy group tabulated at value 1.

Descriptive Statistics			
Reasons for choosing App based cab	Mean	Std. Deviation	N
LOWERPRICE	.50	.503	100
NO BARGAINING	.25	.435	100
EASYACCESS	.0500	.21904	100
TIME	.0500	.21904	100
CONVENIENT	.0500	.21904	100
CUSTOMER SERVICE	.0500	.21904	100
WIDE AVAILABILITY OF RIDES	.0500	.21904	100

Source: Primary data

According to this table, 50% of respondents say that they are choosing app-based cab for the Lower price 25% of the respondents say that they choose app-based cabs for no bargaining

and 10% of respondents report that they choose App based cabs for easy access, time, convenience, customer service and wide availability of rides.

Problems faced by the customers

PROBLEMS FACED BY CUSTOMERS ^a	DRIVERS CHARGES THE EXTRA MONEY	TIME TAKEN TO FIND THE CAB IN PEAKHOURS	RAINY SEASON CABS ARE NOT AVAILABLE	SOMETIMES DRIVERS ASK CUSTOMERS TO CANCEL	Responses		Percent of Cases
					N	Percent	
					7	7.0%	12.1%
					30	30.0%	51.7%
					58	58.0%	100.0%
					5	5.0%	8.6%
Total					100	100.0%	172.4%

a. Dichotomy group tabulated at value 1.

PROBLEMS	MEAN	N	STD.DEVIATION	VARIANCE
Drivers charge extra money	.7	100	.256	.066
Time taken to find the cab in peak hours	.30	100	.461	.212
Rainy season cabs are not available	.58	100	.496	.246
Sometimes drivers ask customers to cancel	.05	100	.219	.048

According to this table, 58% of respondents report that in the rainy season, cabs are usually not available. 7% of customers say that drivers charge extra money. 30% of customers say in peak hours, booking cabs is more time-consuming. 5% of customers say that sometimes drivers ask customers to cancel the ride because of the fine that might be charged for them later in such cases.

Findings of the study

According to this study, we have found the following findings based on the data

1. 50% of people choose Ola because of its lower price. This is because the booking has been done through an artificially intelligent app and the fares are fixed based on the input data. Drivers or other people cannot fix the fares as they wish.
2. 25 % of people choose Ola since there is no bargaining. People generally get irritated when the drivers bargain and tend to avoid using taxis as a result of the same.
3. 10% of respondents say that they choose App based cabs for easy access. By using artificial intelligence, we can send the exact location and the driver will reach the location without any difficulty.
4. 10% of respondents say that they choose App based cabs for convenience's sake. Based on our time convenience, we can book a cab by using an app. The app will book the ride from any one of the nearest cabs.
5. 10% of respondents say that they choose app-based cabs for the wide availability of rides. People book the taxi based on the wide availability.
6. 58% of respondents say in the rainy season cabs are not available. During the rainy season, 58 % of people say that cabs are not available. During the rainy season, the cab drivers disconnect their services along with Ola and hence enable private cab services to collect extra money.
7. 7% of customers say that drivers charge extra money. Even though the booking is being done by app and the price is fixed, the drivers negotiate for extra money.
8. 30% of customers say that cab booking is more time-consuming during peak hours. Sometimes cab booking takes a lot of time and cabs tend to arrive late even after booking.

9. 5% of customers say that sometimes drivers ask customers to cancel the ride because of the fine.

Based on the study, we find that 50 % of people choose the app-based cabs due to the lower price and 25% of people for the feature of no bargaining. A total of 75% of cabs are booked with uniform fares. This study proves that the app developed by artificial intelligence eliminated the exploitation of auto fares. Using app-based cab booking ensures safety as well.

Suggestions

The following suggestions have been given based on the study

1. When it rains, cabs are not easily available. The cab drivers do not accept the app-based booked trip. Most of the cab drivers disconnect from Ola and will provide services like that of private cabs for extra money. Ola should have strict conditions that no one should cancel a trip during the rainy season without proper reason or disconnect from Ola service.
2. Sometimes Ola or Uber drivers charge extra money. If Ola takes strict disciplinary action against those drivers, the same will be avoided. If Ola can give incentives to genuine drivers, it will avoid such cases.
3. In peak hours, cabs are not available. Ola cabs should add more vehicles and it can be avoided.

If the above suggestions are implemented by Ola, the exploitation of auto fares will be eliminated fully by using artificial intelligence.

Conclusion

In this study, we have found why many people prefer app-based cabs and what problems they have faced while they use app-based cabs. Suggestions to solve the problems are provided.

If businesses are carried out in a selfish manner, they will not run for many years. Before the introduction of app-based cab booking, many auto drivers asked for large sums of money for each trip. Most people were affected and avoided private cab rentals to date. This affected the business of cab drivers. Own cab rental business is mostly closed. Nowadays most of the cabs have ties up with Ola and Uber and are getting their businesses run through these apps. If the drivers followed uniform justice fares, Ola and Uber might have not entered this business. If men do business in a genuine manner, their businesses will survive for several years and no one will be required to control their business.

Nowadays technology regulates people. Artificial Intelligence helps in most of our businesses and day-to-day life. In our study, it is proven that app-based booking developed by artificial intelligence eliminates the exploitation of auto fares and leads to financial equality among auto drivers, etc. By using artificial intelligence, we can reduce social inequality, financial inequality, and health inequality.

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Bismuth Vanadate: A material for efficient photocatalytic dye degradation

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Abstract

Pure and Lanthanum doped BiVO_4 were synthesized via chemical precipitation method by taking bismuth nitrate pentahydrate and ammonium metavanadate as precursors to investigate photocatalytic activity. The structural, optical and morphological studies on pure and rare earth doped bismuth vanadate were carried out using powder XRD, SEM analysis, EDAX, UV-Visible spectroscopy and FTIR spectroscopy. Structural analysis confirms the monoclinic phase of the pure material. From UV-Visible studies, the band gap energy was calculated and it was found to be less than pure BiVO_4 . SEM analysis confirms the spherical structure of the as-synthesized sample. As a result, the produced nanomaterials can be employed as a high-performing photocatalyst.

Keywords: *Bismuth Vanadate, dye degradation, SEM Analysis*

Introduction

Because of industrial revolution and urbanization, water pollution has been increasing exponentially and its effects

on humans and other living organisms are acute. Continuous contamination of water resources by the release of untreated effluents from factories, organic dyes from textile industries, and also contamination by infectious microorganisms have been a threat to the aquatic ecosystem. Organic dyes such as Rhodamine B (RhB), Methylene Blue (MB), Methyl Orange (MO) from textile factories and other industrial effluents contaminate the water bodies. These dyes have a slow degradation rate under a normal atmosphere and its presence in water bodies restricts penetration of sunlight into the water for a longer time period. This gives rise to decreased dissolved oxygen content because of lack of photosynthetic activity. Due to the continuous increase of threat of water contamination, various researches have been going on to resolve this problem. Specifically, photocatalytic technology has gained more attention due to its unique advantages. Thus Photocatalytic degradation of dyes got an important role in waste water management and other environmental problems [1]. Because of its utilization of solar energy as a driving force, photocatalysis is a green friendly, economical, clean and renewable wastewater treatment method.

Bismuth Vanadate is a semiconductor-based visible light-responsive photocatalytic material which is an alternative to UV-active TiO_2 [2]. From the sun, the earth's surface receives about 5% ultraviolet light and 45% visible light. BiVO_4 has an advantage of utilizing the entire region of visible light from the solar spectrum due to its narrow band gap energy. Doping the photocatalytic material will increase the efficiency of the photo-degradation rate of the organic dyes. BiVO_4 nanoparticles are employed for photocatalytic dye degradation because of their advantages like high surface-to-volume ratio, high diffusivity, high reactivity and low cost.

In this work, BiVO_4 nanoparticles were synthesized for the application of photocatalytic dye degradation. Bismuth vanadate occurs naturally in the form of the mineral pucherite which has orthorhombic crystal structure. Bismuth Vanadate has three polymorphs [3]. Out of the three polymorphs of BiVO_4 , monoclinic scheelite is found to be a more efficient photocatalyst as they can absorb both visible and UV light whereas the tetragonal structure of BiVO_4 is UV-light responsive.

Material synthesis

Precursors for the synthesis of pure BiVO_4 and lanthanum (0.02 mol %) doped BiVO_4 are bismuth nitrate pentahydrate [$\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$], ammonium metavanadate [NH_4VO_3] and lanthanum chloride heptahydrate [$\text{LaCl}_3 \cdot 7\text{H}_2\text{O}$]. Other materials include concentrated nitric acid [HNO_3], sodium hydroxide [NaOH] and ethanol.

Pure and lanthanum doped BiVO_4 were prepared via the coprecipitation method. Bismuth nitrate pentahydrate solution was prepared by dissolving 0.1M bismuth nitrate pentahydrate into 100 ml dilute HNO_3 . The solution is stirred for 30 minutes at 50°C . Similarly, ammonium vanadate NH_4VO_3 solution was prepared by dissolving NH_4VO_3 into 100 ml dilute HNO_3 . This solution is stirred for 30 minutes at 50°C using a magnetic stirrer for uniform mixing of the solution. Both bismuth nitrate pentahydrate solution and ammonium vanadate solutions were mixed together using a magnetic stirrer (Solution A). The initial pH of the solution was noted. Meanwhile, sodium hydroxide solution was prepared by dissolving NaOH pellets into 200 ml of water. This NaOH solution was added into solution A dropwise with constant stirring until the pH of the solution reaches 10. A yellow solution was obtained which will be made to precipitate overnight. Then the precipitate

was filtered and washed with distilled water and ethanol three times. After filtering, the wet BiVO_4 powder was made to dry in a hot air oven at 60°C . Later the BiVO_4 powder was sintered at 450°C for 3 hours. Then the powder was ground into a fine powder using a mortar and pestle. In a similar way, lanthanum doped BiVO_4 was prepared by the same mentioned steps except mixing 0.02mol% of lanthanum chloride heptahydrate into the solution A.

Results and Discussions

Powder XRD was carried out and the prominent peaks were indexed in the XRD pattern which matches well with the JCPDS card number [14-0688]. In the XRD pattern, (112) peak was found to be the highest intensity peak in both the samples. Using Scherrer's formula, the average crystallite size of Pure BiVO_4 and La (0.02mol %) doped BiVO_4 was found to be 23.1nm and 24.5nm. As dopant was introduced, the average crystallite size of the BiVO_4 was increased. The structures of both the samples were found to be monoclinic. The XRD patterns of both the samples were shown in figure 1.

Lattice Parameter	Pure BiVO_4	La (0.02 mol%)-doped BiVO_4
a (Å)	5.178	5.213
b (Å)	11.652	11.698
c (Å)	5.128	5.111

The morphology of pure BiVO_4 and La doped BiVO_4 nanoparticles were investigated by scanning electron microscope. The micrograph of both the samples prepared by co-precipitation showed the morphology to be spherical structure at 500 nm magnification. SEM analysis of pure BiVO_4 and La doped BiVO_4 showed spherical structures. From energy dispersive X-ray

spectrometer, elemental analysis was done for both the samples. The EDAX spectrum of pure BiVO_4 shows the presence of bismuth, oxygen, and vanadium was confirmed [4]. And in La (0.02mol %) doped BiVO_4 sample, the presence of corresponding elements - lanthanum, bismuth, vanadium and oxygen was confirmed. UV spectroscopic study was performed for both the samples and it is shown in figure 2. By plotting the Tauc plot, the band gap energy for pure BiVO_4 and La (0.02 mol %) doped BiVO_4 samples were found to be 1.73455eV and 1.68787 eV respectively. Energy band gap of nanoparticles depends on their crystalline structure. The arrived data agrees well with this fact i.e. as crystallite size of BiVO_4 increases with addition of dopant, its energy band gap decreases accordingly. FTIR was carried out in the wavelength range 400 – 1400 cm^{-1} for both pure and La doped BiVO_4 samples. This was used to identify the presence of various functional groups in the compound. The wave number of FTIR band vibration of the stretching bond of VO_4^- , Bi-O bond and V-O bond were recorded 468.36, 600.12 and 791.21 cm^{-1} respectively for pure BiVO_4 . For La (0.02mol %) doped BiVO_4 , The wave number of FTIR band vibration of stretching bond of VO_4^- , Bi-O bond and V-O bond were recorded 407.83, 583.13 and 778.04 cm^{-1} respectively. All these characterization studies confirm the formation of pure and La (0.02mol %) doped BiVO_4 samples.

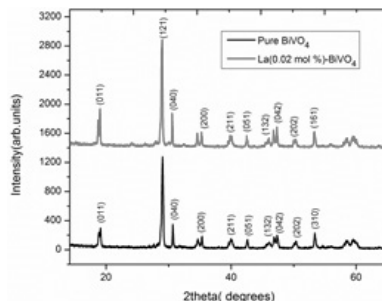


Figure 1 Stacked XRD pattern of pure BiVO_4 and La (0.02 mol %) doped BiVO_4 samples

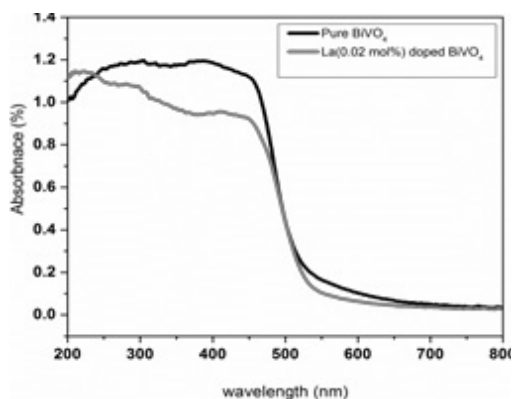


Figure 1 Stacked XRD pattern of pure BiVO_4 and La (0.02 mol %) doped BiVO_4 samples

Conclusion

Pure BiVO_4 and La (0.02mol %) doped BiVO_4 samples were synthesized by co-precipitation method. The X-ray diffraction pattern of pure and doped BiVO_4 samples were taken and monoclinic phase of the samples were confirmed according to Joint Committee Powder Diffraction Standard (JCPDS) file No. 14-0688 [3]. Their average crystallite size was calculated as 23.1 nm and 24.5 nm respectively using Scherrer's formula. The SEM analysis indicated the formation of spherical structures for both the samples at 500 nm magnification. The presence of Bi, La, V, O were confirmed from EDAX studies. From the UV-Visible analysis, the energy band gap of pure BiVO_4 and La (0.02 mol %) doped BiVO_4 samples were found to be 1.734eV and 1.687 eV respectively. FTIR spectra confirmed the functional groups present. As a part of the future work, the photocatalytic degradation test for pure BiVO_4 and La doped BiVO_4 samples will be performed and its effectiveness in the photocatalytic activity will be established.

Acknowledgement

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Exploring innovative strategies to engage students in Physics of music: A free software approach with Bandlab

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Abstract

This paper investigates the effectiveness of utilizing free software, specifically BandLab, to engage students in the Physics of Music. The Physics of Music is a fascinating and interdisciplinary subject that provides an opportunity for students to explore the fundamental principles of physics through the lens of music. Traditional teaching methods often struggle to capture students' attention and interest in this field. To address this challenge, the study proposes the integration of BandLab, a popular cloud-based digital audio workstation, as an innovative tool to enhance student engagement. BandLab allows students to create, edit, and manipulate musical compositions, providing a practical and interactive platform for exploring the underlying physics concepts in music. This paper highlights the potential of integrating technology and creative platforms in physics education, offering educators an innovative and effective means of capturing students' interest, and enhancing their understanding of fundamental physics concepts within the context of music. This paper suggests integrating BandLab into the physics of music instruction and discussing how it can be an effective tool for teaching Physics concepts in an engaging way.

Keywords: *digital audio workstation, bandLab, sound waves, acoustics, virtual instruments BandLab, free software, student engagement, active learning.*

Introduction

In recent years, the integration of technology into education has revolutionized traditional teaching methodologies, offering new avenues to enhance student engagement and foster deeper understanding of complex subjects. The field of physics education has witnessed a growing need for innovative approaches to captivate the interest of students and enable them to explore the intricate relationship between science and the world around them. One fascinating domain that intertwines physics and human creativity is the study of the physics of music. The physics of music encompasses a comprehensive understanding of how sound is produced, transmitted, and perceived, delving into the underlying principles that govern the behavior of musical instruments and the human auditory system. However, conveying these concepts in a way that captivates the attention of students and makes them active participants in their learning journey can be a challenging task for educators. Also, learning the properties of sound and its relation to musical instruments can be challenging for students due to the abstract nature of the subject matter and the difficulty in visualizing sound waves. The traditional methods of teaching, such as lectures and textbooks, can be dry and unengaging for students. As a result, students may struggle to grasp the key concepts of Physics, leading to poor performance and reduced interest in the subject. To address this challenge, this paper explores an innovative approach to engaging students in the captivating realm of the physics of music. The focus is on leveraging the potential of BandLab, a free and intuitive software platform, to facilitate interactive learning

experiences that bridge the gap between theoretical concepts and real-world applications.

The ability to visualize and control acoustic phenomena through an e-learning platform facilitates understanding of the relevant physical principles (Lennart Moheit et al., 2021). Odeon, SoundCheck, REW, and SignalScope are just a few examples of the many software and apps available for virtual augmentation on sound waves. One of the free softwares like Audacity can be used to introduce the basic waveforms for audiences from any educational background (Jaeger, 2017). Also, Audacity can be used for frequency and waveform analysis of different musical sounds and introduction of basic concepts (Pothiyodath, N., & Murkoth, U. K. (2022). While Audacity is a powerful audio editing and recording software, there are some limitations when it comes to using it as an educational tool on Physics of music due to its limited interactive features, lack of built-in lessons and tutorials and limited collaboration features. Also, Audacity's interface can be complicated, making it more challenging for beginners to learn the software and its features. In contrast, BandLab, a digital audio workstation (DAW) offers a more comprehensive set of features and interactive tools for students to learn about Physics of music in a more engaging and collaborative manner. By harnessing the software's capabilities, students can delve into the underlying physics principles, experiment with different musical instruments, analyze waveforms, and even compose their own musical pieces. This interactive approach not only promotes a deeper understanding of the physics of music but also fosters creativity and self-expression among students, allowing them to explore their musical inclinations in a scientific context.

Methods

BandLab is a free online music creation platform that provides users with a range of tools and features to create, edit, and collaborate. Below are some of the key features of BandLab that make it a useful tool for physics education.

Virtual Instruments: BandLab provides users with a range of virtual instruments that simulate real-life musical instruments. These virtual instruments include guitars, basses, drums, keyboards, and synthesizers (Fig 1). Students can use these instruments to create and manipulate sounds, experiment with different musical scales, and explore how these sounds relate to physics concepts such as frequency and resonance. Resonance occurs when an object vibrates at its natural frequency in response to an external stimulus. In music, resonance is what gives instruments their unique sound. By adjusting the settings of the virtual instruments, students can learn how different factors such as the length of a guitar string or the shape of a drum affect the resonance of an instrument. Harmonics are multiple frequencies that are produced by an object vibrating at a single frequency. In music, harmonics are what give notes their timbre or tone color. In BandLab, students can use the virtual instruments to create harmonics by adjusting the settings of the instruments. They can also experiment with different types of harmonics, such as overtones and partials, and learn how they contribute to the overall sound of a note.



Fig 1: Virtual Instruments at BandLab

Sound Editing Tools: BandLab also provides users with a range of sound editing tools that allow them to manipulate and modify sounds. These tools include equalizers, compressors, and reverbs (figure 2). Students can use these tools to analyze the waveform of a sound, understand how the properties of the wave correspond to musical elements such as melody and harmony, and explore how these properties relate to physics concepts such as amplitude and wavelength. With BandLab, students can explore these characteristics of soundwaves by visualizing and manipulating them in real-time. For example, students can adjust the frequency of a sound wave using BandLab's EQ (equalization) tools, or they can adjust the amplitude using volume and compression tools. Students can also explore the effects of phase relationships by manipulating the panning of different audio tracks, creating interesting stereo effects.



Fig. 2: Some of the sound editing options available at BandLab

Acoustic Environments: BandLab can be used as a tool to study acoustic environments by analyzing the sound waves captured by a microphone (figure 3). To achieve this, a user can record a sound clip in the space they intend to study, upload it to BandLab, and then analyze the clip using the platform’s built-in audio tools. One of the critical tools in BandLab that can be used to study acoustic environments is the equalizer. An equalizer is a device that adjusts the balance of different sound frequencies in an audio clip. By analyzing the sound waves captured in a space, a user can use the equalizer tool to identify any frequency imbalances that may be contributing to poor sound quality or high noise levels in a space. Another useful tool in BandLab that can be used to study acoustic environments is the compressor. A compressor is a device that reduces the dynamic range of an audio clip. By analyzing the sound waves captured in a space, a user can use the compressor tool to reduce the amplitude of loud sounds, thus reducing noise levels in each space. BandLab also has a reverb tool that can be used to simulate the acoustic properties of different spaces. By analyzing the sound waves captured in a space, a user

can use the reverb tool to simulate how the same sound clip would sound in a different acoustic environment. This tool can be useful in optimizing sound quality in different settings, such as music production, public address systems, and movie theaters.

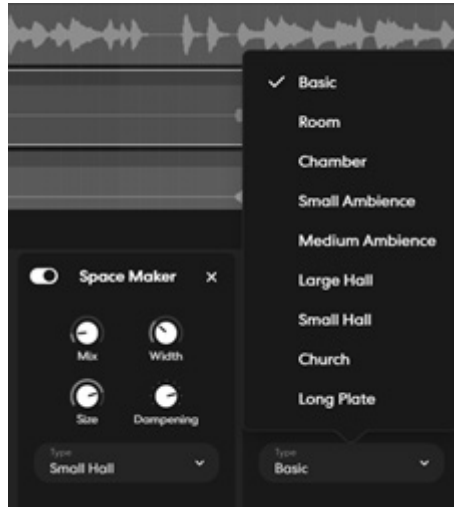


Fig. 3: The options for different acoustic environments available at BandLab

Collaboration and Accessibility: BandLab's collaboration features allow users to work together on audio projects in multiple tracks (figure 4), share ideas and resources, and provide feedback to each other. This makes it an excellent tool for collaborative learning in physics education, where students can work together to explore and discuss the physics of sound waves and acoustics, deepen their understanding of concepts, and develop their communication skills. BandLab is accessible from any device with an internet connection, making it an excellent tool for students who may not have access to traditional musical instruments or equipment. Additionally, BandLab's vast library of sounds and

virtual instruments makes it a valuable resource for students who want to explore musical acoustics in a fun and engaging way.

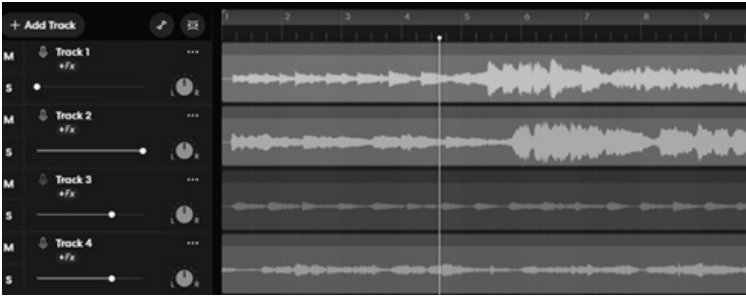


Fig.4: Multiple audio tracks recorded in Bandlab for collaboration

Strategies and Discussion

The methods and strategies for effectively engaging students in the Physics of Music using BandLab are discussed below.

Integration of BandLab into the Curriculum

A course on ‘The Physics of Music’ is designed to develop a scientific understanding of the relationship between music and sound, by exploring the properties of sound and its relation to musical instruments. The syllabus is framed for students with diverse musical backgrounds and technical expertise. The learners will examine the production of sound by a variety of musical instruments, how the resulting sound is propagated, and how it can be measured and analyzed. Additional topics include an analysis of musical scales, the physics and physiology of hearing, and the technology of sound reproduction. This course helps the learners to develop their practical skills in connection of the physics concepts to the musical instruments and how they reproduce

the mathematical nature of music. BandLab can be incorporated as a supplemental tool within this course to provide hands-on experience and reinforce theoretical concepts.

Interactive Experiments and Simulations

Students can be encouraged to conduct experiments and simulations using BandLab's virtual instruments and effects. For example, they can explore how changing the length of a string affects its pitch or how altering the reverb settings impact sound propagation. Through BandLab, simulations of the Doppler effect can be conducted to understand how sound intensity changes as a result of the relative motion between a sound source and an observer. By recording or importing sound clips representing moving sources, the effects and automation features in BandLab can be employed to simulate changes in frequency and intensity, replicating real-world scenarios. Students can investigate the concept of sound absorption and its role in acoustic environments. An audio can be recorded in different settings and can be analyzed for the differences in sound quality caused by various materials and their absorption properties. They can also experiment with different sound-absorbing materials like foam panels, curtains, or carpeting to understand how they affect the overall sound reflections and reverberations. Students can also experiment with different objects, such as tuning forks and record the resulting sounds. By analyzing these recordings, they can identify resonance frequencies and gain insights into how certain objects amplify specific frequencies and produce rich, resonant sounds. Also, they can be encouraged to experiment with microphone placement, distance, and gain settings to understand how these factors affect the quality and character of recorded sound. This hands-on approach encourages students to think critically about the physical properties of sound and how they can be manipulated artistically.

Exploration of Physics Concepts

BandLab's waveform analysis tools will enable the students to visualize and manipulate sound waveforms in real-time. This feature helps to enhance their ability to comprehend concepts related to pitch, frequency, amplitude, and harmonic content. The teachers can use the platform to record and analyze audio samples of different acoustic instruments, showing students how different waveforms correspond to different sounds. BandLab allows students to record their own acoustic instruments, such as guitars, pianos, or percussion, and analyze the recordings. They can use the editing and effects tools to explore how changing parameters like EQ, reverb, or compression can alter the sound of their instrument. This hands-on experience helps students to understand how different acoustic factors affect the final output. Furthermore, virtual instruments and synthesizers available in BandLab create sounds with varying intensities, allowing for the manipulation of sound parameters to study their influence on perceived loudness. BandLab offers features like pitch correction and tuning capabilities. Students can use these tools to improve the pitch accuracy of their recorded tracks. By visually inspecting the pitch correction applied to the recordings, they can gain insights into pitch deviations and work on improving pitch acuity. BandLab's built-in metronome helps the students to practice and develop a sense of rhythm. They can set the tempo, time signature, and customize the metronome sound to match their preferences. The BandLab community also offers a vast library of drum loops and patterns, covering various styles and genres. Studying these loops and experimenting with different rhythmic patterns can enhance their understanding of rhythm and its application

in music. This analysis can deepen the student's understanding of the waveform and its characteristics, contributing to a richer exploration of acoustics and sound in music.

Project-Based Learning

Students can be engaged in project-based learning activities that require them to apply their knowledge of physics and music to create original recording and mixing at different acoustic environments. Specific physics-related constraints can be assigned to challenge students creatively. For instance, they could be asked to design an instrument that exploits the principles of resonance. Students can be instructed to research and explore the technical aspects of MIDI, including MIDI controllers, MIDI interfaces, and MIDI mapping. Teachers can encourage them to explore different recording techniques, such as multi-track recording and overdubbing. The different types of microphones, their polar patterns, frequency response, and how to choose the right microphone for different recording scenarios can also be investigated. Teachers can facilitate a reflection session where students can evaluate their own learning experience, highlighting the connections they made between MIDI recording, and microphone usage. Students can be encouraged to discuss their creative choices, the techniques they employed, and the challenges they encountered during the project. In order to teach the musical perspectives, a flipped classroom environment can be created using Bandlab. This will help the students to access resources and activities outside of class and ready to discuss and apply their knowledge. They can be guided through various activities and collaborative projects, engaging them in conversations about how physics principles are applied in areas such as musical instrument design, audio engineering, or architectural acoustics which will lead to active learning.

Conclusion

Traditional classroom approaches to teaching ‘The Physics of music’ often rely on theoretical explanations and visual aids. However, leveraging technology tools such as BandLab offers students a unique opportunity to engage actively in the learning process, experiment with audio manipulation, and analyze sound waveforms in real-time. This study supports the use of BandLab as an effective tool for enhancing student learning in ‘Physics of music’. It demonstrates the platform’s ability to engage students, facilitate collaborative learning experiences, and foster conceptual understanding. Future research may explore the long-term impact of integrating BandLab into formal curricula and assess its effectiveness across diverse educational settings.

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Step grid graphs connected by a path is graceful

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Abstract

A graceful labeling of a graph G with n edges and vertex set V is an injection $f: V(G) \rightarrow \{0, 1, \dots, n\}$ with the property that the resultant edge labels are also distinct where an edge incident with vertices u and v is given the label $|f(u) - f(v)|$. A graph which states a graceful labeling is called a graceful graph. In this paper, we prove that the two step grid graphs connected at the pendant vertex of the path is graceful.

Keywords: Graceful Labeling, Step grid graph, Path graph.

Introduction

The famous Ringel- Kotzig Conjecture (Ringel *et.al*, 1963) which states that the complete graph K_{2n+1} can be cyclically decomposed into $(2n+1)$ copies of a given tree with n edges, paved way for Rosa in the year 1967 (Rosa, 1967) to introduce the first graph labeling method called β -labeling which was subsequently termed as *graceful labeling* (Golomb, 1972). Many graphs and their families are shown to be graceful for the past few decades which are available in the dynamic survey of graph labeling (Gallian, 2022). Step grid graphs; cycles of step grid graphs; one point union for a path of step grid graphs; m -super subdivisions of the step grid graphs; stars of step grid graphs; one point unions of paths of step grid graphs; open stars of step grid graphs and

graphs attained by joining C_{4m} and step grid graphs with a path of arbitrary length were proved as graceful graphs. (Kaneria et.al, 2014).

Step Grid Graphs connected by a path

In this section we first recall the definition for step grid graph and we prove that the two grid graphs connected at the pendant vertex of the path is graceful.

Definition 1 [3] Let $P_i^{(i-1)}$ denote the $(i-1)^{\text{th}}$ path having i vertices, where $2 \leq i \leq n$. Hence $P_2^1, P_3^2, \dots, P_n^{(n-1)}$ is a sequence of $n-1$ paths with number of vertices as $2, 3, \dots, n$ respectively. Let P_n^n denote the n^{th} path on n vertices. Arrange the $(n-1)$ paths $P_i^{(i-1)}$, $2 \leq i \leq n$ and the n^{th} path P_n^n vertically. A graph acquired by connecting the horizontal vertices of the given n successive paths is known as a step grid graph of size n , where $n \geq 3$ and it is denoted by St_n . It is clear that $|V(St_n)| = 1/2(n^2 + 3n - 2)$ and $|E(St_n)| = n^2 + n - 2$.

Theorem 1: Step Grid graphs connected by an arbitrary path of length m are graceful.

Proof: Let St_{n_1} and St_{n_2} be two step grid graphs. In St_{n_1} , the vertices of the path $P_i^{(i-1)}$, for $2 \leq i \leq n_1$ arranged vertically are denoted as $u_{i-1,j}$ from top to bottom for $2 \leq i \leq n_1$, $1 \leq j \leq i$ and the vertices of the last path $P_{n_1}^{n_1}$ are denoted as $u_{n_1,j}$, for $1 \leq j \leq n_1$. Similarly in St_{n_2} , the vertices of the path $P_i^{(i-1)}$, for $2 \leq i \leq n_2$ arranged vertically are denoted as $v_{(i-1,j)}$ from top to bottom for $2 \leq i \leq n_2$, $1 \leq j \leq i$ and the vertices of the last path $P_{n_2}^{n_2}$, are denoted as $v_{n_2,j}$ for $1 \leq j \leq n_2$.

Let P_m be another path of length m with vertices t_1, t_2, \dots, t_m . Let G be the graph obtained by connecting the two step grid graphs St_{n_1} and St_{n_2} by the path P_m of length m in such a way that

the vertex $u_{n_1,1}$ of St_{n_1} is identified with the vertex t_1 of P_m and the vertex $v_{1,2}$ of St_{n_2} is identified with the vertex t_m of P_m .

The vertices of the graph G is denoted as $P = p_1 + p_2 + (m-2)$ where $p_1 = 1/2(n_1^2 + 3n_1 - 2)$ and $p_2 = 1/2(n_2^2 + 3n_2 - 2)$ and the edges of the graph G is denoted as $Q = q_1 + q_2 + (m-1)$ where $q_1 = n_1^2 + n_1 - 2$ and $q_2 = n_2^2 + n_2 - 2$.

The labelings of the graph G is given below.

$$\begin{aligned}
 f(u_{1,1}) &= 0 \\
 f(u_{i,1}) &= \sum_{k=2}^i (2k-1), & \text{for } 2 \leq i \leq \left\lfloor \frac{n_1}{2} \right\rfloor \\
 f(u_{i,1}) &= \sum_{k=2}^{\left\lfloor \frac{n_1}{2} \right\rfloor} (2k-1) + 2 \sum_{k=\left\lfloor \frac{n_1}{2} \right\rfloor+1}^i (n_1 - k + 1), & \text{for } \left\lfloor \frac{n_1}{2} \right\rfloor < i < n_1 \\
 f(u_{i,2}) &= Q - 2 \sum_{k=1}^i (k-1), & \text{for } 1 \leq i \leq \left\lfloor \frac{n_2}{2} \right\rfloor \\
 f(u_{i,2}) &= Q - 2 \sum_{k=1}^{\left\lfloor \frac{n_2}{2} \right\rfloor} (k-1) - \sum_{k=\left\lfloor \frac{n_2}{2} \right\rfloor+1}^i (n_1 - 2 \left[k - \left(\left\lfloor \frac{n_2}{2} \right\rfloor + 1 \right) \right]), & \text{for } \left\lfloor \frac{n_2}{2} \right\rfloor < i < n_1 \\
 f(u_{i,j}) &= f(u_{i-1,j-2}) + (-1)^{j-1}, & \text{for } 2 \leq i \leq n_1 - 1, 3 \leq j \leq (i+1) \\
 f(u_{n_1,2j-1}) &= Q - \binom{q_1}{2} + j(j-1), & \text{for } 1 \leq j \leq \left\lfloor \frac{n_1}{2} \right\rfloor \\
 f(u_{n_1,2j}) &= \binom{q_1}{2} - \sum_{k=1}^j (2k-1), & \text{for } 1 \leq j \leq \left\lfloor \frac{n_1}{2} \right\rfloor \\
 f(t_{2i}) &= f(u_{n_1,2}) + i, & \text{for } 1 \leq i \leq \left\lfloor \frac{m}{2} \right\rfloor \\
 f(t_{2i+1}) &= f(u_{n_1,1}) - i, & \text{for } 1 \leq i \leq \left\lfloor \frac{m}{2} \right\rfloor
 \end{aligned}$$

Case 1: When m is even

$$\begin{aligned}
 f(v_{1,2i-1}) &= \left\lfloor \frac{Q}{2} \right\rfloor - i(i-1), & \text{for } i = 1, 2, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor \\
 f(v_{1,2i}) &= \left\lfloor \frac{Q}{2} \right\rfloor + 1 + \sum_{k=1}^i (2k-1), & \text{for } i = 1, 2, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor \\
 f(v_{i,1}) &= \left\lfloor \frac{Q}{2} \right\rfloor + \sum_{k=1}^{i-1} (2k), & \text{for } i = 2, 3, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor + 1 \\
 f(v_{i,1}) &= Q - \left(\frac{q_1}{2} \right) - \left(\frac{m}{2} \right) - (n_2 - i + 1)^2 - 1, & \text{for } i = n_2, n_2 - 1, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor + 2 \\
 f(v_{i,2}) &= \left(\frac{q_1}{2} \right) + (m-1) + (n_2 - i + 1)(n_2 - i), & \text{for } i = n_2, n_2 - 1, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor \\
 f(v_{i,2}) &= \left\lfloor \frac{Q}{2} \right\rfloor - \sum_{k=2}^i (2k-1), & \text{for } i = 2, 3, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor
 \end{aligned}$$

Case 2: When m is odd

$$\begin{aligned}
 f(v_{1,2i-1}) &= \left\lfloor \frac{Q}{2} \right\rfloor + i(i-1), & \text{for } i = 1, 2, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor \\
 f(v_{1,2i}) &= \left\lfloor \frac{Q}{2} \right\rfloor - 1 - \sum_{k=1}^i (2k-1), & \text{for } i = 1, 2, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor \\
 f(v_{i,1}) &= \left\lfloor \frac{Q}{2} \right\rfloor - \sum_{k=1}^{i-1} (2k), & \text{for } i = 2, 3, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor + 1 \\
 f(v_{i,1}) &= \left(\frac{q_1}{2} \right) + \left\lfloor \frac{m}{2} \right\rfloor + (n_2 - i + 1)^2 - 1, & \text{for } i = n_2, n_2 - 1, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor + 1 \\
 f(v_{i,2}) &= \left\lfloor \frac{Q}{2} \right\rfloor + \sum_{k=2}^i (2k-1), & \text{for } i = 2, 3, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor \\
 f(v_{i,2}) &= Q - \left(\frac{q_1}{2} \right) - \left\lfloor \frac{m}{2} \right\rfloor - (n_2 - i + 1)(n_2 - i), & \text{for } i = n_2, n_2 - 1, \dots, \left\lfloor \frac{n_2}{2} \right\rfloor \\
 f(v_{i,j}) &= f(v_{i+1,j-2}) + (-1)^j, & \text{for } i = n_2 - 1, n_2 - 2, \dots, 2 \\
 & & j = 3, 4, \dots, n_2 + 2 - i
 \end{aligned}$$

From the above equations, we see that all the vertex labels are different. The distinct edge labels from 1 to q can be calculated from the above vertex labels. Therefore, the graph acquired by connecting two step grid graphs by an arbitrary path of length m is graceful.

The Theorem 1 is illustrated below in Figure 1 for $n_1 = 5$, $m = 7$, $n_2 = 6$, $q_1 = 28$, $q_2 = 40$ and $Q = 74$.

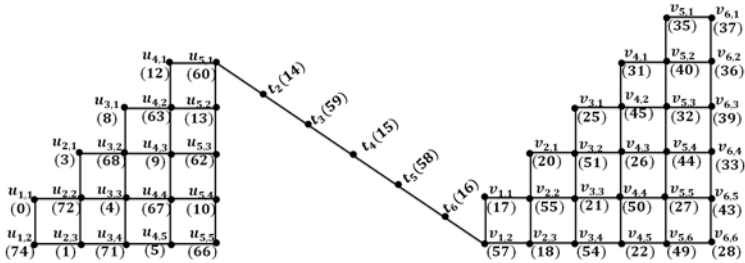


Figure 1 The graph G attained by connecting St_5 and St_6 by a path of length 7

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Monitoring Electrical Energy Consumption Using IoT Technology

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Abstract

The Internet of Things (IoT) is an arising field and the development of IoT based devices has created a major impact in the field of electronics. Internet of Things (IoT) based applications are becoming more and more popular because it provides efficient solutions for various real time problems. (Luechaphonthara, 2019) This paper presents the idea on creating awareness about the rise in the energy consumption level while using defect appliances and making the user to improvise into more standard appliances. It helps to prove that the old or faulty or defect appliances that consumes high electrical energy than the new appliances. (IEA, 2021) An IoT based electrical energy monitoring system promotes to reduce the physical efforts for measuring the electricity units consumed and create awareness among the consumers about the excessive usage of electricity. By developing electricity monitoring system which can be considered to detect faulty appliances, users can easily identify them change their appliances with the help of real-time feedback. (Islam, 2019)

This project is very useful for the users because it gives the live updates regarding the faulty appliances through the form of text message. GSM (Global system for mobile communication) is implemented in order to send information about the appliance to the user (Paramasivan, 2021).

Keywords: *Electrical energy, monitoring, GSM, appliances.*

Introduction

In this modern era, electricity is the most demanded source because it is expected to rise gradually in the upcoming years, along with the development of rapid urbanization, industrialization, and the population growth. People's dependency on electricity is at its peak, because the power consumption has tended to be increasing over the years. It is very important to consider monitoring and measuring the electrical energy system and the appliances which are being used in our day to day life in residents and commercial buildings as faulty or old or defect appliances tend to consume more electricity.

This paper presents a combination of both hardware and software. This physical hardware component is used to detect faulty household appliances. The module's significance is to identify and send messages to the user's mobile phone regarding the household appliances' using hardware and the Internet of Things (IoT).

Methodology

A. Existing System

The existing system involves way more manual procedures and it can take a lot of time and patience in order to find the fault appliances. Consumers who have prior knowledge and information

about electricity and the working of hardware components will be able to identify and rectify the problem but those who don't have any prior knowledge about this will be using the same faulty appliance and will be confused about high electricity consumption.

B. Proposed System

This electrical energy monitoring system will provide the consumers who don't have prior knowledge about this electricity consumption a clear idea of how to track and monitor the electricity consumption of every home appliances and if any appliance is consuming more electricity than the regular level, then the consumer can identify it and change the product immediately, thus reducing the amount of electrical energy consumed and the cost of the electricity bill generated per month.

By doing this, the consumer can reduce the electricity wastage and can contribute to energy conservation which will create an impact on the current requirements of electrical energy needs throughout the world

C. Hardware Components

GSM module

GSM is a mobile communication modem and GSM stands for Global System for Mobile communication. It is most commonly used for mobile communication, which is used to transmit mobile voice and data services at various frequency bands. This GSM is capable of carrying 64 kbps to 120 mbps of data rates.

LED lights

Light Emitting Diode (LED) is a semi-conducting component that emits light when the current flows through it. The color in which the LED emits its light is determined by the energy required

by the electrons for crossing the band gap of the semiconductor.

Jumper wires

Jumper wires have a component called connector pins at both the ends, which makes it possible to connect two points with each other without soldering. These wires are basically used in breadboards and other prototyping tools, to make the changes in the circuit as needed in an easier way. The various colors in these wires help to differentiate the type of connections which are made within them.

Floduino

Floduino Board is a motherboard housing ATmega 328 embedded microcontroller IC. ATmega 328 is a 28 pin DIPIC. It is manufactured by ATMEL Company employing AVR architecture handling FLASH memory which is electrically alterable ROM. Floduino board is a model derived from the arduino board which is basically a micro-controller. Floduino contains 6 analog input/output pins and 14 digital input/output pins embedded within it.

Resistor

A resistor is a component that restricts the current flow in a circuit. Resistors are also used to provide a level of voltage for some devices. LCD Screen

Liquid Crystal Display (LCD) is an electronic display module that is used in circuits & devices like mobiles, calculators, computers, and so on. These LCD have light-emitting diodes and seven segments. The advantage of LCD is inexpensive, easily programmable and there is no limitation for displaying characters and animations, etc.

Printed Circuit Board

Printed Circuit Board (PCB) is used in electrical and electronic fields to connect components with each other. The structure of a PCB is like a laminated sandwich consisting of conductive and insulating layers. All the electrical components are fixed to the conductive pads on the outer layers designed to accept the component's terminals by soldering.

Push Buttons

Push-button acts as a switch for controlling certain features and components of a machine. These buttons are mostly biased buttons, but still many of the un-biased buttons will require a spring to return to their default state.

D. Circuit Design

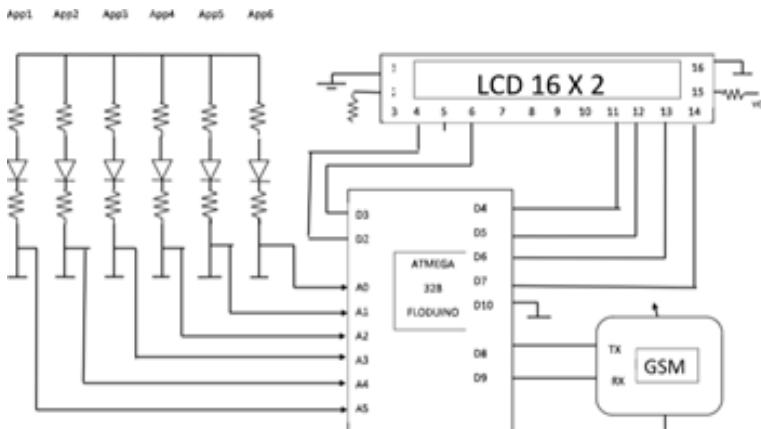


Fig 1. Circuit Design of the proposed system

E. Working Principle

In this work, there will be 6 LED lights to represent 6 different household appliances which are soldered with the Printed Circuit Board (also known as PCB) with resistors to change the variance

in the consumption of voltage according to each and every resistor. There is also a push button soldered in the Printed Circuit Board, so as whenever the user pushes it, the consumer will receive the message about the consumption of each and every appliance.

A micro-controller called floduino is used in this work. Floduino Board is a motherboard housing ATmega 328 embedded microcontroller IC. Floduino board is a model derived from the arduino board which is basically a micro-controller. Floduino consists of 6 analog input/output pins and 14 digital input/output pins embedded within it.

This floduino provides 6 analog inputs A0 to A5. It has 14 Digital I/O pins to handle input/ output digital data to control the output devices. Out of these 14 I/O pins, six of them are Analogue output (D3, D5, D6, D9, D10, D11) analog pin can provide output voltage varying from 0V to 5V continuously employing PWM technique. By varying the duty cycle of the output waves, it is able to produce variable pulse with output waves.

In this work, libraries such as `<SoftwareSerial.h>` and `<LiquidCrystal.h>` are imported to develop the program for supporting the serial communication on other digital pins of the floduino and allowing communication with alphanumeric Liquid Crystal Display.

After importing the necessary packages, the initialization of the appliances takes place according to the pin port used from A0 to A5. Voltage is defined as v and is initialized with a certain threshold to a value of $v=400$. Instead of altering the value of v in the program wherever it is included, it is easier to change at the initial stage and that's the reason for assigning it in the initialization stage.

In the void setup() function, it usually contains statements that set the pin modes to OUTPUT and INPUT depending on the need. All the pins that are used in this work from A0 to A5 will be receiving only the input, so they are defined as INPUT pins in the sketch.

The void loop() function is the place where the bulk of the sketch is executed. Inside the loop() method println is used to display the message in the LCD. If,elseif conditional statements is used to check the condition of the appliance that which draws more current and the good working appliance. For six appliances will be checking 64 combinations.

If the appliance consumes more than the given threshold value then it will consider as a fault appliance. For example, the 1st appliance is compared with the other 5 appliances using the AND operator. Suppose if the 1st appliance consumes more than the given threshold value, then it will display the message as appliance 1 draws more current.

Likewise, 2 LEDs 1 combination, 3 LEDs 1 combination, 5 LEDs, 6 LEDs combination takes place. The voltage value will be displayed in the form of integer value. If the user wants know about the appliance status, when he presses the pushbutton, the loop will takes place and it will display the message.

This program can be downloaded in the floduino and can be executed in both the computer and the floduino simultaneously. Inside the GSM module, there will be a working SIM card attached to it. This SIM card connects with the nearest mobile tower and helps in transferring and communicating from the GSM information to the user's mobile phone in the format of text message.

The GSM component and floduino can be powered using power adapters. Once after program code is installed in the floduino board, it can be executed through the power adapters and GSM module will display and send the text message to the user mobile for that we need to specify the mobile number inside the Send Message() method whenever the user pushes the push button, which is soldered in the Printed Circuit Board. Through this message, the user is able to identify the fault and good working appliances and can able to take measures in order to change the fault appliances to reduce the consumption of electrical energy thus saving the amount of electrical energy consumed and the amount of bill generated.

Internet of Things has proved to be one of the developing technologies these days. Various fields of development and research have included this IoT feature because of its various benefits like easy accessibility and so on. Using this IoT technology, a hardware system is developed in order to track and monitor the electrical energy consumption of appliances to track and identify the faulty appliance comprising certain components like floduino, GSM module and LCD screen. This system creates awareness among the consumers about electrical energy consumption of each appliance, making them identify the faulty and good working appliance and changing the faulty appliance as soon as possible, thus contributing to the conservation of electrical energy.

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Comparative Analysis of NLP Models For Sentiment Analysis

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Abstract

Sentiment analysis, a fundamental task in natural language processing (NLP), aims to automatically detect and classify sentiment expressed in textual data. With the emergence of advanced NLP models, such as BERT, GPT, and RoBERTa, there is a need to compare their performance and effectiveness in sentiment analysis tasks. This research paper presents a comparative analysis of NLP models, VADER and RoBERTa, for sentiment analysis, evaluating their efficiency. The objective is to provide insights into the strengths and limitations of these models and assist researchers and practitioners in selecting the most suitable NLP model for sentiment analysis applications. The comparative analysis is conducted on a customer review dataset from Amazon. Statistical tests are employed to determine if performance differences are statistically significant. The findings of this comparative analysis highlight the strengths and weaknesses of different NLP models for sentiment analysis. By evaluating the comparative performance of NLP models, RoBERTa model has proved to be the best for this dataset.

Keywords: *Sentiment analysis, NLP models, VADER, RoBERTa*

Introduction

A. Sentiment Analysis

Sentiment analysis is a field of natural language processing that deals with the interpretation and analysis of sentiments expressed in spoken or written language by people. (B. Liu, 2012) Sentiment analysis seeks to determine if a text is positive, negative, or neutral by determining its polarity. Several industries, including marketing, customer service, politics, and healthcare, use sentiment analysis to understand customer feedback, track brand reputation, and monitor public opinion about their goods and services. For instance, sentiment analysis in marketing can assist companies in better understanding client preferences, spotting patterns, and boosting client happiness. The issues of sentiment analysis include detecting and managing sarcasm, irony, and other figurative language (Van Looy,2022). The target audience should be considered while doing sentiment analysis because cultural and linguistic variations can also have an impact.

B. Natural Language Processing (NLP)

NLP is an area of computer science and artificial intelligence that focuses on the interaction between computers and people in natural language (Zong,2021). In order to make computers comprehend, interpret, and react to human language more humanely, NLP entails analysing, understanding, and producing human language. A group of algorithms known as NLP models allow computers to comprehend and produce human language. In order to analyse sentiments and discover the patterns of human language, these models employ statistical methodologies and machine learning techniques (Xia, 2015). VADER from Rule-based models and roBERTa from deep learning models have been chosen to perform sentiment analysis.

VADER Model

A rule-based sentiment analysis model called VADER (Valence Aware Dictionary and Sentiment Reasoner) was created specifically to examine social media text. A dictionary of words and phrases that have been manually assigned a positive, negative, or neutral sentiment score serves as the foundation for VADER. Together with the vocabulary, VADER also uses a set of guidelines and heuristics to deal with intensifiers, negations, and other linguistic elements that may have an impact on sentiment. Because of its rule-based methodology, it is especially beneficial for evaluating brief, informal, and colloquial content, like tweets and online reviews.

roBERTa Model

The cutting-edge language model roBERTa (Robustly Optimized BERT Approach) was created by Facebook AI Research. It is a development of the well-known BERT (Bidirectional Encoder Representations from Transformers) approach, which creates high-quality language representations using transformer architecture and a vast corpus of text (Das, 2007). In order to increase roBERTa's robustness and generalisation abilities, it was tuned using a variety of strategies like dynamic masking, continuous training, and bigger batch sizes (Alexandridis, 2021). roBERTa has considerably enhanced the state-of-the-art in natural language processing and has become a vital tool for many academics and developers working with language data.

I. Methodology



This session explains about the process involved in this research paper. Fig. 1 pictures the sequential flow of the process. Online food review data is selected for this study. Data pre-processing such as stop words removal and tokenizing are done on the raw data to get it into the desired data for usage. Here, VADER model from rule-based models and roBERTa from deep learning model are deployed. The models are evaluated based on the efficiency and most accurate model is chosen.

A. Data Selection

A benchmark dataset on Amazon food review is chosen from the internet. Table I describes the attributes of the dataset. There are 10 attributes and 568450 records in the dataset which makes the analysis more accurate.

Columns of the Dataset	Description
Id	A unique identifier assigned to a particular product in a database.
Product Id	A unique code or number assigned to a specific product.
User Id	A unique name or code assigned to a particular user of a product.
Profile Name	A name or username that a user chooses to represent themselves on a particular platform.
Helpfulness Numerator	The number of times a review or feedback has been marked as "helpful" by other users.

Helpfulness Denominator	The total number of votes or ratings that a review or feedback has received, regardless of whether they are marked as "helpful" or not.
Score	Contains ratings of how satisfied customers are with the product, with higher scores (5) indicating greater satisfaction.
Time	Represents time of the comment.
Summary	A one or two words description by the customers about the product usefulness.
Text	A brief description by the customers about the usefulness of the product.

TABLE I. DESCRIPTION OF THE DATASET

A. Data Pre-processing

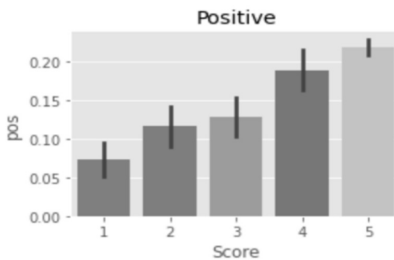
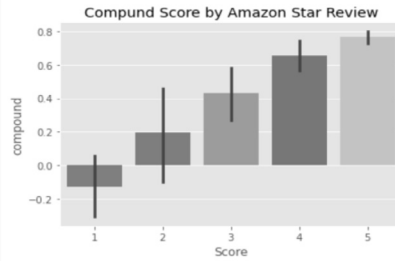
VADER and roBERTa use preprocessing techniques like stop word removal and tokenization to break down the input text into individual units, such as words or phrases. Stop words removal helps to improve the recall value but hurts the precision so stop words are not being removed. Tokenization (Separating the phrase into words) is done using AutoTokenizer that offers a uniform interface for tokenizing various sorts of text input. Based on the supplied model architecture and settings, it chooses the best tokenizer automatically. Tokenizers from several pre-trained models, including BERT, GPT-2, roBERTa, and others, can be loaded through the AutoTokenizer module. This makes using various tokenizers simpler. The cleaned data is then converted into numerical representations through embedding. In python, LabelEncoder() method encodes the categorical value and give a numeric value for the attributes.

B. Implementation of NLP Models

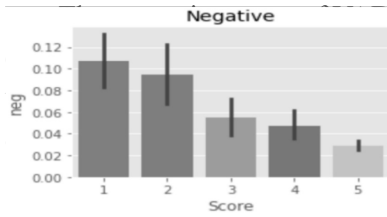
VADER

With the help of Sentiment Intensity Analyzer, the polarity scores have been generated for the dataset. The result will be in positive, neutral, negative, and compound (aggregate score of positive, neutral,

and negative) scores. To check whether the compound score matches with the “score” column of the dataset, comparison has been done. The compound score which has been found out matches with the score column of the dataset. At score 1, the compound score leans towards 0 stating at score 1, all reviews are negative. As scores (ratings) increase, the compound scores lean towards 1 stating at score 5, all reviews are positive. Next, to check whether the positive, neutral, and negative scores match with the “score” column of the dataset, comparison of all four has been done.



The positive score of VADER and the score column of the dataset has a positive relationship meaning that, as scores (ratings) increase, the positive reviews increase. At score (ratings) 1, there is a positive score of 0.7 (approximately). But at score (ratings) 5, there is a positive score above 0.20.



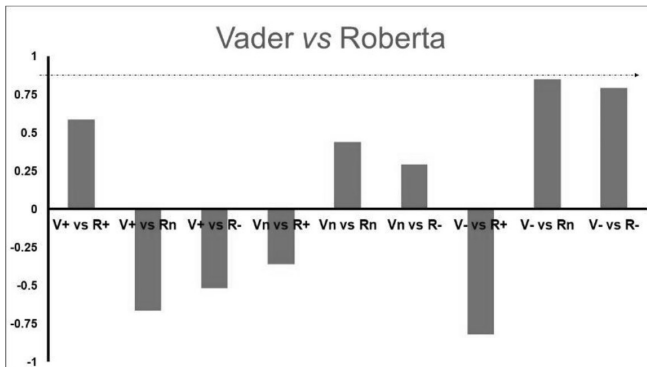
R and the score column of the meaning that, as scores increase, core 1, there is a negative score a negative score below 0.04.

Here, tensors have been used to perform sentiment analysis using the roBERTa model. This function will take a string of text as input, tokenize the text using the roBERTa tokenizer, and pass the tokenized text and converts it on a scale of 0 to 2 and gives the result as positive, neutral or negatives according to the scale of 0 to 2.

Results and Discussion

The scores of both the models, VADER and roBERTa are calculated. By performing t-test, it is proved that there is a major difference between the VADER and roBERTa results. To check which the accuracy of the models, correlation coefficient is performed. The correlation coefficient is calculated and shown in figure 5.

Fig. 5 Comparison of VADER scores with roBERTa with Correlation Coefficient



When comparing VADER with roBERTa, most of the correlation coefficient values are negative which means that the VADER model is weak and less accurate than roBERTa. Thus, roBERTa proved to be more efficient than VADER for this dataset.

Conclusion

The VADER and roBERTa NLP models are both helpful for analysing sentiments, but how well they perform depends on the kind of text being evaluated. Here for the Amazon food review dataset, roBERTa model scored high in efficiency. The decision between the use of NLP models will ultimately be based on the needs and specifications of the sentiment analysis. This research can be broadened by extracting the real-time data from the E-Commerce websites through web scrapping technique. A web sentimental analysis application can be built on the best and efficient NLP model.

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Antimagic Labeling on Cycle of Star Graph

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Abstract

Antimagic labeling, introduced by Hartsfield and Ringel, is an edge labeling which maps to such that the resultant vertex labels are distinct, where the label of a vertex is computed as the sum of the labels of the edge incident with it. In this study we prove that cycle of stars is antimagic.

Keywords: Antimagic labeling, cycle of stars. 2010 Mathematics Subject Classification: 05C78

Introduction

Graph labeling is a fundamental concept in graph theory that involves assigning values to the vertices or edges of a graph. In 1990, Hartsfield and Ringel introduced the concept of an antimagic labeling of graph. Hartsfield and Ringel (1990) showed that paths, stars, cycles, complete graphs K_n , wheels W_n and bipartite graphs $K_{2,m}$, $m \geq 3$, are antimagic. The antimagic labelings of cycle related graphs which have been derived from wheels graphs have been studied by Krishna (2012). Results relating to antimagic graphs are given in the dynamic survey by Gallian (2020).

Cycle of Graphs

Definition : The cycle of stars is the graph obtained by appending a star $K_{1,m}$ to every vertex of the cycle C_n . It is denoted by $C(n;m)$.

Theorem 1: The cycle of stars graph is antimagic.

Proof:

Let $C(n;m)$ be a cycle of stars. Denote the vertices of the cycle v_1, v_2, \dots, v_n . Denote the pendant vertices adjacent to v_i as $u_1^i, u_2^i, \dots, u_m^i$. Denote the edges of the cycle as in the anticlockwise direction, where y_1 is the edge incident with v_1 and v_2 , y_2 is the edge incident with v_2 and v_3 and so on. Denote the edges incident with v_i as $x_1^i, x_2^i, \dots, x_m^i$. An illustration is given in Figure 1. Thus we have the vertex set $V(C(n;m)) = V_1 \cup V_2$, $V_1 = \{v_1, v_2, \dots, v_n\}$, $V_2 = \{u_\delta^i, i = 1, 2, \dots, n, \delta = 1, 2, \dots, m\}$. Also the edge set $E(C(n;m)) = E_1 \cup E_2$, where $E_1 = \{y_1, y_2, \dots, y_n\}$, $E_2 = \{x_\delta^i, i = 1, 2, \dots, n, \delta = 1, 2, \dots, m\}$. Note that $C(n;m)$ has $mn+n$ vertices and $mn+n$ edges.

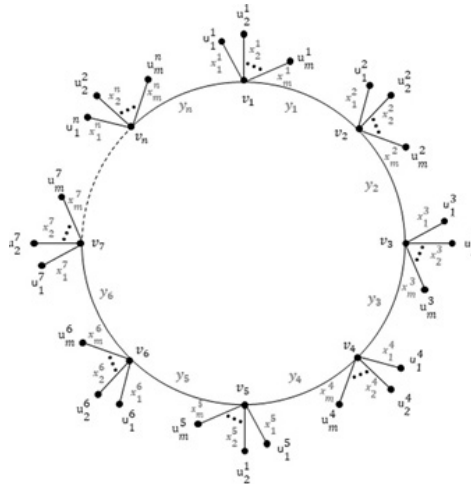


Figure 1 : Cycle of Stars $C(n;m)$

The edge labeling is defined by is $\zeta : E(V(C(n; m))) \rightarrow \{1, 2, \dots, mn + n\}$ defined as $\zeta(x_\delta^\lambda) = (\lambda - 1)m + \delta, \lambda = 1, 2, \dots, n, \delta = 1, 2, \dots, m$
 $\zeta(y_\lambda) = mn + n - i + 1, \lambda = 1, 2, \dots, n$

It is observed that the edge labeling defined above generate distinct edge labels for all the $mn+n$ edges satisfying the condition for antimagic labeling.

$$\xi(v_\lambda) = 2n(m + 1) + \frac{m(m+1)}{2} + \lambda(3m - 2) - 3(m - 1), \lambda = 2, 3, \dots, n$$

$$\xi(v_1) = \frac{m(m+1)}{2} + 2mn + n + 2$$

$$\xi(u_\delta^\lambda) = m(\lambda - 1) + \delta, \lambda = 1, 2, \dots, n, \delta = 1, 2, \dots, m$$

The entire $mn+n$ vertices labeled are distinct. Thus the cycle of stars $C(n; m)$ admits antimagic labeling.

Conclusion

In this paper we have proved that cycle of star graph admits antimagic labeling. The Cycle of stars can be used to model network topologies where a central node represent a main hub or central server and the surrounding nodes represent individual devices or clients connected to the hub. This can be useful in designing and analysing the efficiency of various network configurations. It can also be used in Social and Communication networks.

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Edge Vertex Prime Labeling

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Abstract

A graph G is said to have edge vertex prime labeling if there exists a bijection $f: V(G) \cup E(G) \rightarrow \{1, 2, \dots, |V(G) \cup E(G)|\}$ with the property that given any edge $uv \in E(G)$, the numbers $f(u)$, $f(v)$ and $f(uv)$ are pairwise relatively prime. In this paper, we prove edge vertex prime labeling of graphs such as Frock graph and (n, t) - Kite graph.

Key words: Edge vertex prime labeling, Frock graph, (n, t) - Kite graph.

Introduction

The notation of prime labeling originated with Roger Entringer and was introduced in a paper by Taut, Dabboucy and Howalla [8]. A graph with vertex V is said to have prime labeling if there exist a bijection $f: V(G) \rightarrow \{1, 2, \dots, |V|\}$ such that each edge $xy \in E(G)$, $f(x)$ and $f(y)$ are relatively prime. In other words the greatest common divisor of $f(x)$, $f(y)$ denoted by $\gcd(f(x), f(y)) = 1$.

R. Jagadesh and J. Baskar Babujee [1] introduced the concept of edge vertex prime labeling and proved the existence for the following graphs: paths, cycles and star- $K_{1,n}$. A graph G is said

to have edge vertex prime labeling if there exists a bijection $f : V(G) \cup E(G) \rightarrow \{1, 2, \dots, |V(G) \cup E(G)|\}$ with the property that given any edge $uv \in E(G)$, the numbers $f(u)$, $f(v)$ and $f(uv)$ are pairwise relatively prime. A graph G is said to be edge vertex prime if it admits edge vertex prime labeling. Parmar [2,3] proved that wheels, fans, friendship graphs, and $K_{2,n}$ are edgevertex prime.

Simaringa and Muthukumaran [5] has proved that following graphs have edge vertex prime labelings: triangular and rectangular books, butterfly graphs, $K_n \cup K_{1,m}$, $K_{1,m} + K_1$, $K_m \cup K_n$, Jahangir graphs $J_{n,3}$ and $J_{n,4}$. Simaringa and Muthukumaran [6] investigated the existence of edge vertex prime labelings for crowns, unions of cycles, and wheel related graphs. Shrimali and Parmar [7] has proved that the following graphs have edge vertex prime labelings: bistars, n -centipede trees, coconut trees obtained from the path P_n by appending m new pendent edges at an end vertex of P_n , double coconut trees (graphs obtained by attaching $n > 1$ pendent vertices to one end of the path P_r and $m > 1$ pendent vertices to the other end of path P_r), and special classes of banana trees and fire crackers.

Edge vertex prime labeling of Frock graph

Theorem : Frock graph FG_n admits edge vertex prime graph, for any integer $n \geq 2$.

Proof. Let $G(V, E) = FG_n$, $n \geq 2$. Then G has $n + 3$ vertices and $2n + 2$ edges. The frock graph is described as follows: Let u be the apex of the cycle graph C_3 and

the fan graph F_n . Label the vertices of the cycle C_3 as u, v_1, v_2 where u is the apex. Label the vertices of the fan F_n as u, u_1, u_2, \dots, u_n where u is the apex. The labeling is done in the clockwise direction from the apex u .

The vertex set for the graph is given by,

$$V = \{u \cup y_j \cup u_i\}, \quad i = 1, 2, \dots, n \quad j = 1, 2$$

The edge set for the graph is given by,

$$\begin{aligned} E &= E_1 \cup E_2 \cup E_3 \cup E_4 \\ E_1 &= u y_j, \quad j = 1, 2 \\ E_2 &= v_j v_{j+1}, \quad j = 1 \\ E_3 &= u u_i, \quad i = 1, 2, \dots, n \\ E_4 &= u_i u_{i+1}, \quad i = 1, 2, \dots, n-1 \end{aligned} \quad (1)$$

Define a bijective function $f: V \cup E \rightarrow \{1, 2, \dots, 3n + 5\}$ as follows

$$\begin{aligned} f(u) &= 1 \\ f(y_j) &= 2j + 1, \quad j = 1, 2 \\ f(u_i) &= \begin{cases} 3i + 4, & i \text{ is odd} \\ 3i + 5, & i \text{ is even} \end{cases} \\ f(y_j y_j) &= 2(2j - 1), \quad j = 1, 2 \\ f(v_j v_{j+1}) &= 2j + 2, \quad j = 1 \\ f(u u_i) &= \begin{cases} 3i + 5, & i \text{ is odd} \\ 3i + 4, & i \text{ is even} \end{cases} \\ f(u_i u_{i+1}) &= 3i + 6, \quad i = 1, 2, \dots, n-1 \end{aligned} \quad (2)$$

The conditions for the cycle are as follows,

$f(y_j), f(v_{j+1})$ and $f(v_j v_{j+1})$ are pairwise relatively prime.

$f(u), f(y_j)$ and $f(u u_i)$ are pairwise relatively prime for $j = 1, 2$.

For $j = 1, 2$

$$\begin{aligned} \gcd\{f(y_j), f(v_{j+1})\} &= \gcd\{2j + 1, 2j + 3\} = 1 \\ \gcd\{f(y_j), f(v_j v_{j+1})\} &= \gcd\{2j + 1, 2j + 2\} = 1 \\ \gcd\{f(v_{j+1}), f(v_j v_{j+1})\} &= \gcd\{2j + 3, 2j + 2\} = 1 \end{aligned} \quad (3)$$

For $j = 1, 2$

$$\begin{aligned} \gcd\{f(u), f(y_j)\} &= \gcd\{1, 2j + 1\} = 1 \\ \gcd\{f(u), f(u u_i)\} &= \gcd\{1, 2(2j - 1)\} = 1 \end{aligned} \quad (4)$$

$$\gcd\{f(y_j), f(u u_i)\} = \gcd\{2j + 1, 2(2j - 1)\} = 1$$

The conditions for the fan are as follows,

$f(u), f(y_j)$ and $f(u u_i)$ are pairwise relatively prime.

$f(y_j), f(u_{i+1})$ and $f(u u_{i+1})$ are pairwise relatively prime.

$$\gcd\{f(u), f(u u_i)\} = \begin{cases} \gcd(1, 3i + 5), & i \text{ is odd} = 1 \\ \gcd(1, 3i + 4), & i \text{ is even} \end{cases} \quad (5)$$

Therefore, for any edge $uv \in E(G)$, the numbers $f(u), f(v)$ and $f(uv)$ are pairwise relatively prime. Hence, the Frock graph FG_n is an edge vertex primegraph.

Edge vertex prime labeling of Kite graph

Theorem: An (n, t) -Kite graph admits edge vertex prime labeling where $n \geq 3$, $t \geq 1$.

Proof. Let $G(V, E)$ be an (n, t) - Kite graph, where $n \geq 3$, $t \geq 1$. Then G has $n + t$ vertices and $n + t$ edges. The graph G is described as follows : Let u_1 be the apex of the cycle of length n and the t - edge path. Let u_1, u_2, \dots, u_n be the vertices of C_n labeled in the clockwise direction from u_1 , which is the apex vertex. Let v_1, v_2, \dots, v_m be the vertices of the t - edge path attached to the apex vertex u_1 which is also a vertex of the t - edge path.

The vertex set for this graph is given by,

$$\underline{V} = \{u_1 \cup u_i \cup v_i\}; \quad 1 \leq i \leq t, \quad 2 \leq j \leq n$$

The edge set for this graph is given by,

$$\begin{aligned} E &= E_1 \cup E_2 \cup E_3 \cup E_4 \\ E_1 &= u_1 v_1 \\ E_2 &= \begin{cases} 2j-2t-2, & j=2 \\ 2j+2t-j = n \end{cases} \end{aligned}$$

$$E_3 = 2i + 2, \quad 1 \leq i \leq t-1 \quad (6)$$

Define a bijective function $f: V \cup E \rightarrow \{1, 2, \dots, 2(n+t)\}$ as follows

$$\begin{aligned} f(u_1) &= 1 \\ f(v_i) f(v_i) &= 2i + 1, \quad 1 \leq i \leq t \\ f(u_j) &= 2j + 2t, \quad j = 2, \dots, n \\ f(u_1 v_i) &= 2i, \quad i = 1 \\ f(u_1 u_j) &= \begin{cases} 2j + 2t - 2, & j=2 \\ 2j + 2t - j = n \end{cases} \\ f(v_i v_{i+1}) &= 2i + 2, \quad 1 \leq i \leq t-1 \\ f(u_j u_{j+1}) &= 2j + 2t, \quad 2 \leq j \leq n-1 \end{aligned} \quad (7)$$

The conditions for the graph are as follows,

$f(u_1), f(v_i)$ and $f(u_1 v_i)$ are pairwise relatively prime.
 $f(u_1), f(u_j)$ and $f(u_1 u_j)$ are pairwise relatively prime.

$f(u_i), f(u_{j+1})$ and $f(u_j u_{j+1})$ are pairwise relatively prime.

For $i=1$

$$\begin{aligned} \gcd\{f(u_1), f(v_i)\} &= \gcd\{1, 2i + 1\} = 1 \\ \gcd\{f(u_1), f(u_1 v_i)\} &= \gcd\{1, 2i\} = 1 \\ \gcd\{f(v_i), f(u_1 v_i)\} &= \gcd\{2i + 1, 2i\} = 1 \end{aligned} \quad (8)$$

For $j = 2, n$

$$\begin{aligned} \gcd\{f(u_1), f(u_j)\} &= \gcd\{1, 2j + 2t - 1\} = 1 \\ \gcd\{f(u_1), f(u_1 u_j)\} &= \begin{cases} \gcd(1, 2j + 2t - 2), j = 2 \\ \gcd(1, 2j + 2t - 1), j = n = 1 \end{cases} \end{aligned} \quad (9)$$

$$\gcd\{f(u_j), f(u_1 u_j)\} = \begin{cases} \gcd(2j + 2t - 1, 2j + 2t - 2), & j = 2 \\ \gcd(2j + 2t - 1, 2j + 2t), & j = n = 1 \end{cases}$$

Therefore, for any edge $uv \in E(G)$, the numbers $f(u)$, $f(v)$ and $f(uv)$ are pairwise relatively prime. Hence an (n, t) - Kite graph is an edge vertex prime graph.

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Odd Graceful Labeling of Stalked Subdivided Shell Graph

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Abstract

Graph labeling is an assignment of integers to the vertices or edges or both subject to certain conditions. Graceful labeling was introduced by Rosa while the concept of odd graceful labeling was introduced by Gnanajothi. In this paper, we prove that the stalked subdivided shell graph joined by an edge is odd graceful.

Keywords: *Odd graceful labeling, Shell graph, Subdivided Shell graph. 2010 Mathematics Subject Classification: 05C78*

Introduction

In Mathematics, graph theory is the study of graphs, which are mathematical structures used to model pairwise relations between objects. The first paper in graph theory was written by Euler (Bondy *et al.*, 1976), in 1736, when he solved the Konigsberg Bridge Problem. Graph labeling is an assignment of integers to the vertices or edges or both subject to certain conditions Most Graph labeling methods trace their origin to β -valuation introduced by Rosa [6]. Odd graceful labeling is to inject $f: V(G) \rightarrow \{0, 1, 2, \dots, (2q-1)\}$ whenever the edge ab is identified the label $|f(a)-f(b)|$, so that

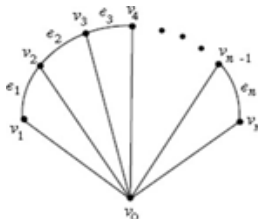
the derived edge labels are $\{1,3,5,\dots,(2q-1)\}$. Many results exist on Odd graceful labeling. Gnanajothi (Gnanajothi 1991) proved that the path P_n , the cycle C_n if and only if n is even, the complete bipartite graph $K_{m,n}$ are odd graceful. For more applications one can refer to Gallian survey (Gallian 2018). In this paper, we prove that stalked subdivided shell graph joined by an edge is odd graceful.

Stalked Subdivided Shell graph

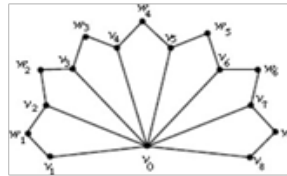
In this section we state few definitions which are relevant to this paper and prove that two copies of stalked subdivided shell graph joined by an edge is odd graceful.

Shell Graph

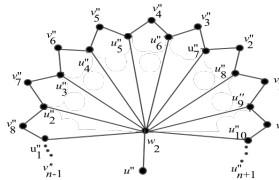
Create a cycle. The apex of C_n with $(n-3)$ chords with a shared end point is defined to be the *shell graph* (Ezhilarasi Hilda K *et al.*, J 2020). C is used to represent shell graphs $(n,n-3)$.



Shell graph



Subdivided Shell graph



Stalked Subdivided Shell graph

Figure 1.

Subdivided Shell Graph

When each edge in the path of the shell graph is subdivided, then a *Subdivided Shell graph* (Jesintha J et al., 2014), is obtained.

Stalked Subdivided Shell Graph

Stalked Subdivided Shell graph is obtained by adding an edge at the apex vertex of the subdivided shell graph.

Theorem. Stalked subdivided shell graph joined by an edge is odd graceful.

Proof. Let S_1 be the first copy of the stalked subdivided shell graph. The vertices of S_1 are denoted as follows. The vertex at the stalk of S_1 is denoted by u_0' . The apex of the graph of S_1 is denoted by w_1 . The middle vertices of the subdivided shell graph of S_1 are denoted by u_1', u_2', \dots, u_m' in the anticlockwise direction. The vertices of subdivided edge of the subdivided shell graph S_1 is denoted by $v_0', v_1', \dots, v_{n-1}'$ in the anticlockwise direction. Let e_0, e_1, \dots, e_{n+1} be the edges joining the apex to inner vertices and let $c_1, d_1, c_2, d_2, \dots, c_n, d_n$ be the outer alternate edges. Now S_2 be the second copy of the stalked subdivided shell graph. The vertices of S_2 are denoted as follows. The vertex at the stalk of S_2 is denoted by u_0'' . The apex of the graph S_2 is denoted by w_2 . The middle vertices of the subdivided shell graph S_2 are denoted by $u_1'', u_2'', \dots, u_m''$ in the anticlockwise direction. The vertices of the subdivided edge of the subdivided shell graph S_2 is denoted by $v_0'', v_1'', \dots, v_{n-1}''$ in the anticlockwise direction. Let G be the graph obtained by adding edge between S_1 and S_2 . General figure is shown in Figure 3. The total number of vertices and edges of the graph G is defined by

$$|V(G)|=4n+6, |E(G)|=6n+5.$$

Defined the vertex labelling $f:V(G)\rightarrow\{0,1,2,\dots,(2q-1)\}$ as

$$\begin{aligned} f(w_1) &= 2q - 1 \\ f(w_2) &= 2q - \left\lfloor \frac{n}{2} \right\rfloor - 7 \\ f(u'_0) &= 0 \\ f(u''_0) &= 2n + 8 \\ f(u_i) &= 2i; \quad 0 \leq i \leq n + 1 \\ f(u''_i) &= 2n + 8 + 2i; \quad 0 \leq i \leq n + 1 \\ f(v'_i) &= 2q - 6i - 5; \quad 0 \leq i \leq n - 1 \\ f(v''_i) &= 4n + 11 + 2i; \quad 0 \leq i \leq n \end{aligned}$$

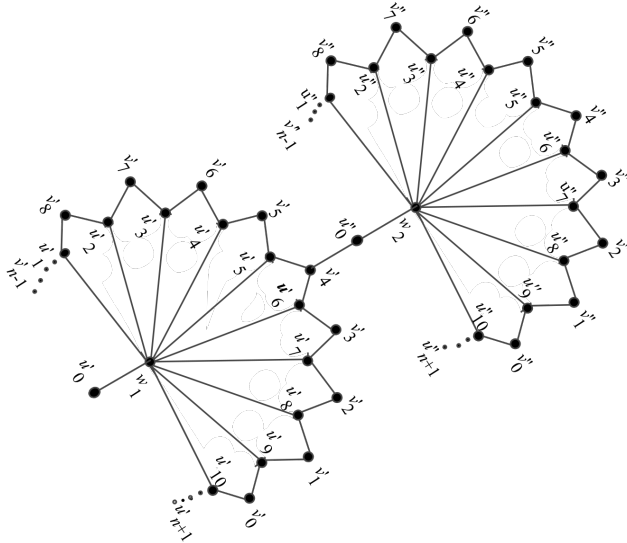


Figure 2. Stalked subdivided shell graph joined by an edge

Edge labeling is calculated as follows:

$$\begin{aligned}
 |f(u'_0) - f(w_1)| &= |0 - (2q - 1)| = |2q - 1| \\
 |f(w_1) - f(u'_i)| &= |(2q - 1) - 2i| = |2q - 2i - 1|; 1 \leq i \leq n + 1 \\
 |f(u'_i) - f(v'_j)| &= |2q - 6j - 2i - 5|; 1 \leq i \leq n - 1, n - 1 \leq j \leq 0 \\
 |f(v'_i) - f(u''_{i+1})| &= |2q - 6j - 2i - 7|; 1 \leq i \leq n, n - 1 \leq j \leq 0 \\
 \left| f\left(v''_{\lfloor \frac{n}{2} \rfloor}\right) - f(u''_0) \right| &= \left| 2q - 6 \left\lfloor \frac{n}{2} \right\rfloor - 2n - 13 \right| \\
 |f(u''_0) - f(w_2)| &= \left| 2q - 6 \left\lfloor \frac{n}{2} \right\rfloor - 2n - 15 \right| \\
 |f(w_2) - f(u''_i)| &= \left| 2q - 6 \left\lfloor \frac{n}{2} \right\rfloor - 2n - 2i - 15 \right|; 1 \leq i \leq n + 1 \\
 |f(u''_i) - f(v''_j)| &= |2n + 3 + 2j - 2i|; 1 \leq i \leq n - 1, n - 1 \leq j \leq 0 \\
 |f(v''_i) - f(u''_{i+1})| &= |2n + 1 + 2j - 2i|; 1 \leq i \leq n, n - 1 \leq j \leq 0
 \end{aligned}$$

Edge labels are distinct and are in the set $\{1, 3, 5, \dots, 2q - 1\}$. Hence, stalked subdivided shell graph joined by an edge is odd graceful.

Conclusion

In this paper we have proved that stalked subdivided shell graph joined by an edge is odd graceful. We intend to prove the same for the number of copies of stalked subdivided shell graphs.

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Adjacent Vertex Distinguishing Total Coloring of Certain Graphs

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Abstract

A total coloring (TC) is an allocation of colors to the elements of the graph G in such a way that no two elements receive the same color. The least number of colors that satisfies the conditions of TC for G is called total chromatic number (TCN) and denoted by $\chi''(G)$. Behzad and Vizing individually proposed the Total Coloring Conjecture (TCC) which states that, \forall simple graph $G, \Delta(G)+1 \leq \chi''(G) \leq \Delta(G)+2$. Let G be a graph without self-intersecting vertices and multiple edges having total coloring ψ , and define color set for vertex $x \in V(G), C(x) = \{\psi(x)\} \cup \{\psi(xy) \mid xy \in E(G)\}$. Total coloring is an AVD-TC if $\forall x, y \in V(G)$ where xy is adjacent, $C(x) \neq C(y)$. In this paper, we determine AVD-TCN of umbrella graph, middle graph of comb graph, and investigate total coloring conjecture.

Keywords: AVD- total coloring, Total chromatic number, umbrella graph, middle graph, comb graph.

Introduction

A total coloring $\psi: U \rightarrow \{1, 2, \dots, k\}$ ($U = V \cup E$), of G is an allocation of colors to the elements of the graph \exists (i) $\psi(u) \neq \psi(v), \forall uv \in E(G)$ (ii) $\psi(uv_1) \neq \psi(uv_2), \forall uv_1, uv_2 \in E(G)$

(iii) $\psi(u) \neq \psi(uv), \forall uv \in E(G)$. The least number of colors that follows TC of graph G is called its TCN and denoted by $\chi''(G)$. (Behzad, 1965) introduced TCN in 1965. We know that for any graph G , $\chi''(G) > \Delta(G)+1$. The TCC states that, $\chi''(G) < \Delta(G)+2$. The graphs with TCN equals to $(\Delta(G)+1)$ and $(\Delta(G)+2)$ are called type 1 and 2 graphs. Hence, $\Delta(G)+1 \leq \chi''(G) \leq \Delta(G)+2$.

Let G be a graph with a TC $\psi: U \rightarrow \{1, 2, \dots, k\}$, the color set of an element $x \in V(G)$ is defined as $C(x) = \{\psi(x)\} \cup \{\psi(xy) | xy \in E(G)\}$. Two elements $x, y \in V(G)$ are distinguishable if $C(x) \neq C(y)$. TC is an AVD-TC if $\forall x, y \in V(G), \exists xy \in E(G)$ of a graph G , $C(x) \neq C(y)$.

Zhang et al. [11] presented a new concept of the AVD-TC of graphs and have obtained the AVD-TCN of some graphs such as C_n , K_n , $K_{m,n}$, fan, wheel and tree. (Xiangen Chen, 2010) proved $\chi''^a(G) \leq 6$ for graphs with $\Delta(G) = 3$. (Yiqiao Wang et al., 2010) investigated AVD-TCN of outerplanar graphs. (Jie Hu et al., 2019) verified that any planar graph with $\Delta(G) \geq 10$ has an AVD total $(\Delta+2)$ coloring and the bound $\Delta+2$ is sharp. AVD-TCN for pan graph, sunlet graph, tadpole, (Priyanka et al., 2022) bar bell graph, lollipop graph, windmill graph (Padma Priya et al., 2019), line graphs and splitting graphs (Thirusangu et al., 2017) was found.

The TC, is applied in varied real-world problems like the FTP on computer networks, Match Scheduling, Network task Efficiency, Aircraft scheduling and so on. We now formally define the AVD-TC and the graphs considered in this study.

Definition 1.1 (Padma Priya et al., 2019): A TC of graph is the method of assigning its vertices and edges different colors \exists no two related elements have the same color.

Definition 1.2 (Padma Priya et al., 2019): The TCN is the least number of colors required for TC of G , it is denoted by $\chi''(G)$.

Definition 1.3 (Padma Priya et al., 2019): TC is an AVD-TC if $\forall x, y \in V(G)$ where xy is adjacent, $C(x) \neq C(y)$, where $C(x) = \{\psi(x)\} \cup \{\psi(xy) | xy \in E(G)\}$.

Definition 1.4 (Padma Priya et al., 2019): The least number colors for AVD-TC is called AVD-TCN and is denoted by $\chi''_a(G)$.

Theorem 1.8 (Mythili et al., 2022): The umbrella graph is $U_{(m,n)}$. For $m \geq n$, the Total chromatic number is, $\chi_t(U_{(m,n)}) = m+2$.

Theorem 1.9 (Arundhadhi et al., 2017): The Total chromatic number of flower graph is $\chi_t(Fl_n) = 2n+1, n \geq 4$.

Theorem 1.10 (Mythili et al., 2022): Let the middle graph of comb graph be $M(P_n^+)$, then for any $n \geq 3$. Then the Total Chromatic number is $\Delta(M(P_n^+))+1$.

Adjacent vertex distinguishing total coloring

In this section, we find AVD-TCN for certain graphs.

Theorem 2.1: AVD-TCN of umbrella graph $U_{(m,n)}$ is $\chi''_a(U_{(m,n)}) = \Delta(U_{(m,n)})+1, m \geq n$.

Proof: The $V(U_{(m,n)})$ and $E(U_{(m,n)})$ are now constructed as regards

$$V(U_{(m,n)}) = \{u_i, v_j : j = 1, \dots, m \text{ \& } i = 1, \dots, n\} \text{ and}$$

$$E(U_{(m,n)}) = \{u_i u_{i+1}, v_j v_{j+1} : i = 1, \dots, n-1 \text{ \& } j = 1, \dots, m-1\} \cup \{v_i u_1 : i = 1, \dots, m\}$$

There are $m+n$ vertices and $2m+n-2$ edges in the umbrella graph.

The total coloring $\psi: U \rightarrow k, U = V(U_{(m,n)}) \cup E(U_{(m,n)})$ and $k = \{1, 2, \dots, m+2\}$

The following is the total coloring assignment

$$\psi(v_i) = i \text{ for } i = 1, \dots, m$$

$$\psi(u_i) = i+m \text{ for } i = 1$$

$$\psi(u_j) = j \text{ for } j = 2, \dots, n$$

$$\psi(v_i v_{i+1}) = i + 2 \text{ for } i = 1, \dots, m - 1$$

$$\psi(v_i u_i) = m \text{ for } i = 1$$

$$\psi(u_i v_j) = j - 1 \text{ for } i = 1, j = 2, \dots, m$$

$$\psi(u_i u_{i+1}) = m + 2 \text{ for } i = 1$$

$$\psi(u_i u_{i+1}) = i + 2 \text{ for } i = 2, \dots, n - 1$$

$$V_1 = \{u_1\}; V_2 = \{u_i : i = 2, \dots, n-1\}; V_3 = \{u_i : i=n\};$$

$$V_4 = \{v_i : i = 2, \dots, m - 1\}; V_5 = \{v_i : i=2, m\};$$

Let $C(V_i) = \{C(u) : u \in V_i\}$ denote the set of color set of elements of V_i . The edges of $(U_{m,n})$ is between the vertices of these disjoint vertex set. Since degrees of elements of each vertex set is different. Hence their color set is also distinct. There are edges between V_2 and V_4 , elements of color set $C(V_2)$ and $C(V_4)$ are distinct. Hence their color set is also distinct. Therefore, this total coloring is AVD- total coloring with $\chi''_a(U_{m,n}) = \Delta(U_{m,n}) + 1 = m + 2$. Figure 2.1 illustrates AVD-TC of umbrella graph $(U_{7,4})$.

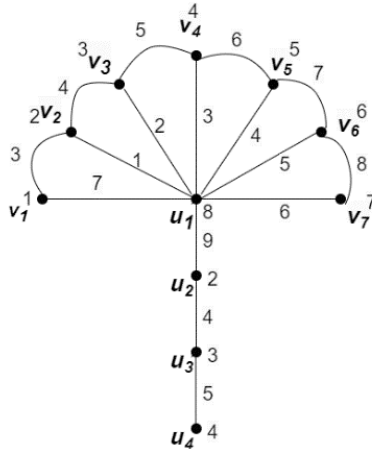


Figure. 2.1 Umbrella graph ($U_{7,4}$)

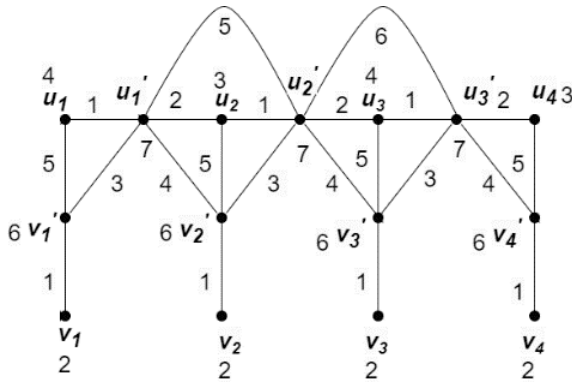


Figure. 2.2 Middle graph of comb graph ($M(P_4^+)$)

Theorem 2.2: AVD-TCN of middle graph of comb graph $M(P_n^+)$ is $\chi''_a(M(P_n^+)) = \Delta(M(P_n^+)) + 1, n \geq 3$.

Proof: The $V(M(P_n^+))$ and $E(M(P_n^+))$ are now constructed as regards

$$V(M(P_n^+)) = \{u_i, v_i, v_i': i = 1, \dots, n\} \cup \{u_i': i = 1, \dots, n-1\} \text{ and}$$

$$E(M(P_n^+)) = \{u_i v_i', v_i v_i': i = 1, \dots, n\} \cup$$

$$\{u_i u_i', u_i' u_{i+1}, u_i' v_i', u_i' v_{i+1}': i = 1, \dots, n-1\} \cup \{u_i' u_{i+1}': i = 1, \dots, n-2\}$$

There are $4n-1$ vertices and $7n-6$ edges in the middle graph of comb graph. The total coloring $\psi: U \rightarrow k$, $U = V(M(P_n^+)) \cup E(M(P_n^+))$ and $k = \{1, 2, \dots, \Delta(M(P_n^+)) + 1\}$

The following is the total coloring assignment

$$\psi(u_i) = \{(4 \text{ if } i \text{ is odd} / 3 \text{ if } i \text{ is even})\}$$

$$\psi(u_i') = 7 \text{ for } i = 1, \dots, n-1$$

$$\psi(v_i') = 6 \text{ for } i = 1, \dots, n$$

$$\psi(v_i) = 2 \text{ for } i = 1, \dots, n$$

$$\psi(v_i v_i') = 1 \text{ for } i = 1, \dots, n$$

$$\psi(u_i v_i') = 5 \text{ for } i = 1, \dots, n$$

$$\psi(u_i' u_{i+1}') = \{(5 \text{ if } i \text{ is odd} / 6 \text{ if } i \text{ is even})\} \text{ for } i = 1, \dots, n-1$$

$$\psi(u_i u_i') = 1 \text{ for } i = 1, \dots, n-1$$

$$\psi(u_i' u_{i+1}) = 2 \text{ for } i = 1, \dots, n-1$$

$$\psi(u_i' v_i') = 3 \text{ for } i = 1, \dots, n-1$$

$$\psi(u_i' v_{i+1}') = 4 \text{ for } i = 1, \dots, n-1$$

$V_i = \{u \in V(M(P_n^+)) : \deg(u) = i\}$. Let $C(V_i) = \{C(u) : u \in V_i\}$ denote the set of color set of elements of V_i . The edges of $(M(P_n^+))$ is between the vertices of these disjoint vertex set. Since the degrees of elements of each vertex set is different. Hence their color set is also distinct. There are edges between V_i , elements of color set $C(V_i)$ are distinct. Hence their color set is also distinct.

Therefore, this total coloring is AVD- total coloring with $\chi''_a(M(P_n^+)) = \Delta(M(P_n^+)) + 1$. Figure 2.2 illustrates AVD-TC of middle graph of comb graph $(M(P_4^+))$.

Conclusion

In this paper we found AVD-TCN for umbrella graph and middle graph of comb graph. Also, verified Total Coloring conjecture is followed for the above-mentioned graphs by assigning $\Delta + 1$ colors. These results can be extended to other families of graphs.

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Research and Innovation in Social Sciences



Aesthetics and International Relations: A Postmodern Outlook

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Abstract

Art has continued to take upon innumerable forms and has impacted human society as an actor of change across the globe. This multi-dynamic evolution can be exclusively witnessed through paintings or sculptures, but their significance in the socio-political realm remains the same. International events characterized by changes of such nature have been sources of inspiration for artists at various points in history making art traverse through numerous social phenomena being depicted visually through paintings and sculptures across both time and space. On the other hand, the paintings and sculptures have also been a reason for incitement of reformations in society. Psychological perspectives, economic vagaries, governance, terminology, contemporary perspectives of ethnicity, religion, and gender diversity are some of the focal points of this research as an attempt to understand their impacts with the help of suitable theoretical underpinnings. The dialectical and inimitable relationship between visual arts and politics makes it pertinent to observe them in a non-linear fashion. This paper will focus on tracing and identifying such unique congruences and patterns between visual arts and politics with a special focus on paintings and sculptures across the effluxion of time.

Keywords: *Aesthetics, Art, International Relations, Postmodernism*

Introduction

“The longer you look at an object, the more abstract it becomes, and, ironically, the more real.”

- Lucian Freud (1922)

Zimmer. T, (2021), documents how Freud explains art’s perspective of events and the impact it has on the onlookers. The tangible and intangible tools involved in the creation of an art piece have evolved to include novel elements and art has mirrored human behaviour since time immemorial. Redolent visual artworks have served as sources of inspiration to political movements and sometimes, even as revolutionary initiations. Paintings and sculptures are often shelved but these are rudiments to societal changes in itself. In this paper, the main focus is on visual arts and its relationship with international relations. Therefore, in international relations parlance, visual arts are entitled to aesthetics. The term “aesthetics” form a more theoretical and historical perspective, where it is also begun with it being a branch of philosophy. The term was first published and dates back to the 1750s from Baumgarten’s *Aesthetica*, where Gregor and Mary.J (2015) credentials mentioning the quote by Immanuel Kant on Art as the form of purposiveness, “*To begin with the term to concern the philosophical status of our sensuous grasp of the world, in all its particularity*”. The origin and evolution of art styles and art movements has been intricate. From the earliest discoveries of cave paintings to contemporary art including Artificial Intelligence powered digital art, the world of painting has evolved in all shapes and sizes that complement the time period and discoveries of each era.

Analysis of psychological perspectives

Art is known to be one of the best habits of expression. This phenomenon has been observed by art theorists, philosophers, and psychologists who have come up with their explanations on the reason why art is created and what inspired the artist or the creator to do so. Stephen P. Thornton (2001) states that Sigmund Freud assessed and studied various artist's personalities and their works of art including the legendary, Leonardo's "Virgin and St. Anne," The work of art was more important than a scientific problem for the author of psychoanalysis says Hoffeld. J., (1973). Freud's belief is that art is close to reality says Palmer. D., (1991). Freud set up in the life and work of Leonardo numerous parallels with his happenings of youth, his parents, and his anxieties about his homosexual impulses, which implies the role of gender inequality and unacceptance during the earlier times which seems to barely disappear in these contemporary times documents Freud which was translated by Strachey. J., in his Five lectures on Psycho-Analysis Leonardo da Vinci and other works compilation (1957).

Gender Stereotyping

During the symbolism art movement, (1880-1910) an iconic painting named "The Three Brides" was created by Jan Toorop (1893), its symbolisation of the Human psyche's yearning for immortality and Gender generalizations and stereotyping where lilies were regarded as the elixir of eternal femininity explains an article by Google Arts & Arts. Similarly, during the expressionism movement (1905-1925) paintings based on gender were prevalent. For instance, in *The Blue Horses* by Franz Marc (1911), Here, Gender color-coding was done as the artist considered the colour blue of the horse to depict "manliness" but refused yellow as it was a less manly hue remarks Tate, the Organization on Expressionism.

War history – Symbolisation (War scenario, war crimes, depiction of war in Media)

The primary purpose of war is ritual and emblematic. Seeing war in this way alters one's traditional understanding. Naturally, individuals simply accept what eyes tell us war is what it is, and what it is. Physical violence is used to impel others to our will. Israeli art has always developed in a complex environment. Reuven Rubin's notorious painting *First Fruits* is a good illustration where he depicted the land as an Oriental paradise, a place of harmony and fertility – the perfect setting for the birth of a new kind of Jew and the shaping of native Israeli identity. Alongside these artists, others expressed social and political engagement through their art, depicting a more sober reality in an attempt to bring about change documents Mendelsohn, a senior curator at the Israel museum.

Economic vagaries and the state's socio-cultural fluctuations

Famines, floods, wars, pandemics, endemics, and so on have been factors for increased economic instability which causes disturbances to society. Howden-Chapman and Mackenbach. (2002) convey that, the normal standard of life is disturbed for every individual in the state under conflict. Poverty has been a popular and chosen subject of the innumerable forms of art existing throughout time. The experience of poverty, sickness, homelessness due to attacks, the agony of starvation, and tears are effectively captured on canvases. An outstanding illustration is "*The Gleaners*" by Jean Francois Millet depicting two peasant women tending to a field of wheat. Here, the concept and existence of poverty have also contributed to the handiwork of noticeable works of art says in the description of the painting

Economic Stability

The status attached to the wealth acquired by the state and the state's elite gives birth to various events taking place in society. The luxuries and opportunities that are available to certain sects of the social fabric of society lead to inequality where the domination of the rich over the poor is very evident. When one community flourishes, the other suffers. A remarkable example under this category is The Arnolfini Portrait (Portrait of Giovanni Arnolfini and his Wife) by Jan Van Eyck. Upon observation, the painting had hidden detailing that signifies religious faith, status and virtue-based innuendos (oranges on the windowsill, casket and a pouch) symbolising dedication, and fidelity.

Cultural Identity and Tradition

An incredible variety of artifacts, materials, techniques, and ideas are included throughout African art. The manufacture of objects and costumes for religious and ritual purposes articulates DiPalma. J., (2022). Masquerades that are the centre of cults and those that are more secular in character are distinguished in Guro culture remarks Delafosse. M., (2012) about African Art. Likewise, Rekhi. P., on her article titled "*The Legacy of a Rasik: Ibrahim Adil Shah II and the Patronage of Painting at Bijapur, Indian Painting*" explains that the painting, The Tambur playing Sultan Ibrahim 'Adil Shah II by Farrukh Beg (1595-1600) portrays the fusion of art style and religious ideologies – Hindu and Islamic styles. And also displays the learned nature of the creator through the poetic rendition symbolised in the painting.

Statehood and state identity

Numerous events in history have left tons of scars as well as memories on the individuals who witnessed them with their

own eyes, those who heard about them, or those who learned about them. Artists who fight for equality and free of expression often produce art with deep meanings. Baker.H., (2010) writes on his article "*Ai Weiwei: 13 works to know*" that Ai Weiwei has been campaigning for human rights, and addressing issues faced by his fellow nationals who struggle with the political fabric of China and their Chinese identity and history. His art installations specifically *Still Life* (1993-2000), *Fragments* (2005), *Sunflower Seeds* (2010), and *Straight* (2008-2012) are examples of his strong view and criticism of the Chinese government and their authorities in handling the social history of the state.

Environmental awareness and Global emergencies

Lessor. R., (2020) mentions on her research on "*Art of Awareness: Understanding Environmental Art in 8 Works*" that in recent years, a lot of environmental art has included an ecological message to raise awareness of the climate change dilemma and the harm human lifestyles are causing to the earth. From large-scale interventions in isolated areas to enormous perforated tunnels and alleyways littered with broken glass art is used as a medium of awareness. For instance, *Spiral Jetty* (1970), by Robert Smithson. Environmental Art is a veritably broad term. As a movement, environmental art surfaced in the 1960s.

An assessment

Aesthetics and Politics may be two separate fields but, their contribution as a unified entity is endless. The above-mentioned impacts majorly relate with each other, in the light of revolutions or rebellions against the existing government or policies of a particular place, the paintings that are born out of the revolution as a result of a movement have the potential to induce and trigger

another art movement or a social movement as a sign of liberation. Therefore, this research can be considered as an attempt in adding one more aspect to this area of focus by making an effort in building the bridge between aesthetics and international relations. If the importance of the impacts of politics and aesthetics are understood from varied perspectives, the understanding of international events and identification of such events which can eventually help in predicting complex phenomenon, that might take place in the upcoming eras and assist in understanding the vents of the past and present as well.

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Addiction and Societal Disturbance: A study on Drug Trafficking in the Asia-Pacific Region

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Abstract

The manufacture, trade and transit routes of illegal drugs in the Asia Pacific region will be covered in this chapter. Opium addiction in China was the single biggest drug issue the world had ever faced a century ago. Since then, the Asia Pacific area has faced a security challenge from drug trafficking and illicit drug use. The most recent report from the Asia-Pacific Drug Issues Committee of the Australian National Council on Drugs, titled "Situational Analysis of Illicit Drug Issues and Responses in Asia and the Pacific," demonstrates how this problem has spread to several nations in the region. It was discovered that Myanmar is the primary manufacturer of opium, heroin and stimulants similar to amphetamines. Heroin, a more potent version of the substance, is the main issue of the twenty-first century and today 16% of heroin users worldwide come from China. In East Asia and the Pacific, there are currently thought to be 3.3 million heroin addicts, and this number is anticipated to climb. It is still very difficult to effectively combat the complexity and scope of drug manufacture and trafficking in the Asia-Pacific area. The UNODC has played a significant role in addressing the problem to reduce drug usage. The issues presented by drug trafficking in the Asia Pacific area are examined in this

article, along with a number of potential countermeasures to this serious socioeconomic and security risk.

Key Words: *Drug Trafficking, Heroin, Asia Pacific, Security risk*

Introduction

The huge Asia Pacific region, often known as APAC, includes a large portion of East Asia, South Asia, and Oceania and is characterised by its proximity to the Western Pacific Ocean. Worldwide drug addiction and accessibility have increased as international borders have become more permeable. According to the UNODC, “Drug trafficking is a worldwide illegal business that involves the production, distribution, and sale of drugs that are illegal under international law.” The so-called Golden Triangle, which includes the Shan State of Myanmar, is regarded to be the source of the spread of drugs throughout the Asia-Pacific area. (Ebbighausen, 2020) Parts of Thailand, Laos, and Myanmar’s Shan State are included in the Golden Triangle. There are two key factors that contribute to the favourable environment in the area. First, there is the inaccessible mountain range, which creates perfect conditions for the production and trafficking of drugs. The second factor is the unstable power dynamics in the area, which the International Crisis Group refers to as ‘stable insecurity.’ The yearly value of the drug traffic in the Asia-Pacific region is estimated to be \$61.4 billion, with Thailand, Myanmar, Cambodia, and Laos accounting for more than 90% of all pills intercepted in Asia. In East and Southeast Asia, Thailand has continuously placed first in terms of drug-related arrests and methamphetamine seizures. (Arcado, 2022)

Methamphetamine production replacing traditional opium production

In the 19th century, the British Empire gained huge profit from smuggling opium into China, which is when drug trafficking and drug gangs first emerged. The proliferation of narcotics and the creation of the biggest criminal organisations have been influenced by major powers, the pharmaceutical industry, banks, and secret agencies. The Golden Triangle area has a long history of being infamous for its opium and heroin production. But methamphetamines have long been expanding their market share. Methamphetamine manufacturing provides a number of benefits over opium growing. The key benefit of making methamphetamine is that it does not rely on the opium poppy harvest cycles and does not require extensive growing sites. However, only labs and those can be made mobile and moved as needed. Cannabis, cocaine, heroin, and methamphetamine are just a few of the narcotics that are trafficked by criminal organisations. Seizures of methamphetamine alone reached a record level in 2021, totaling 1 billion pills, or about eight times the weight of seizures from ten years prior. According to a UNODC report, authorities in Asia seized a record 170 tonnes of meth in 2018, an increase of almost 20% from 2019, bringing it on pace with the synthetic drug industry in North America. At current rates, the 340 tonnes of heroin consumed worldwide each year and the 430–450 tonnes seized each year constitute the yearly influx of heroin into the international market. About 50 tonnes of that amount come from opium produced in Myanmar and the Lao People’s Democratic Republic.(United Nations Office on Drugs and Crime)

Concerned traffic routes and cross border drug trafficking

Some Southeast Asian nations have long been used as a conduit for the export of illegal drugs to regions throughout the world, including North America, Europe, and Northeast Asia. Because of the porous borders and the fact that, in Myanmar for instance, border controls are carried out by the same organisations that receive funding from drug trafficking, there is concern over the drug trade routes. For instance, militant ethnic groups in Myanmar have long been involved in the drug trade. Two such groups are the United Wa State Army (UWSA) and the National Democratic Alliance Army (NDAA). They also have sovereignty over the territory that borders Thailand, Laos, and China. Additionally, the security services of Thailand and Laos only have a modest amount of control over the wilderness and mountains covered in jungle.

Despite a recent decline in opium output, Myanmar is still the second largest producer worldwide trailing only Afghanistan. (Ng, 2023) The majority of heroin manufactured in Myanmar is being transported through China, as opposed to the peninsula's former route through Thailand. The most significant transshipment route for the global market is currently via China. New routes from Afghanistan into western China, especially through Xinjiang region, have been added to routes from Myanmar through China. Over the past year, new sea routes from Myanmar to Malaysia through the Andaman Sea have appeared.

The impacts of drug trafficking

Growers, producers, couriers, suppliers, and dealers are all part of the global drug trade. It has an impact on all of the associated countries, concerning political and economic stability as well as ruining people's lives and entire communities. End users

and victims are frequently the targets of a strong and cunning business. (Interpol) It can be difficult to define and pinpoint a population's susceptibility to involvement in the manufacturing, trafficking, or consumption of illegal drugs. However, there are a number of elements that have increased illicit drug usage or manufacturing in similar circumstances. Several socioeconomic factors include:

- A booming middle class youth population, strong economic expansion, and domestic migration.
- An unequal distribution of growth's benefits, which widens the gap between the rich and the poor and affects people's capacity to engage in the formal economy.
- Political unrest and external migration creates human trafficking for the unlawful drug trade and deprived populations without access to the formal economy. (John Howard, 2009)

Related efforts taken to combat the drug menace

Prior to 2010, certain Asian countries in this area had established objectives to be 'drug-free' by 2025. While all of the others under consideration take part in cooperative drug control initiatives with other nations to improve information sharing and integrated efforts. The ASEAN Narcotics Cooperation Centre has been set up as a focal point to provide regional preventative and suppressive actions as well as to start proactive prevention and resolution on drug addiction in all ASEAN nations. The 'Operation Lionfish' in the Asia-Pacific region was carried out under the auspices of INTERPOL's Project AMEAP (Africa-Middle East-Asia Pacific), which coordinates initiatives for a number of anti-drug trafficking activities. (Operation Lionfish, n.d.)

Policy responses

The majority of nations have a primary organisation that oversees supply and demand reduction activities for drugs, frequently one that is at least ostensibly multisectoral. Examples include the Narcotics Division of the Security Board in Hong Kong, the Central Committee for Drug Abuse Control in Myanmar, etc. Every nation in the poll has a significant governmental objective to reduce drug usage, trafficking, production, and/or cultivation, frequently to zero. The implementation of a variety of supply and demand approaches, including ongoing and frequently intensified law enforcement efforts against drug users and traffickers, community-based prevention efforts like school-based education, and the provision of treatment and rehabilitation for drug users, are strategies to achieve this goal. These methods differ in their emphasis and level of effort for different countries.

Relevant protocols and drug laws enforcement

A helpful tactic to lessen reliance on illegal production or the trade in chemical precursors could be to permit farmers to monetize the plant as a medical or cash crop. The necessity for tax autonomy is another topic that hasn't received much attention while talking about illicit finance in Southeast Asia. Local governments are able to maintain their operations, respond to demands at the local level, help to reduce poverty, and discourage illegal economic activity thanks to tax income. China has had great success shutting down medication manufacturing facilities there. Beijing also takes action against drug trafficking and shares intelligence data with its neighbours. But if we want to control the situation, closer collaboration is crucial.

Analysis

Drug enforcement authorities claim that stopping the flow of precursor chemicals into the Golden Triangle is the only way to stem the tide of meth. A bigger risk exists, according to the UNODC, if novel precursors are not swiftly found and controlled. Border Liaison Offices have been a key part of border management and control in this location as well as a productive means to enhance cross-border collaboration between authorities. (Douglas, 2020) The region's border patrol police, army, navy, and customs have coordinated efforts to gather and exchange intelligence in order to combat organised illegitimate gangs. Thai police now have new instruments to employ against illicit trafficking, including drugs and precursor chemicals, which are thought to be crucial to preventing the damaging trade. These new technologies include X-ray devices, from hand-held to lorry-sized machines. Policymakers now need to place the levels of heroin and synthetic drug crime in a worldwide context. (Coyne, 2022)

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Intersecting Inequalities: Examining the case of Gender and Disability Discrimination in India

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Abstract

Gender, and, disability, as topics of independent study, have been extensively researched, but when taken together, it is evident that this is an ambivalent, indefinite and under-explored dependency. Census 2011 reports that there are 26.8 million disabled people in India, out of which, 11.8 million (44%) are disabled females. In a country where gender inequality itself is an entrenched issue, disability and gender is a double discrimination to women. Additionally, 55% of these women are illiterate which pushes them into poverty, thereby adding a third – economic - dimension to discrimination. Such multiple discriminated women are subject to sexual harassment, social stigma, violence and neglect. The legal ecosystem regarding disability and women is enshrined predominantly in the Constitution of India and The Rights of Persons with Disabilities Act 2016. While these do address non-discrimination and inclusion, however their scope is severely restricted. On this backdrop, this paper discusses several questions such as how do we perceive disability in general and, gender and disability in particular? Do we have de facto equality when it comes to disabled women and their representation in political and economic spheres? The author employs a literature review approach and a comparative

analysis to throw light on these issues. The paper concludes by making certain recommendations to diminish negative stereotyping of disabled women and to construct a positive approach to ensure that they live a life of dignity.

Keywords: *Gender, Disability, Discrimination, Indian Constitution, PWD Law*

Introduction

Disability can be a confounding experience. Persons with disabilities are amongst the most disempowered groups. Women with Disabilities are experiencing continuous unfair treatment by the hands of society. In India, the dominant attitude towards persons with disability is that of pity. Women are nearly half of the human population but are placed unequally with men in every respect starting from right to freedom, to education, to health, reproduction, nutrition etc. Despite disability being a widely studied topic, the intersection of gender and disability is an unexplored issue. This paper aims to examine the influence of disability on the lives of women in India and its overall impact. An overall analysis reveals several lacuna in the understanding of the very notion of disability itself, and further, its implications with respect to women.

Gender and Disability

Disabled people have often been represented as without gender. More precisely, as asexual people, the 'Other' to the social norm. In this way it may be assumed that for disabled people gender has little bearing. Oftentimes, women more than men are classified as disabled. The Societal treatment of disability highlights the difference between men and women.

Definition of disability

The UN Convention on the Rights of Persons with Disabilities (UNCRPD) recognizes that “disability is an evolving concept (UNCRPD, 2006)”. “Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others (UNCRPD, 2006)”.

The Meaning of Gender

Gender is the structure of social relations that centres on the reproductive arena, this subgroups the behaviours of human beings as feminine and masculine. Gender is hierarchical and produces inequalities and results in Gender inequality and discrimination faced by women and girls which puts their health and well-being at risk.

Disability and Feminism

Feminism challenges the belief that femaleness is a natural form of physical and mental deficiency or constitutional unruliness. Feminists have critiqued the traditional roles of daughters, wives, and mothers as oppressive but these may be the very roles that women with disabilities aspire to precisely because they are denied to them. Historically, the Indian women’s movement has focused on issues like poverty, caste inequality, social practices like sati and dowry, female feticide. However, disability based oppression was not found in the agenda. They are now only being recognized as a distinct marginal category. Inclusive feminist projects must be affirmed for disabled women to express their views, agency and desire.

International Law

“United Nations Conventions on the Rights of Persons with Disabilities (UN CRPD, 2008)”, is an inclusive process for persons with disabilities. This Convention is intended as a human rights instrument with an explicit, social development dimension.

“UN convention on the Elimination of All Forms of Discrimination Against Women (CEDAW)”, is an international legal instrument which has long recognized the unique discrimination women with disabilities experience and is trying to include women with disabilities in their gender equality efforts.

Constitutional and legal conception of Disability in India

Disability as a ground itself is not mentioned directly in the Indian Constitution but has evolved from jurisprudence on the issue. The most important Act with respect to disability in India is “Rights of Persons with Disabilities Act, 2016 (RPWD Act, 2016)”. The RPWD Act, 2016 of India has provided 21 categories to identify disability and has been considerably modified towards progressive dimensions than its predecessor “PWD Act, 1995”. Nevertheless, Disability Constitutionalism of India is still a worrisome issue and the quest to define disability is not going to end any time soon.

Challenges faced by the women with disabilities

The plight of women with disabilities as earlier mentioned is far worse than that of men, as they suffer on account of being a woman in a male-dominated society. According to the 2011 Census, “around 2.2% of India’s population live with a disability”. Amongst 26.8 million disabled people, 11.8 million i.e. 44% are females. Various research studies show that girls and women with

disability face an additional risk of violence and sexual violence. Disability is often another excuse for domestic violence as they are perceived to be ‘more dependent’.

Denial of basic rights

Women and girls with disabilities face barriers in accessing education, employment, transportation, and housing, which hinders their ability to achieve economic independence and contribute to their communities. According to a research conducted by Mitra and Samba Moorthi in India, “men with disabilities have three times higher employment rates compared to women with disabilities (2006)”. Additionally, existing gender discrepancies in India pans out in adding to the disadvantage of the women with disabilities.

Marriage and disabled women

A disabled woman faces the challenge of being seen as unable to meet the traditional expectations of being a homemaker, wife, and mother, which creates an additional burden for women. Especially in the case of marriage, there arises unique challenges for disabled women. These challenges can contribute to differences in certain outcomes such as marital status, caregiving responsibilities, and experiences of violence.

Increased violence

Protection against violence, even the inadequate protection afforded to non-disabled women, is not available to women and girls with disabilities. Women with disabilities frequently find themselves subjected to acts of violence, rendering them highly vulnerable with various societal contexts. They encounter significant challenges, such as sexual misconduct, domestic abuse, and workplace mistreatment. The situation of intellectually

disabled girls and women are far worse because they are abused by the people to whom they were entrusted with their safety and well-being. The perpetrators exploit the belief that these victims may struggle to report the incidents, enabling them to evade accountability and consequences for their actions.

Other fallouts

Women with disabilities, especially the deaf community, lack access to information. Women with disabilities have little access to formal information. Their right to information is restricted. Persons with speech and hearing difficulties may have limited communication skills to report abuse. Furthermore, since disabled persons are often taught to be obedient, this may make them easy victims. Lack of awareness is one of the many reasons as to why disabled women are unable to ask for correct aids for themselves.

Triple Discrimination

In India, poverty is considered to be both the reason as well as the result of disability. According to the World Bank report, “a quarter of these disabled women in India are rarely able to manage three complete meals in a day” (World Bank 2007). Therefore, a large number of women with disabilities in India end up facing what is known as “triple discrimination”.

Psychosocial Issues of a Disabled Women

Gender disparities are eminent in depression. Women with disabilities have been called the “poorest of the poor”. It directly affects their self-esteem. On average, the reported problems associated with low self-esteem include depression, unemployment, and social isolation, limited opportunities, compared to women without disabilities.

Way Forward

Discriminatory social attitudes and denial of basic rights to persons with disability has made them weak, powerless and isolated throughout history. It resulted in more complications for women with disabilities compared to men.

Certain recommendations can be considered:

1. Formulating a wide array of acts to protect the interests of the disabled people. More specifically, having created separate laws for disabled women.
2. Ensuring the provision of high-quality education to women with disabilities and motivating them through the provision of scholarships
3. Creating an environment for an equal representation.
4. Ensuring their active participation in the decision making processes and giving them with an opportunity to express their opinions
5. Organizing a recurring awareness campaign to firmly establish that disability is not uncommon
6. As the Deaf do not have access to informative information, personnels of public & health institutions should be taught sign language to their staff to be able to interact with the deaf.
7. Comparative analysis serves as a valuable tool in recognizing the deficiencies in the Indian legal system and enable to formulate strategies by learning from other nations

Consequently, there is a need to reclaim what has been traditionally viewed as negative and off centered. Actuality of Women with different disabilities should be explored, recognized

and redeemed. Ableism should be avoided at all costs and should pave the path for inclusion.

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Female Political Participation in India: A case study on the Political Leadership of Women

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Abstract

Gender dimensions in political leadership and citizens' perspectives on female leaders have influenced power systems since ancient times. As we aim to achieve the Sustainable Development Goals by 2030, women need equitable access to political power and leadership positions. Worldwide, however, women are underrepresented in positions of power, and political parity for gender is still a long way off. Only 13 out of the 193 members of the United Nations are now led by women. To attain gender equality at the highest echelons of authority, another 130 years will pass. The study traces barriers to female leadership and participation in political decision-making, focusing on how gender influences societal attitudes on leadership. Data from civil society organizations and international organizations are used to understand the perception of voters about women in leadership today with India as a case study.

Keywords: *Leadership, gender, politics, societal perspectives*

Introduction

Global authorities are concerned about women's leadership, an issue that has been a matter of concern since the early nineteenth century. Feminist thinkers aimed to establish women's place in

society but faced social challenges and social neglect. The late twentieth century saw liberal thinkers redefine women's roles, and women in the twenty-first century are now more aware of the challenges they face and are determined to close the gender gap. The main focus of study in this paper includes the lack of women in political leadership roles, the challenges they face, and societal perspectives on female leadership and its changes.

Participation of women in Politics

Modern constitutional democracy emphasizes the proportionate political representation of all populations, but women have traditionally been politically marginalized in all parts of the world. Social movements have successfully enacted reforms since the mid-19th century, with the United Nations Organization (UNO) supporting women's rights in its Charter. The Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) affirms "women's right to political and public office" (CEDAW, 1979). The Millennium Declaration of 2000 defined eight MDGs to be achieved by 2015, one of which was to "promote gender equality" (Millennium Development Goals, 2015). In 2016, the initiative was expanded to target 17 SDGs, with Goal 5 seeking to achieve "gender equality and empower all women and girls" (Sustainable Development Goals: 17 Goals to Transform Our World, 2016).

Many parliaments and legislative bodies have enacted laws and procedures to ensure women are represented in leadership positions. However, data from September 2022 demonstrates that "women are underrepresented at all levels of decision-making worldwide, and that achieving gender parity in political life is far off" (*Facts and Figures: Women's Leadership and Political Participation*, 2022). Only 14 countries have achieved

50% or more female cabinet representation, implying that only 21% of government ministers were female. Gender equity in ministerial seats has increased by only 0.52 percentage points per year, highlighting the need for further analysis and steps toward inclusion in leadership roles (*Facts and Figures: Women's Leadership and Political Participation, 2022*).

Perception of Female Leadership

Female leadership faces barriers to advancement compared to men with similar strengths and talents, known as the glass ceiling. This process is described as a 'labyrinth' (Eagly and Karau, 2022) that must be navigated, with women often placed in difficult situations or subjected to double standards when evaluating their leadership. In a world where male dominance is prevalent, women's access to leadership positions becomes a challenge.

Women leaders' historical images often reflect their marginalization, with their portrayal as 'feminine' often being a double-edged sword. Being too feminine risks being perceived as weak and emotional, while being insufficiently feminine results in being labeled as masculine, abrasive, or pushy. This gender bias and disparities in the language used to describe female leaders in masculinized contexts contribute to the perception that women's roles and those of leaders are incompatible. Eagly and Karau (2002) found that "women are perceived less favourably than men as potential occupants of leadership roles, and their behavior that fulfills the prescriptions of a leadership role is evaluated less favorably when enacted by a woman". This makes it more difficult for women to succeed in leadership positions.

Indian Women's Political Participation

Women have historically been marginalized and oppressed in India, owing to patriarchal societal institutions. Social reform movements, such as the Swadeshi in Bengal, have played a significant role in promoting women's welfare and political empowerment. Following independence, the Indian Constitution guarantees that "women and men have equal rights in all social, political, and economic aspects of life. Part III of the Constitution guarantees men's and women's fundamental rights, while the Directive Principles of State Policy ensure economic empowerment through equal pay, humane working conditions, and maternity relief" (Ghosh, 2022).

Indian nationals must be at least 25 years old to contest for election to the lower house of Parliament or state legislative assemblies, with a minimum age requirement of 30 for the upper house. Articles 325 and 326 of the Constitution ensure "political equality and the right to vote" (Chary, 2012). The Constitution also provides provisions for the "reservation of seats in Parliament and legislative assemblies for Scheduled Castes and Tribes" (Chary, 2012). Despite criticism from prominent Indian women's organizations and the ruling party, Congress, a plan to offer a reserved quota for women was denied. The Committee on the Status of Women in India emphasized women's representation in political institutions in 1974 (Hasan, 1974). In 1992, the 73rd and 74th amendments to the Constitution allocated "one-third of seats in Panchayati Raj Institutions and municipal bodies for women" (Chadha, 2014). Proposals to legislate seat reservation in parliament and state legislatures in 1997 faced opposition, and till today no law has been passed.

Before the early 1990s, there were not many women running for office in parliamentary and state assembly elections; nevertheless, local reservations for women increased the number of women in leadership positions. Major political parties began to nominate more women after the 1996 elections due to a proposal to increase the reserved seats for women as candidates in the state and federal legislatures. Despite increased voting participation, women are still underrepresented in both the Lok Sabha and the Rajya Sabha as compared to male candidates. Among the 8,049 candidates in the 2019 Lok Sabha elections, women made up fewer than nine percent (*Record 78 Women MPs in New Lok Sabha, n.d.*)

The number of female candidates and members of parliament varies substantially among states and parties. Women account for 14% of all MPs in Uttar Pradesh and 26% in West Bengal in the current Lok Sabha. In 2019, the Congress Party had 54 female candidates, while the Bharatiya Janata Party had 53. Women made about 17% of all candidates in Goa and Manipur, the states with the greatest percentage of female candidates (Ghosh, 2022). According to 2020 data, “women’s representation in the Rajya Sabha has been marginally lower than that in the Lok Sabha, with the overall membership of the chamber still falling short of 13%. The average representation in state legislative assemblies, or Vidhan Sabhas, is even lower, usually dipping below 10%” (SamVridhi forum, 2021).

Women have achieved tremendous success in local politics in India’s third tier of government, municipalities, and rural regions. Women’s political engagement at the municipal level increased dramatically as a result of the 1992 constitutional amendments, which gave women one-third of the seats up for election in local bodies. Since then, reservations have climbed to

50% in 20 of India's 28 states (Shanker, 2014). The challenge of proxy representation, where women elected to office were mostly controlled by male family members, has also decreased (Ghosh, 2022). The enhancement of women's political awareness has been facilitated by several skill development programmes and leadership training sessions at the grassroots level, run by both government and non-governmental organizations (NGOs).

Understanding the Voters' Views on Gender Dimensions to Political Leadership in India

According to a recent Pew Research Centre survey of over 30,000 individuals in India, most Indians feel that "women and men make equally good political leaders," and "more than one-tenth believe that women normally make better political leaders than males" (Ghosh, 2022). Overall, a slight majority of respondents (55%) agree that men and women make equally competent political leaders. Minor gender differences have been observed, with men being more likely than women to believe men are better politicians (29% vs. 21%, respectively), while women are slightly more likely to believe women leaders have abilities to govern the country (16% vs. 13%). It has been observed that younger Indian adults and college graduates are slightly more likely to agree that women and men make equally good political leaders than their elders and those with less formal education (Ghosh, 2022).

The opinions towards gender and political leadership vary widely throughout Indian states, with certain states having populations where males are preferred as political leaders by a third or more of the populace. By large, Indian adults' support for equal rights for women is roughly in line with the global median. While there is still a long way to go for women's political representation

in India, policy change can contribute to India's improved performance on other indicators of development including women's economic independence, educational attainment, health, and survival.

Conclusion

“No country can ever truly flourish if it stifles the potential of its women and deprives itself of the contribution of half of its citizens” (Obama, 2014). Michelle Obama's words highlight the issue of underrepresentation and bias in society, which hinder sustainable development and socio-cultural harmony. Current leadership theories often overlook gender identity, lived experience, and its intersection with multiple dimensions of self-identity. The future scope of gender studies in leadership should focus on understanding the conditions under which women leaders' strengths lead to better outcomes and working towards effective leadership in gender-equitable environments. This may require paradigm shifts and the resolution of difficult problems, such as avoiding unconscious biases and promoting gender-equitable organizational cultures. It is crucial to avoid conflating perceptions and expectations of effective leadership with socially constructed gender and racial stereotypes.

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Assessing Neutrality in the framework of Non-Aligned Movement: A Case Study on India's Perception and Influence

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Abstract

Developing nations gathered and stood by the concept of non-alignment, which led to the formation of the Non-Aligned Movement, a grouping of countries that are not formally aligned with or against any major power bloc. The group was formed under the leaders of India, Indonesia, Yugoslavia, Egypt and Ghana, an action referred to as "The Initiative of Five", with the first summit held in Belgrade in 1961. The purpose of the organization is to promote solidarity among developing countries, to strengthen their collective voice in international affairs, and to provide a platform for developing countries to discuss international issues, including political, economic, and social. This paper focuses on Prime Minister Nehru's influence on the formation of the Non-Aligned Movement (NAM) and India's foreign policy under PM Narendra Modi's directions which reflects his non-alignment philosophy. This research paper focuses on Non-aligned movement in India and its contemporary relevance and its influence in the international system.

Keywords: *Non-Aligned Movement, Nehru, Perception, India, Foreign Policy*

Introduction

The Non-Aligned Movement (NAM) was established at the height of the Cold War, with the fall of the colonial order and the fights for independence of the peoples of Africa, Asia, India and other parts of the world. It was a group of nations that aimed to maintain their independence rather than overtly aligning with either the United States or the Soviet Union, the dual power blocs. The group's fundamental idea first surfaced in discussions in 1955 at the Asia-Africa Bandung Conference in Indonesia. Newly independent Asian and African nations had adopted an autonomous foreign strategy in which they seek to become independent through the NAM. The NAM nations were all developing nations. The three primary factors that have shaped its methodology are the right to independent judgement, the fight against imperialism and neo-colonialism, and the use of moderation in interactions with all major nations. Facilitating a reorganisation of the global economic system is currently a second objective. During the Cold War, the NAM functioned as a platform for developing countries to voice their concerns and advocate for their interests. They were given a platform to advocate for decolonisation, disarmament, and economic growth. The NAM made a great contribution to promoting peace and settling disputes in numerous locations. The NAM has widened its scope in recent years to encompass concerns like terrorism prevention, human rights, and climate change. Also, it has been more involved with international organisations like the World Trade Organization and the United Nations. The NAM is currently the largest international organisation outside of the UN, with 120 members and 17 observer nations. Although the NAM may not be as well-known as it was during the Cold War, it nevertheless gives developing nations a platform to advance their objectives and push for a more just and equitable international system. (NTI, 2020)

PM Jawaharlal Nehru and NAM

Jawaharlal Nehru was one of the founding fathers of the Non-Aligned Movement. Nehru had a major role in propagating the idea of non-alignment and in generating support for the movement. Nehru hosted the first NAM summit in 1955 in Bandung, Indonesia, where participants from 29 nations came together to talk about subjects of shared interest and to reaffirm their commitment to non-alignment. The movement's guiding ideals and objectives, which supported disarmament and development while rejecting imperialism and colonialism, were shaped by Nehru's lobbying and leadership. When faced with pressure from the superpowers, Nehru believed that non-alignment was a method for newly independent nations to preserve their independence and sovereignty. He also saw it as a tool to advance the interests of the developing countries and to advance world peace and cooperation. The Korean War began in 1950, and Nehru was India's prime minister at the time. Nehru advocated for a peaceful end to the Korean War and urged all sides to the conflict to look for a diplomatic resolution in a 1950 speech he gave to the UN General Assembly. In addition, he criticised the use of force and highlighted the significance of upholding the sovereignty of all countries.

His non-alignment foreign policy, which placed an emphasis on neutrality and international cooperation, was reflected in Nehru's stance on the Korean War. Nehru emphasised his disapproval of the US involvement in Vietnam during the Vietnam War, which was from 1955 to 1975, and his desire for a peaceful solution to the war. According to Nehru, the Vietnamese conflict was a civil war that the Vietnamese people must resolve peacefully, without outside intervention. (David Malone, 2016)

PM Narendra Modi and NAM

Since taking office in May 2014, Prime Minister Narendra Modi has served as India's prime minister. India has maintained its active involvement in NAM under PM Narendra Modi's leadership and stressed the necessity of the movement adapting to the shifting international landscape. In his remarks at NAM summits and other international venues, PM Modi has urged more collaboration amongst NAM member nations on problems like terrorism, climate change, and economic growth. PM Modi has also promoted India's interests and increased its influence internationally by taking advantage of India's membership in NAM. For instance, India has requested assistance from NAM nations in its quest for a permanent seat on the UN Security Council, and Modi has used NAM meetings as a stage to highlight India's accomplishments in a variety of areas. Narendra Modi attended the BRICS (Brazil, Russia, India, China, South Africa) meeting in Brazil in 2014. Modi advocated for a non-aligned, cooperative world order during the summit, one that is more fair and just. By urging a stop to violence and violations of human rights but also highlighting the significance of preserving Myanmar's sovereignty and territorial integrity, Prime Minister Modi has adopted a circumspect stance towards the ongoing crisis in Myanmar. Prime Minister Modi has made statements regarding Russia's invasion of Ukraine. In September 2022, he directly rebuffed Moscow's invasion and told Russian President Vladimir Putin that now is not the time for war. In general, PM Modi's strategy for non-alignment is evident in his attempts to keep the balance between various powers and to advance international cooperation and communication. (PIB, May 2020)

India's Perception and Relevance

India still views the Non-Aligned Movement (NAM) as important since it continues to play a significant role in the nation's foreign policy. India was among the NAM's founding members, although over time, its position and contributions have changed. On the evening of May 4, 2020, the Non -Aligned Movement (NAM) conducted an online summit to debate how to respond to the current COVID-19 pandemic catastrophe. Prime Minister Narendra Modi took part in the summit. The online NAM Summit on the theme of "Together against COVID-19" was hosted by the current Chairman of NAM, President of the Republic of Azerbaijan HH Ilham Aliyev. The summit's goals were to mobilise State and international organisation efforts to combat the COVID-19 epidemic and to encourage global cooperation in this endeavour. As part of the celebration, the International Day of Multilateralism and Diplomacy for Peace was recognised. As one of NAM's most important founding members, PM Modi's participation highlighted India's steadfast dedication to its principles and ideals. In his remarks, the Prime Minister emphasised the significance of the international community responding in a coordinated, inclusive, and equitable manner to this crisis, outlining the domestic and international actions India had taken while reasserting India's readiness to provide assistance in solidarity with the Movement, to the greatest extent possible. (Rasool, 2019)

Conclusion

The Non-Aligned Movement (NAM), a loosely organised group of nations during the Cold War, has developed over the previous six decades into a more significant and active worldwide organisation. The NAM has stepped up its advocacy of multilateralism, global governance, and sustainable development.

The organisation has also broadened the scope of its work to address topics including terrorism, disarmament, and human rights. Members of the NAM are currently actively involved in programmes like the New International Economic Order, which aims to eradicate poverty and inequality through trade, investment, and technological advancement. The NAM has also been more active in the international sphere, particularly at the UN, where it has taken a prominent role in the effort to combat terrorism and other security challenges on a worldwide scale. Notwithstanding the fact that a lot has changed since Nehru's era, the Non Aligned Movement's guiding ideas and objectives are still crucial and necessary.

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**Community-based Research
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Nutritional Status of College-going Cricketers in Chennai and Impact of Nutrition education on their Knowledge and Attitude (18-25yrs)

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Abstract

Sports has been gaining a great momentum across the world. It improves physical as well as mental health of students. Cricket being an exuberant sport requires proper nutrition and training program to achieve optimal performance. However, there is not much documented evidence on the assessment of nutritional status among college-going cricketers. Hence, this study was conducted with an objective to assess the nutritional status of college-going cricketers in Chennai, and to determine the impact of nutrition education on their Knowledge and Attitude. One hundred college-going cricketers from various city colleges in Chennai were surveyed to elicit their background profile. Anthropometric measurements like height, body weight, waist circumference, hip circumference, body fat percentage were assessed for all the subjects and their BMI and waist-to-hip ratio were calculated. The nutrient intake of the subjects was assessed using 24-hour dietary recall method. A sub-group of 50 subjects were selected for the experimental phase and a pre-test questionnaire was given to these subjects to assess their Knowledge and Attitude in the field of nutrition. A nutrition education program was

conducted among the sub-group with an aim to create awareness on Nutrition. The impact of nutrition education on the Knowledge and Attitude of the subjects was assessed 30 days after the Nutrition education program with the help of a post-test questionnaire. Results revealed that the subjects reported a normal BMI, but there was a deficit in energy, carbohydrate, protein, dietary fibre, calcium and iron intake among college-going cricketers. The mean Knowledge and Attitude scores increased 30 days after the nutrition education program and it was found to be statistically significant ($p < 0.01$). The findings of the present study reveal that college going cricketers had a deficit in certain essential nutrients which may be attributed to the wrong choices of food due to lack of knowledge in the field of nutrition. Nutrition education program conducted had a significant impact in improving the Knowledge and Attitude among college-going cricketers which may go a long way in improving their overall nutritional status.

Keywords: *Sports, Cricket, Nutrition education.*

Introduction

Physical activity promotes wellness in youths as well as adults. Physical inactivity has been identified as the fourth leading risk factor for global mortality and it is evident that engaging in regular physical activity early in life can lead to healthy activity habits in later years thus reducing the risk of disease and improving the quality of life (Kant, 2014). Elementary students who play sports are more likely to become active teens who, in turn, are more likely to be active adults (Bhat and Wani, 2018). Cricket is a great sport and an energetic game, giving happiness and enjoyment, which requires adequate training and a level of commitment

(Santosh and Jyoti, 2011). Cricket is a long duration game which requires explosive power, speed, agility, strength, flexibility and cardio-vascular endurance (Kumar and Kumar, 2018).

Nutrition is a major contributor to an athlete's overall sports performance. Poor nutrition can lead to injury, fatigue and poor recovery, all three of which can hinder how well an athlete performs (Kaur, 2020). Appropriate nutritional guidelines are essential for optimal training programs to aid in adaptations, peak sports performance and injury prevention (Greenwood et al., 2015).

Athletes and other exercising individuals are often in need of proper nutrition education. Nutrition education can help people learn to eat well by enhancing their motivation through effective communication as well as by improving their ability and opportunities (Contento, 2016).

Methodology

The present study was carried out with a broad objective to conduct a survey among 100 college going cricketers in Chennai. The study also aimed to assess the nutritional status of the subjects using selected anthropometric measurements and nutrient intake and, to determine the impact of nutrition education on the Knowledge and Attitude of a sub-group of college-going cricketers.

The area chosen for the study was Chennai due to the familiarity of the investigator with various Educational Institutions in the city. With the support of the Head of the Physical Education Department along with the students in various Educational Institutions, the investigator was able to conduct a survey among 100 college-going cricketers. The subjects included male and female college students aged 18-25 years who were cricketers.

They were chosen from the following Educational Institutions: Women's Christian College, Ethiraj College for Women, Queen Mary's College, Quaid-E-Millath Government College for Women, St.Thomas College of Arts and Science and Dr.M.G.R Educational and Research Institute University.

A survey design was chosen to elicit the background profile of one hundred college-going cricketers. An interview schedule was used for this purpose and information on age, gender, educational status, income, health status, activity pattern, personal habits and dietary pattern were gathered. The experimental design chosen for the study was pre-test, post-test experimental design to assess the impact of nutrition education on the Knowledge and Attitude of a sub-group of 50 subjects from the surveyed college-going cricketers.

A period of two months was required to conduct a survey and assess the nutritional status of 100 college-going cricketers. Nutritional status was assessed for all the subjects using selected anthropometric measurements like height, body weight, waist circumference, hip circumference and body fat percentage. BMI and waist-to-hip ratio were calculated. The nutrient intake of all the subjects was assessed using a 24-hour dietary recall method. The study duration for the experimental phase included 30 days for the sub-group of 50 subjects who participated in this phase. A pre-test questionnaire was given to them to assess their Knowledge and Attitude in Nutrition. A nutrition education program was conducted among the sub-group with an aim to create awareness on nutrition among the subjects. The program focused on balanced diet, MyPlate concept, basic five food group, importance of macronutrients and micronutrients, water, electrolyte balance and pre-event and post-event meals. After a period of 30 days, the same

questionnaire used for pre-test was given as post-test to find out if there was any improvement in their Knowledge and Attitude, and their scores were compared. A pamphlet, bookmark and a recipe book was distributed to all the subjects who participated in the nutrition education program.

Results

The survey on 100 college-going cricketers revealed that a majority (58 %) of the subjects belonged to the age group of 21-23 years. 67 per cent were females and 33 per cent were males. Among the subjects who had medical problems, a majority (40 %) had asthma and 30 per cent of the subjects were diagnosed with anaemia. It was observed that about 39 per cent of the subjects reported family history of diseases and among them, 66.7 per cent of the subjects reported a family history of diabetes. About 44.4 per cent of the cricket players experienced dehydration and 49.2 per cent suffered from joint pain after exercise session or matches. A greater percent (58 %) of the subjects practiced cricket daily. About 32 per cent of the subjects engaged in regular physical activity other than sports with 50 per cent performing it thrice a week. Majority (98 %) of the subjects were non-smokers. About 94 per cent of the subjects never had the habit of consuming alcohol. A greater per cent (92 %) of the subjects were non-vegetarians. Ninety-five per cent of the subjects had the habit of snacking, of which 37.9 per cent consumed snacks on a daily basis. A majority (78.9 %) consumed samosa and puffs. Meals were skipped occasionally by 40.7 per cent of the subjects. Among the subjects who had the habit of consuming ergogenic aids, 96.2 per cent consumed fruit juices and 66.7 per cent consumed tender coconut water. Majority (46 %) of the subjects had the habit of drinking 2-3 litres of water daily. About 92 per cent of the subjects consumed plain water to

replenish the body to prevent from dehydration while 17 per cent of the subjects consumed fruit juices. The mean BMI of males and females were found to be 20.7 ± 3.12 kg/m² and 21.5 ± 3.79 kg/m² respectively and it can be inferred that their BMI was found to be normal. The mean waist circumference for males and females was found to be lower when compared to the normal cut-off values.

A. Mean Nutrient Intake of the Subjects

The mean nutrient intake of the subjects and the percentage excess or deficit in nutrients is depicted in fig.1.

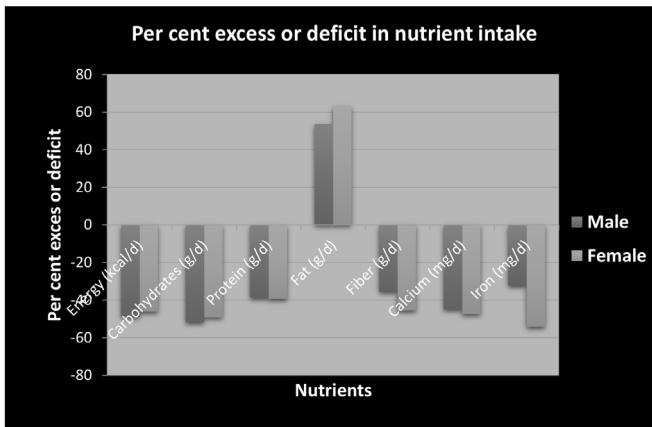


Fig.1: Per cent excess or deficit in nutrient intake of the subjects

Results revealed that energy consumption of both males and females was found to be in deficit when compared to the recommended dietary allowance (RDA). The carbohydrate intake of the subjects was also found to be in deficit by -51.8 per cent and -49.2 per cent for both male and female subjects respectively. Protein intake of both males and females were found to be in deficit by -38.7 per cent and -39.4 per cent respectively. However, the

mean fat per cent was found to be high when compared to RDA by +53.6 per cent and +63 per cent for both male and female subjects respectively. Intake of dietary fibre by both the male and female subjects was in deficit when compared to the RDA. The calcium intake of the subjects was found to be in deficit by -44.9 per cent and -47.4 per cent, while iron intake was also found to be in deficit by -32.3 per cent and -54.2 per cent for both male and female subjects respectively.

B. Mean Knowledge and Attitude Scores of the Subjects

The pre-test and post-test scores on the Knowledge and Attitude of the subjects is graphically presented in figure.2.

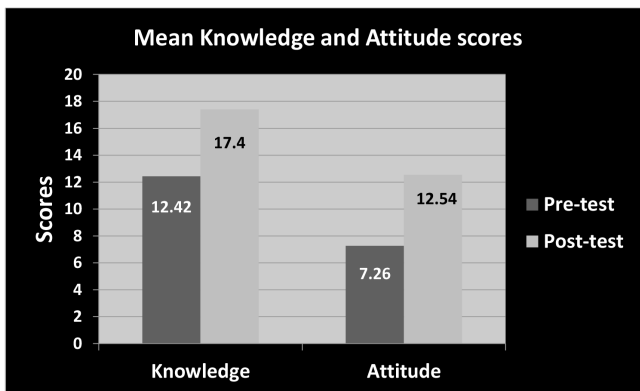


Fig..2: Mean Knowledge and Attitude scores of the subjects

It can be inferred that the mean Knowledge and Attitude scores increased 30 days after the nutrition education program and it was found to be statistically significant ($p < 0.01$). This shows that the nutrition education had a significant impact in improving the Knowledge and Attitude among college-going cricketers, which in turn could improve the overall dietary practices of cricketers.

Conclusion

To conclude, the findings of the present study indicated that college-going cricketers had limited knowledge and awareness on healthy dietary practices. Certain unhealthy dietary habits were observed among them such as skipping meals, frequent consumption of junk foods and inadequate nutrient intake. Unhealthy personal habits such as smoking and alcohol consumption were seen in some of the subjects. The nutrient intake was found to be in deficit for energy, carbohydrate, protein, dietary fibre, calcium and iron while fat was consumed in excess compared to the RDA.

Adequate nutrient intake is crucial for the maintenance of health and optimizing sports performance. Thus, it is important to create awareness to modify the dietary habits of cricketers. The findings from the experimental phase showed that nutrition education given to the sub-group of college-going cricketers was very effective in improving their Knowledge and Attitude that will go a long way in improving their overall nutritional status.

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A comparative study on the eating behaviours of children from select schools

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Abstract

Background: Nutritional status of children is significantly affected by dietary preferences and eating behaviour. Objective: To examine the variation in eating behaviours of children with different categories of Body Mass Index (BMI). Methodology: A cross-sectional study was conducted among 884 children aged 10 to 15 years in Chennai. Eating behaviour was assessed with the Children's Eating Behaviour Questionnaire (CEBQ). Age- and sex-adjusted BMI z-scores were calculated using India Academy of Pediatrics cut-offs, and children were categorized as thin, normal weight, overweight and obese. ANOVA and chi-square tests were performed using MS Excel 2007. Results: The prevalence of thinness, overweight and obesity was 7.9%, 19.6% and 5.5%, respectively. The scores of 'Food Approach' subscales of CEBQ showed higher mean score in overweight and obese groups as compared to the other groups. The scores of 'Food Avoidance' subscales showed higher mean score in thinness group as compared to the other groups. Conclusions: This study indicated the eating behavior of children to be associated with BMI. Therefore, awareness on healthy eating behaviors from a young age

should be emphasized, which will help children keep a check on their BMI, and prevent lifestyle related disorders associated with higher BMI's.

Keywords: *Children's Eating Behaviour Questionnaire, Nutritional Status, Body Mass Index, Malnutrition.*

Introduction

India is in a phase of rapid nutritional transition. From being a region with high prevalence of underweight and communicable diseases and having low prevalence of overweight and non-communicable diseases (NCDs), it is now changing into a region with dwindling rates of underweight and communicable diseases and along with a steep rise in overweight and NCDs (Aiyar, Dhingra and Pingali, 2021). As per the National Family Health Survey – 5 report, nearly 16-18% adults are underweight and 23-24% are overweight or obese (NFHS-5). Similar transition of rising overweight and obesity is being observed in adolescents in India (Shinde, Wang and Fawzi, 2021). Ending all forms of malnutrition is crucial in meeting two Sustainable Development Goals (SDG-2 and SDG-3): zero hunger, and good health and well being (Binns et al., 2017).

According to the Comprehensive National Nutrition Survey (CNNS), 24% of adolescents are thin and 5% of them are overweight or obese in India (UNICEF, 2019). Adolescence is a period of life where new habits are formed and appropriate dietary changes can improve nutritional status and overall health (Lassi, Moin, and Bhutta, 2017). To curb high rates of both undernutrition and overnutrition, it is essential to act on modifiable risk factors such as food consumption behaviour that could prevent malnutrition and chronic NCDs later in adulthood

(Aiyar, Dhingra and Pingali, 2021). Problematic eating behaviours have had mixed relationship with Body Mass Index (BMI) of children and adolescents. Discrepancy has also been seen with respect to data between male and female children (Czeczor-Bernat and Brytek-Matera, 2019). Hence, the aim of this study was to examine the variation in children's eating behaviours among children with various BMI categories, and to identify particular eating behaviours, which when modified can help in reducing and preventing both thinness and overweight.

Materials and Methods

Study design and participants: This cross-sectional study was conducted among 884 children aged 10 to 15 years in Chennai, India. Stratified random sampling was used to select one private and one state run school from north, east, south, west and central zones of Chennai. Convenience sampling design was used to select children from each of these schools after written parental consent and child's assent. The study protocol was approved by the Institutional Ethics Committee and registered under the Clinical Trials Registry of India (CTRI/2022/02/040501).

Anthropometry: Height was measured barefoot using a stadiometer to the nearest 0.1 cm. Body weight was measured barefoot with light clothing using a calibrated digital scale to the nearest 0.1 kg. Body Mass Index (BMI) and BMI-for-Age z-score (BAZ) were calculated based on Indian Academy of Pediatrics Growth Charts Committee et al., (2015) cut-offs. Children were classified as thin (BAZ < -2 SD), normal weight (BAZ between -2 SD and +1 SD), overweight (BAZ between +1 SD and +2 SD) and obese (BAZ > +2 SD). (Indian Academy of Pediatrics Growth Charts Committee et al., 2015)

Eating behaviour: Along with socio-demographic data, this study also assessed eating behaviour using a validated Children's Eating Behaviour Questionnaire (CEBQ) developed by Wardle et al. (2001). It is a parent report of their child's eating behaviour on a five-point Likert scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always). CEBQ is a 35 item tool measuring eight subscales of eating behaviour; four assessing "food approach behaviour" (food responsiveness, enjoyment of food, emotional overeating and desire to drink) and the other four assess "food avoidance behaviour" (satiety responsiveness, slowness in eating, emotional undereating and food fussiness). For ease of understanding, the questionnaire was available in English and Tamil.

Statistical analysis: Data analysis was performed using Microsoft Office Excel 2007. Descriptive statistics such as mean, percentage, and standard deviation were performed along with inferential statistics such as analysis of variance (ANOVA), and chi-square test. $P < 0.05$ was considered as a statistically significant association.

Results

Among the 884 children, 533 (60.3%) were female and 351 (39.7%) were male. The mean age was 12.30 ± 1.26 years. Prevalence of thinness, overweight and obesity was found to be 7.9%, 19.6% and 5.5%, respectively (Fig 1). The mean BAZ score was 0.07 ± 1.20 , which corresponded to the normal weight category for both male and female children. Mean CEBQ scores for male and female children are presented in table 1. Interestingly, no statistically significant differences were observed between male and female children in this study. The CEBQ scores for various BMI categories are presented in Fig 2.

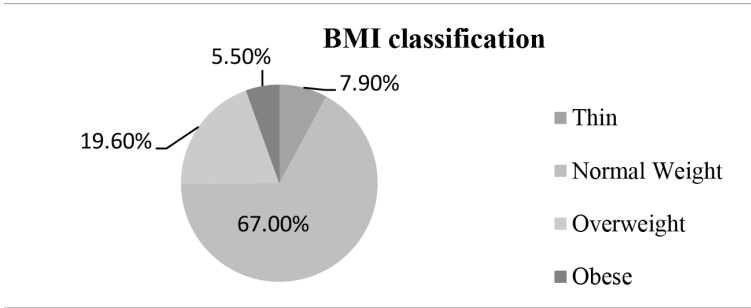
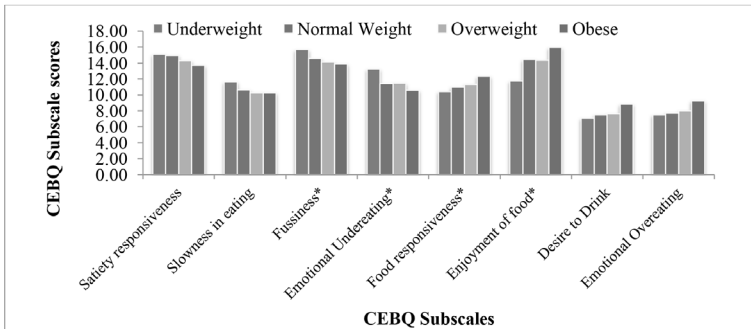


Fig. 1: BMI classification of children

Table 1 Mean CEBQ scores of participants

CEBQ Subscales	Mean \pm SD		
	Male (n = 351)	Female (n = 533)	Overall (n = 884)
Food approach behaviour			
Food responsiveness	11.03 \pm 4.57	10.85 \pm 4.32	10.92 \pm 4.42
Enjoyment of food	15.05 \pm 4.37	13.97 \pm 4.30	14.40 \pm 4.36
Emotional overeating	7.97 \pm 4.08	7.96 \pm 3.72	7.96 \pm 3.86
Desire to drink	7.58 \pm 3.63	7.53 \pm 3.26	7.55 \pm 3.41
Food avoidant behaviour			
Satiety responsiveness	14.80 \pm 3.20	14.73 \pm 3.24	14.76 \pm 3.22
Slowness in eating	10.11 \pm 4.14	10.86 \pm 4.25	10.57 \pm 4.22
Emotional undereating	11.17 \pm 4.44	11.61 \pm 3.88	11.44 \pm 4.11
Food fussiness	14.54 \pm 4.25	14.89 \pm 4.10	14.50 \pm 4.15



* p < 0.05 **Fig. 2: CEBQ Scores for various BMI categories**

Discussion

Thin children had stronger responses for CEBQ food avoidance subscales and weaker responses for CEBQ food approach subscales. On the other hand, overweight and obese children had stronger responses for food approach scales and weaker responses for food avoidance subscales. These results are comparable with other recent literature (Roy et al., 2020).

Based on the CEBQ, it was observed that not enjoying a diverse diet, having inhibitions in trying newer variety of foods and eating less when upset, angry or tired were highly associated with being thin. However, food responsiveness and enjoyment of food as exhibited by having an extreme liking for food, being able to eat a meal at anytime of the day, always looking forward to eating the next meal and eating favorite foods even after a full meal were associated with being overweight and obese. Other domains such as satiety responsiveness and slowness in eating had lower means for overweight and obese children, although not statistically significant. This draws attention to mindful eating, observing and identifying hunger cues and neuronal signals. Appropriate assessment of children's eating behaviours and necessary corrective action can be helpful in tackling malnutrition.

The strength of this study lies in using a validated tool to measure children's eating behaviour and computing BMI-for-Age z-scores with nationally representative IAP cut-offs. CEBQ is a validated tool but is based on subjective assessment of parents about their child's eating behaviour and hence, could be subject to bias.

Conclusion

Eating behaviour is strongly correlated with children's BMI. Higher CEBQ food avoidant behaviour scores are associated with thinness and higher CEBQ food approach behaviour scores are associated with overweight and obesity. Parents, teachers and other caregivers may possibly identify problematic or unusual eating behaviour and rectify it at a younger age to prevent or prolong the onset of malnutrition.

Implications for practice and future research: Increasing awareness about appropriate and inappropriate eating behaviours among children and their caregiver can provide an opportunity to correct unhealthy dietary practices at an early stage. Conducting intervention studies among children targeting multiple risk factors, including eating behaviours and others, in school settings with active involvement of family and community holds great potential in improving dietary practices and health.

Conflict of interest: No conflict of interest.

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The Impact of Stress Management on UG and PG Students at Guru Nanak College

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Abstract

Stress is a mental pressure that causes mental, physical, and behavioral effects on any student. To some extent, stress is common, but if the stress is beyond the limit, then necessary action needs to be taken. Therefore, the study aims to reveal the impact of stress on students and the common stress management activities they practice. The only subjects of this study are students of Guru Nanak College. The main objective of the study is to determine the level of stress among students based on different demographic variables.

The factor analysis showed five major factors that are associated with stress, which can be classified as family, academic, financial, relationship, and environmental problems. A sample size of 236 students has been taken for the study, which includes both undergraduate and postgraduate students at Guru Nanak College. The result indicates that the gender of the students has no association with stress levels. The result also indicates that there is a significant difference among students of different ages with stress levels, but there is no significant difference in graduation and stress levels.

Key Words: *Family, Academic, Financial, Relationship, and Environmental Problems.*

Introduction

Stress is an emotion with which people react to unpleasant situations. Our body responds to stressful situations mentally, physically, and behaviorally. Students frequently experience stress, but being able to control it can make tasks easier. The adrenal glands, which are found on top of the kidneys, release hormones like adrenaline and cortisol in response to a mix of nerve and hormonal impulses.

Adrenaline causes an upsurge in blood pressure, heart rate, and energy levels. The primary stress hormone, cortisol, increases the sugar level in the bloodstream and enhances the brain's ability to make use of glucose. When a threat is no longer perceived, adrenaline and cortisol levels reduce, the heart rate and blood pressure returns to normal, and other systems carry on as usual. If the stress level keeps on increasing, the cortisol level increases to produce more sugar, which affects the body. Stress management is a strategy that reduces stress levels and also the negative impacts that are caused by stress on our mental or physical well-being.

Statement of the problem

Stress has a significant impact on students. Stress can cause a negative impact on a student's behavior and affect their health. So, the main aim of the study is to describe which stress factors have a high impact on students at Guru Nanak College, and in addition to that, discuss what the most common stress effects among students are. This study also describes the most frequent stress management activities that are adopted by Guru Nanak College students.

Need of the Study

Stress is a normal human reaction, but if it exceeds a certain limit, it can have a serious impact on human health. Stress management helps in preventing and managing long-term stress. This can reduce the risk of heart disease, obesity, high blood pressure, and depression.

Objectives of the Study

- To study the impact of stress on students based on gender.
- To determine the influence of stress on students based on their age.
- To determine the effect of stress on students based on their graduation.
- To provide stress-reduction strategies that students can utilize to lower their stress levels.

Limitations of the Study

- The study limits its scope to only Guru Nanak College.
- The sample size of the study is only 236 respondents.
- The study focuses only on the stress management of UG and PG students.

Review of Literature

Kaur (2014) concluded that academic stress put a negative impact on the mental health of the students. Considering this, the teachers should not over burden the students with work and should not over expect beyond the capabilities of the child.

Prabu (2015) acknowledged that higher secondary students have moderate level of academic stress. The academic stress of the urban students is high than that of the rural students, and the academic stress of the government school students is less than the private school students.

Research Design

The study's research methodology is a descriptive one. It is very important to note that in the descriptive research method, no data are manipulated or controlled, unlike in experimental research. The descriptive research is highly accurate.

Data collection

Primary and secondary data collections were used for this study and were collected through a Google Form. A purposeful sampling technique was used for this study to understand the stress level of UG and PG students at Guru Nanak College.

Sample size

The number of samples collected from the population is known as the "sample size". A sample size of 236 was collected from the Guru Nanak College students.

Research Tools

1. Percentage
2. Chi-square
3. ANOVA

Findings of the Study Descriptive Analysis

Table - 1: Description of the demographic variable

Demographic Variable	Classification of Variable	Frequency	Percentage
Age (in Years)	18	87	36.9
	19	48	20.3
	20	48	20.3
	21	26	11
	22	21	8.9
	23	6	2.5
	TOTAL	236	100
Gender	Male	153	64.8
	Female	83	35.2
	TOTAL	236	100
Graduation	UG	188	79.7
	PG	48	20.3
	TOTAL	236	100
Year of Study	UG 1	78	33
	2	43	18.2
	3	67	28.4
	PG 1	22	9.3
	2	26	11.1
		TOTAL	236

Hypothesis testing

Table - 2: Stress Level of students based on Age ANOVA, two-factor without replication

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	2637228	5	527445.6	419.816	1.57E-19	2.71089
Columns	42992.53	4	10748.13	8.554888	0.000341	2.866081
Error	25127.47	20	1256.373			
Total	2705348	29				

Inference:

The F-critical value is less than the F value for students of different ages ($F_{\text{Crit}} = 2.866081 < F = 8.554888$) for different stress factors too, and the p-value is 0.05 ($p = 0.000341$). It can be concluded that there is a significant difference in stress levels

among students of different ages, and there is a significant difference among the five stress factors at a 5% level of significance.

Table - 3: Stress Level of students based on Graduation ANOVA, Two-Factor Without Replication

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	6278978	1	6278978	454.9951	2.86E-05	7.708647
Columns	128977.6	4	32244.4	2.336534	0.215638	6.388233
Error	55200.4	4	13800.1			
Total	6463156	9				

Inference:

However, the difference between the various stress factors is not significant, as the F value is below the F critical value ($2.336534 < 6.388233$) and the p-value is above 0.05 ($p = 0.215638$). It can thus be inferred that there is a significant difference in stress levels among UG and PG students, but there is no significant difference among the 5 stress factors at a 5% level of significance.

Ranking Analysis

Table - 4: Effects of Stress among Students

Ranking	Common effects of stress	Frequency
I	Problem in Concentration	80
II	Becoming easily frustrated/ short tempered	61
III	Sleeping Trouble	48
IV	Eating more or less than usual	25
V	Health issue	18
VI	Thoughts of committing suicide	4
Grand Total		236

Inference:

According to the data in the table above, the problem of retaining concentration is the most frequent stress-related symptom among students, followed by difficulty in sleeping, tendency to

become quickly irritated or short-tempered, eating more or less than normal, and the recurrence of health issues.

Table - 5: Stress-reducing Activities of Students

Ranking	Stress overcoming activities	Frequency
I	Involving in entertainment activities	127
II	Exercise	37
III	Indulge in a hobby	30
IV	Meditation/ Yoga	27
V	Prayer and Devotional activities	13
VI	Attending students counseling	2
Grand Total		236

Inference:

According to the above table, the most common stress-relieving activities among students are participating in entertainment activities, followed by exercise, engaging in hobbies, meditation or yoga, and prayer or devotional activities. Attending student counseling is the least common stress-relieving activity among students.

Conclusion

According to the survey, environmental problems are the biggest source of stress for both male and female students. Students between the ages of 18 and 22 experience the most stress from environmental issues. Stress is a result of the academic problem factor for students above the age of 23. Yet the study also demonstrates that there is a slight distinction between problems with college work, money, and relationships. The study also shows that students of different ages exhibit significant differences in their levels of stress. The main side effect of stress is difficulty concentrating. Thus, the best strategy to help pupils deal with stress is to engage them in enjoyable activities.

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Awareness and Perception of Youth and Adults towards Freelancing, Its Income and Financial Implications

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Abstract

This study examines the awareness and perception of freelancing among young adults and adults in India, as well as its potential impact on the economy. The study finds that freelancing has a positive outlook among the Indian society and suggests the inclusion of freelancers as an active working population with appropriate frameworks. The study also indicates that the tendencies to save, invest or expend on incurring income varies between youth and adults. Various factors are taken into consideration for individuals' willingness to take up freelancing as a profession.

Keywords: *Freelancing, Perception, economy, willingness.*

Introduction

Freelance work, which involves independent contractors using their talents on a project-by-project basis, has become increasingly popular due to technology and the demand for flexible work arrangements. The COVID-19 pandemic has further amplified the appeal of freelancing as companies seek competent specialists to handle their tasks remotely. Online freelance markets provide an interface for freelancers and companies to interact and collaborate.

The growth of tech platforms, desire for flexible work schedules, and emphasis on skills are driving the gig economy. India is the fifth-largest flexi-staffing market in the world. More people are seeking flexible jobs that allow them to work from anywhere, making freelancing the way of the future. Remote employment is appealing to many, especially those who lost their jobs due to the pandemic. Freelance work is becoming more popular, and this trend is expected to continue in India and globally, leading to specialized communities and niches.

Research has extensively covered the trends in online and remote working, freelancing, and its statistics but there is a lack of knowledge about the perception of job seekers and awareness regarding freelance work. This research aims to understand the attitudes and perception of freelancing as a source of income and its potential use for financial purposes among both the current and emerging workforce.

Research Objectives

- To observe the awareness of freelancing in youth and adults.
- To explore the demographic profile of the respondents with regard to their knowledge on freelancing.
- To assess the tendency of adults and youth to save, expend, or invest the freelancing income.

Literature Review

The rise of technology and e-commerce has led to the emergence of freelance work as a new and innovative approach to self-employment. The COVID-19 pandemic has contributed to the growth of freelancing by causing a decline in traditional business and

employment models. This has resulted in an increasing popularity of freelancing in many countries (Dr. Madiha Riaz et al. 2021)

In India, gender-based financial preferences of suburban and rural investors do not show significant differences, contradicting earlier findings. Some local analysts believe that these investors lack sufficient understanding of financial markets. To address this, the study suggests that governments and financial service providers in developing countries promote investment education programs. However, it is important to consider the moderation of investment aggressiveness and risk appetite among the new generation of investors to avoid conflicts of interest that led to the Western financial crisis (James Thomas Kunnanatt, Mithu Emiline, 2012) Based on the literature review the following hypotheses were formulated

Hypothesis 1 - Covid-19 has positively influenced the level of awareness on freelance work.

Hypothesis 2 -To determine whether there is a significant difference in their reasons to take up freelance work based on age.

Hypothesis 3 - There is a significant relationship between tendency to save, expend or invest and investing the freelancing income in ventures.

Methodology

This study aimed to provide a comprehensive understanding of the subject matter, utilizing a descriptive research approach to gather data from a sample size of 300 respondents. The data was collected through a questionnaire, with both primary and secondary sources being utilized. To analyze the data, a range of statistical tools were employed providing valuable insights into the subject matter.

Results

Hypothesis Testing

The hypotheses have been tested using independent samples t-test, chi-square, regression and ANOVA. The results are as follows.

H1: There is a significant difference in the level of awareness on freelancing with regard to influence of Covid-19.

Interpretation: Using t-Test, it is found that there is a significant difference in the level of awareness on freelancing with regard to influence of Covid-19, as $p = 0.009$, which is less than 0.05.

H2: There is a significant difference in their reasons to take up freelance work based on age.

Interpretation: Using ANOVA, it is concluded that there is a significant difference between age of the respondent and their reasons to take up freelance work, as $p = 0$, which is less than 0.05.

H3: There is a significant relationship between the tendency to save, expend or invest and investing the freelancing income in ventures.

Interpretation: Using ANOVA it is concluded that there is a significant relationship between tendency to save, expend or invest and investing the freelancing income, as $p = 0$, which is less than 0.05.

Discussion

Awareness and freelance

The level of awareness of freelancing varies among individuals, but the majority of people are aware of it and its potential for generating income. The rise of the gig economy has

influenced people of all segments to consider freelancing as a mode of employment, and there are several factors that have contributed to this rise. Many people are looking for alternative employment options that give more flexibility and control over their work lives, which freelancing can provide. While there may be differences between how adults and youth perceive freelancing, it is not an entirely new concept. Older individuals prioritize reliability and certainty, while younger individuals prioritize liberty and versatility in their work.

Age and freelance

The study shows that age has a significant impact on people's tendency to freelance. Older adults are more skeptical about freelancing due to uncertainty and lack of job security, while younger people are more willing to work freelance for its benefits. These perceptions are influenced by the current trend of the gig economy in India. Furthermore, there is no institutional support for freelancers or protection against fraudulent activities.

Tendencies to save, expend, or invest the freelancing income

The study found that many respondents are not willing to save their freelance income, possibly due to the belief that investing money is better than saving it. This is influenced by psychological perceptions of freelancing as a means of extra income. Instead, respondents are more likely to spend their income on materialistic things like clothing, accessories, and gadgets, since freelancing is often pursued alongside traditional employment. This leads people to view their freelance income as available for funding their lifestyle wants.

Conclusion

Freelancing is becoming a more viable option for professionals seeking flexibility, control, and increased earning potential. Despite this, there is still a belief that freelancing is not a reliable source of income due to irregular workloads and a lack of job security. Younger individuals are more likely to be drawn to freelancing, while older adults prefer more stable sources of income. Extra income from freelancing is typically used for immediate expenses or investments rather than being saved. Although it may not be viewed as a reliable source of income, there are benefits to be gained from freelancing if managed correctly.

Managerial Implications - More people are interested in freelance work and this study provides insights for companies looking to hire freelancers for one-time technical tasks. The study found that older adults perceive freelance income as unstable and payment systems should be established for fair and timely payment. Companies should also consider the level of autonomy and freedom for freelancers, as well as target youth for hiring.

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Caffeine and Lung Cancer: A Systematic Review

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Abstract

Intake of caffeine is associated with risk of lung cancer, but evidence is inconsistent. This review aims to summarize research studies assessing the effect of caffeine on lung cancer. A systematic search performed in the databases yielded 698 studies, out of which only 17 studies were included and reported as per PRISMA guidelines. Results were inconclusive as it revealed increased risk of lung cancer among coffee consumers and reduced risk among tea consumers. Future research narrowing on the quantity of caffeine consumed from different sources, processing methods and its association with lung cancer is needed.

Key words: Lung cancer, Coffee, Tea, Caffeine, Non-Communicable Disease.

Introduction

Globally, lung cancer is the most often diagnosed cancer which accounts upto 12.7% of all cases. In India, about 30,000 newly diagnosed lung cancer cases are registered every year (Manjunath *et al.*, 2022). With increasing prevalence, identification of risk factors and timely intervention is critical as it aids to reduce the disease risk and burden on health systems.

Caffeine is a globally consumed stimulant and a non-bioactive component present predominantly in coffee, tea, cocoa, carbonated and energy drinks which has been associated with risk of lung cancer. However, the results are scattered and are quite conflicting on the outset thereby leading to uncertainty. Hence, this review aims to identify and summarize studies reporting the association between caffeine and lung cancer.

Methods

Search strategy

A search was performed in the PUBMED database and WHO International Clinical Trial registry for studies evaluating the effect of caffeine on lung cancer, bronchiolitis and acute lung injury. Articles published in English from 1st January, 2000 to 20th March, 2023 were filtered using the following Boolean operators: “caffeine AND lung cancer”, “coffee AND lung cancer” and “tea AND lung cancer.

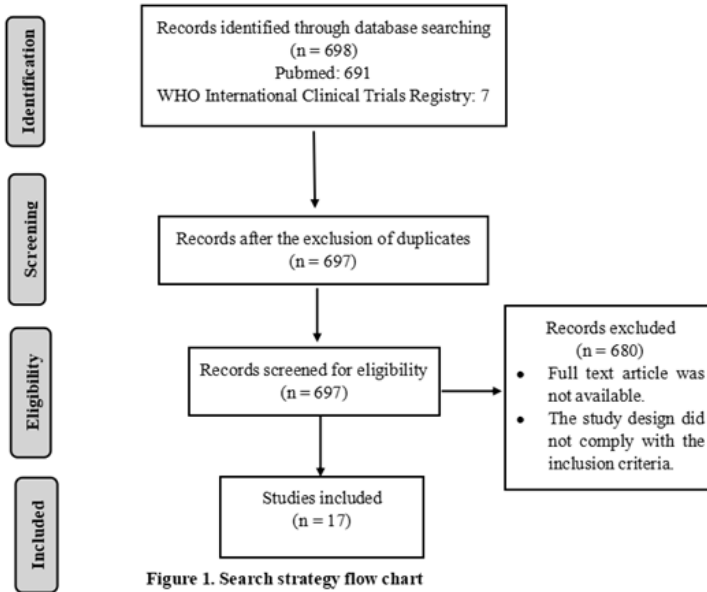
Eligibility criteria

Studies were included based on the inclusion and exclusion criteria. The inclusion criteria of this systematic review were: randomized controlled trials (RCT), non-randomized clinical trials, cross-sectional studies and cohort studies written in English language assessing the effect of caffeine on lung cancer. The exclusion criteria were: *in vitro* studies, *in vivo* rodent studies, review articles, editorials and articles written in other languages.

Results and Discussion

Based on the MeSH terms, the number of studies identified, screened and included in the study are presented in a flow chart

adapted from Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart (Moher et al., 2009) in Fig 1.










Lung Cancer






The present study has included 17 studies and 19,623 lung cancer cases from USA, Japan, China, Czech Republic, France, India, Korea, Pakistan and Thailand. Summary of studies evaluating the association between caffeine and lung cancers are presented in table 1. Results revealed increased risk of lung cancer among those

who consumed coffee. However, Hu *et al.* (2002) and Sanikini *et al.* (2015) reported that intake of >2 cups of coffee/day was beneficial in reducing the risk of lung cancer. With respect to tea, studies have reported lower risk of lung cancer (Hu *et al.*, 2002, Hashibe *et al.*, 2015, Seow *et al.*, 2020, Kudwongsa *et al.*, 2020).

Increased risk of lung cancer on consumption of coffee could be due to higher caffeine content when compared to tea. Recall bias and the confounding impact of tobacco smoking and alcohol use may also play a role in the observed relationships. Besides, significant controversy has erupted around acrylamide, a carcinogen in both animals and humans that is created early in the roasting process of coffee beans. However, there is no solid evidence to link the positive connections between coffee and lung malignancies to acrylamide since such low levels of acrylamide in coffee are unlikely to cause cancer in humans (Zhao *et al.*, 2020). The working group of the International Agency for Research on Cancer (IARC) re-evaluated the risk of coffee as carcinogen in the year 2018 and declared that the evidences are inconclusive.

Table 1. Summary of Studies on Caffeine and Lung Cancer

Reference	Study design	Country	Cases	Results/Risk Ratio (RR/OR [95% CI])	Outcome
Takezaki <i>et al.</i> , (2001)	CC-H	Japan	1045	Higher risk with ≥ 3 cups per day of coffee intake	
Hu <i>et al.</i> , (2002)	CC-P	Canada	161	Reduced risk of lung cancer with increasing intake of tea (>7 cups/week)	
Khan <i>et al.</i> , (2004)	PC	Japan	51	Increased risk of lung cancer coffee drinkers (2.10 [0.50-8.0])	
Baker <i>et al.</i> , (2005)	CC-H	USA	993	Increased risk of lung cancer with increased intake (>12 cups/day)	
Kubik <i>et al.</i> , (2008)	CC-H	Czech Republic	1096	Increased risk of lung cancer among smokers (male) who had the habit of drinking coffee	
Chiu <i>et al.</i> , (2010)	CC-P	China	279	Increased risk of lung cancer with increased intake (10 cup-years)	
Ganesh <i>et al.</i> , (2011)	CC-H	India	408	Increased risk of lung cancer among coffee drinkers (1.90 [1.30-2.70])	

Bae <i>et al.</i> , (2013)	PC	Korea	93	Increased risk of lung cancer with increased intake (>1time/day)	
Luqman <i>et al.</i> , (2014)	CC-H	Pakistan	400	The risk of lung cancer was higher among coffee drinkers (1.80 [1.10–2.80])	
Sanikini <i>et al.</i> , (2015)	CC-P	France	5926	1)Increased intake of 2-3 cups of coffee per day was found to be associated with increased risk of lung cancer (Men-1.30 [0.83–2.04]; Women- 1.61 [0.97–2.67]) 2)Increased intake of >5 cups of coffee per day was associated with lower risk (Men -1.11 [0.72–1.72]; Women - 1.15 [0.69–1.94])	
Hashibe <i>et al.</i> , (2015)	CT	USA	1137	1)Moderate risk of lung cancer (1.10 0.94–1.28) among those who consumed >2 cups of coffee 2)The risk of cancer was lower with increased consumption of tea 3)No significant effect was observed for caffeine intake	
Ghertin <i>et al.</i> , (2016)	PC-P	USA	510	Increased risk with >6 cups of coffee per day	

Narita <i>et al.</i> , (2018)	PC-H	Japan	1668	1)Increased risk for small cell carcinoma 2)No risk for other types of lung cancer	!
Li <i>et al.</i> , (2019)	PC	China	4046	Consumption of > 4.0g tea per day was found to increase the risk of lung cancer (1.31 [1.17, 1.46])	-
Seow <i>et al.</i> , (2020)	PC-P	China	1486	1)Intake of coffee >2 cup/day was associated with increased risk of lung cancer 2)Intake of tea >2+ cups/day was associated with reduced risk of lung cancer	!
Kudwongsa <i>et al.</i> , (2020)	PC	Thailand	138	Reduced risk of lung cancer on consumption of coffee	+
Kim <i>et al.</i> , (2021)	Cross sectional	Korea	186	No association	×

Note: + - beneficial effect; ! - negative effect; × - no effect; ! - inconclusive effect. PC: Prospective Cohort; PC-P: Prospective Cohort Population based; PC-H: Prospective Cohort Health Centre based; CC: Case Control; CC-H: Case Control Hospital based; CC-P: Case Control Population based; CT: Clinical Trial

Conclusion

The association between caffeine and lung cancer remains inconclusive. As numerous pharmaceutical formulations, commercial food and beverages containing caffeine, it is crucial to rule out disease risk. Future research focusing on the quantity of caffeine consumed from different sources, processing method and its association with lung cancer is needed.

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Benefits of Fermented Rice Drink (Pazhayadhu): A Narrative Review

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Abstract

Cereals and cereal products are one of the major contributors to the global diet diversity. Fermentation of cereal products has shown to enhance the nutritional content, palatability, organoleptic characteristics and bioavailability of various nutrients. Decrease in anti-nutritive factors due to fermentation has been one of the major contributing factors in enhancing bioavailability and nutritional properties. Since rice is one of the most commonly consumed cereals, this paper enumerates on the various health benefits of fermented rice drink (Pazhayadhu) which is a traditional food indigenous to the people of Indian origin. The primary articles were taken from various published sources including journals, newspapers and blogs. Being cost-effective, nutritious, and available at all times, consumption of Pazhayadhu regularly may confer health benefits related to lifestyle changes. However, more studies may be required to derive conclusions for quantitative and qualitative information required for conferring the myriad health benefits associated with the consumption of this traditional health drink.

Keywords: *fermented rice, fermentation, nutrition, rice, cereal*

Introduction

The increasing occurrence of overweight, obesity and non-communicable diseases (NCDs) has been widely acknowledged since 1990s with halting the approach towards hunger alleviation, and concentrating instead on micronutrient malnutrition (Poole et al., 2021a).

There are different types of cereals which are consumed globally including wheat, rice, maize, barley, sorghum, millets, oats and rye. Staple cereals such as wheat, rice and maize, which, for long, have been major components of global diets, are now sometimes considered to contribute to the malnutrition problem because they are rich in energy and not major sources of ‘nutrient-rich’ foods. Although many researchers consider experimenting with other food groups, few have suggested that enhancing the nutrient content of these widely consumed cereals would be beneficial in positively impacting the global burden of malnutrition (Pingali, 2015; Lenaerts and Demont, 2021; Poole et al., 2021a; Poole et al., 2021b).

Half of the world’s population and about 90% of Asians consume rice as their staple food. There are many medicinal properties of rice apart from being consumed as a staple cereal (Chaudhari et al., 2018). Among Indians, many notable changes in lifestyle and health were witnessed over the past few decades (Chaudhari et al., 2018). Rice is nutritionally rich in many of the vital nutrients (Verma and Shukla, 2011). It also contains anti-nutritive factors which were found to be heat-stable or heat-labile (Samtiya, Aluko and Dhewa, 2020). Phytic acid, which is a major anti-nutritional factor present in rice, affects the bioavailability of

micronutrients including iron, magnesium, zinc and phosphorus (Varnakulendran et al., 2016).

Fermentation of cooked rice overnight has been an age-old practice of traditional Indian families. Fermentation process was found to enhance the organoleptic characteristics, nutritional content, palatability and bioavailability of micronutrients (Terefe, 2016). Studies have also indicated the presence of probiotic bacteria such as *Enterococcus faecium*, *Leuconostoc mesenteroids*, *Lactobacillus curvatus*, *Lactic Acid Bacteria* and *Pediococcus pentosaceus*. A few yeast species including *Saccharomyces kluyveri*, *Saccharomyces cerevisiae* and *Debaryomyces hansenii* have also been found in fermented rice drinks (Tiwari et al., 2019). Although many practitioners and health blogs have mentioned the benefits of its consumption, more studies may be required to derive conclusions for quantitative and qualitative information, such as nutrient composition or quantities that are required for conferring the myriad health benefits associated with the consumption of this traditional health drink. Therefore, this review enumerates various benefits of consuming fermented rice drink (*Pazhayadhu*) as a traditional health drink.

Methodology

The primary articles were taken from “Google Scholar”, “PubMed”, “Research Gate” and “Scopus” sites with keywords such as “Fermented Rice” and “Health Benefits of Fermented Rice”. Newspaper articles and blogs were also included as the scientific literature for health benefits of fermented rice was very limiting. A total of 21 articles published in English between 2010 to 2023 were taken in this review.

Fermented Rice Drink: A Narrative Review

The traditional fermented rice gruel or porridge or drink has many different native names throughout India and is tabulated below.

Table 1: Names of Fermented Rice Drink in Different Indian States

S.No	Name	State	Reference
1.	Pazhayadhu/Pazhaya Saadham	Tamil Nadu	Aahaaram Online (2019)
2.	Pazhamkanji	Kerala	
3.	Poita Bhat	Assam	
4.	Pakhala Bhat	Odisha	
5.	Geel Bhat	Bihar	
6.	Panta Bhat	Bengal	
7.	Bore Bhat	Chhattisgarh	
8.	Paani Bhat	Jharkhand	
9.	Chaddannam	Andhra Pradesh	

The process of preparing fermented rice gruel is by soaking the cooked rice overnight in water and having it next morning with buttermilk or curds. Shallots and green chilies can also be added to the drink. The process of overnight soaking in water increases the lactic acid bacteria, lactobacilli, *Bifidobacterium*, yeast and molds through the fermentation process and also breaks the anti-nutritional factors in rice. This increases the bioavailability of minerals including iron, calcium and potassium in white rice, and magnesium in brown rice after 12 hours of fermentation (Kumar et al., 2013).

Nutritional changes observed in the fermented rice gruel in various studies are as follows:

- The carbohydrates present in rice becomes available and easily digestible due to the lactic-acid bacteria, which produces glycoside hydrolase enzyme that helps in the conversion of polysaccharides or the complex indigestible carbohydrates into simpler forms. The starch content in the rice facilitates the growth of microbes. It was also observed that the sugar content was reduced in fermented rice due to its utilization by bacteria (Kumar et al., 2013).
- An increase in protein availability due to the presence of yeast which releases proteolytic enzymes, and a reduction in fat content due to the production of lipolytic enzymes by microbes during fermentation was also noted (Kumar et al., 2013).
- Fermented rice was shown to have higher fiber, vitamin and mineral content especially vitamins B1, B2, folic acid, B12, C, A, K and E, and minerals especially iron, zinc and calcium (Ray et al., 2016).
- It was found to reduce anti-nutritional factors like trypsin, lectin and phytate inhibitors (Ray et al., 2016).

Some health benefits obtained from consumption of fermented rice gruel are as follows:

- An improvement in gut health was observed through enabling a favorable environment for the native gut microbes. Since fermented rice contains multistrand probiotics, this was found to maintain the gut microbiome and prevent inflammation (Ray et al., 2016).

- Regular consumption of fermented rice helped improve epithelial lining and also strengthened immunity via production of short-chain fatty acids like butyrate (Ogue-Bon et al., 2011).
- It was considered a functional food due to the presence of various antimicrobial, phenols, vitamin E, linoleic acid, antioxidant substances, flavones, anthocyanins, phytosterol or proanthocyanins (Ryan et al., 2011).
- These microbes play an important role in improving peristalsis, transit time, reducing cholesterol levels and preventing diarrhoea. It also has properties to suppress cancers of liver, colon, bladder, esophagus, stomach and can be consumed by lactose intolerant people (Ray et al., 2016).
- Vitamins such as B12 are present abundantly in fermented brown rice (Ryan et al., 2011; Intellects Review, 2017). The fermented rice gruel has been certified by the American Nutrition Association as one of the richest sources of vitamin B12 for vegans, and has also emphasized the health benefits on regular consumption (Quora, 2021). Vitamin B helps in prevention and treatment of ulcers, as the microbes produced during fermentation helps reduce the pH levels in the stomach, and vitamin B12 helps in the prevention of fatigue.
- Lactic acid is produced in abundance in fermented rice and this aids in the process of lactation by secreting more breast milk which thereby enhances breast milk production imitating the effect of a galactagogue (Poulin, 2017).
- It is a natural laxative and helps prevent constipation and improves bowel functions without causing any side-effects (Poulin, 2017).

- Fermented rice is also rich in collagen, which is mostly included as a component in beauty care products to maintain skin elasticity (Intellects Review, 2017; Poulin, 2017).
- As it is rich in potassium, a reduction in blood pressure is also noticed (Poulin, 2017).
- Other diseases in which beneficial effects have been observed are duodenal ulcers, infectious ulcerative colitis, Crohn's disease, irritable bowel syndrome, candida infection or celiac diseases (Ray and Swain, 2013; Choi et al., 2014).

Some sensory changes observed in fermented rice gruel are as follows:

- Adding variety to the diet, the fermented rice can be made into batter and can be consumed as idli and dosa, or eaten as porridge. Addition of certain native ingredients was shown to increase aroma, taste, flavor and texture of the foods (Ray and Swain, 2013).
- A reduction in cooking time of fermented rice was also observed (Ray and Swain, 2013). However, a few precautionary measures were suggested in some newsletters as follows:
- High levels of histamine were found in fermented rice foods and beverages; therefore, people with histamine intolerance should avoid consumption of these foods (Chakrabarty, 2021).
- This food also possessed high amounts of potassium, which required people with chronic kidney diseases and those not on dialysis to avoid its consumption (Chakrabarty, 2021).

Conclusion

From the above literature reviewed, fermented rice (*Pazhayadhu*) has been identified as the traditional Indian food that has an emerging interest due to its vast benefits and properties. The

composition of this fermented rice drink and its varieties or cultivar differences in which these health benefits would be obtained are also to be further scrutinized for extensive usage of this super food. Areas related to reproductive health and allied conditions could also be taken into account in future research studies.

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Formulation and Development of Seeds enriched millet biscuits for Polycystic Ovarian Syndrome

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Abstract

Objective: *The primary objective of the study was to formulate and develop seeds enriched millet biscuits which could be a suitable supplement for the condition polycystic ovarian syndrome.*

Methodology: *Biscuits were formulated using millet flours such as foxtail millet (SEFMB), kodo millet (SEKMB) and pearl millet (SEPMB) respectively, with the incorporation of 5g of coarsely ground flax seed, pumpkin seed, sesame seed and sunflower seeds. These seeds enriched millet biscuits were compared with control-wheat biscuits (WBC) for sensory and physical characteristics. Sensory evaluation was done using a 9-point hedonic scale by seven panelists in 3 trials. Physical properties were analyzed using vernier caliper and digital weighing machine. Organoleptically best accepted biscuit was analyzed for water activity, textural properties and nutrient content such as carbohydrates, protein, fat, fibre, ash, moisture, pH, acidity, zinc and Vitamin E. Analysis of variance was used to compare the sensory characteristics of the control with the developed biscuits.*

Results: *SEPMB* scored highest for all sensory characteristics and overall acceptability followed by *SEFMB*, *WBC* and *SEKMB* in that order. However, no significant difference in sensory characteristics such as appearance, colour taste, texture and overall acceptability was found between control and the developed seed enriched millet biscuits. *SEPMB* had higher spread ratio, lower water activity than *WBC*. Desirable textural properties such as decreased hardness, gumminess, increased cohesiveness, fracturability, chewiness and resilience were found in *SEPMB* as compared to *WBC*. Nutrient profile of *SEPMB* also showed higher energy, protein, fat and ash with substantial amounts of zinc and vitamin E in comparison with the regular wheat biscuits.

Conclusion: *Seeds enriched pearl millet biscuits (SEPMB)* could be considered as an ideal food supplement owing to their high acceptability, desired physical and textural properties and superior nutrient profile. *SEPMB* could be recommended as a therapeutic supplement to adolescents and women with polycystic ovarian syndrome (PCOS) as they are a good source of omega 3 fatty acid, vitamin E, zinc, selenium all of which help to mitigate the symptoms of PCOS.

Introduction

At present, women of reproductive age are facing many issues due to hormonal imbalance caused by unhealthy eating practices and physical inactivity. Polycystic ovarian syndrome (PCOS) is one such common female endocrine disorder affecting 4% to 20% of women in the reproductive age (12-45-year-old) and it is thought to be one of the leading causes of female infertility (Deswal, 2020).

PCOS is defined as an imbalance in female hormones such as oestrogen and progesterone.

Evidence from research indicates that hormonal imbalance could be regulated by a process called ‘Seed cycling’, which is timely incorporation of seeds (flax seed, pumpkin seed, sesame seed, sunflower seed) in certain periods of menstrual cycle. It is important to address and take corrective measures to treat PCOS, as women who do not get timely treatment may develop complications such as insulin-resistant diabetes, obesity, and hypercholesterolemia (Legro, 2013). In view of this, development of a food product such as biscuits was considered as it would be an ideal medium for the incorporation of seeds that could benefit women afflicted by PCOS. A study was therefore undertaken to formulate and standardize seeds enriched millet biscuits.

Materials and method

Selection of ingredients

Millets were chosen as the principle ingredient in the formulation of biscuits as they are good source of dietary fibre, essential amino acids, vitamins and minerals (Singh, 2012). Seeds like flax seed have phytoestrogen that have a weak oestrogenic effect, additionally pumpkin seed have zinc content which prevent progesterone from being converted into testosterone (Hodari, 2020). Sesame and sunflower seeds are rich in vitamin E, zinc and selenium which help in production of progesterone and detoxify excess oestrogen in liver (Hodari, 2020). Considering the health and nutritional benefits that millets and seeds could offer, they were chosen as principal ingredients in the formulation of biscuits that were suitable for PCOS conditions.

Standardization of recipe

Dry ingredients like wheat flour and millet flours (foxtail millet, kodo millet, pearl millet) of 120 gm are mixed with pepper powder(1.5gm), jeera powder(1.5gm), baking powder. Then butter(25gm), sugar(15gm), salt(1.5gm), milk(50ml) and chilli paste(1.5gm) were combined together. The paste so formed was added to the flour mixture and mixed together. Coarsely ground seeds such as flaxseed(5gm), pumpkin seed(5gm), sesame seed(5gm) and sunflower seed(5gm) were added to the mixture and kneaded into soft dough. Dough was spread into a round shape using 6.1 cm diameter stencil. Then baked at 180°C for 25 mins, cooled and stored in an airtight container.

Sensory evaluation

The three types of seed enriched millet biscuits and the control wheat biscuits were tasted by a semi trained panel of seven members and evaluated for sensory attributes such as appearance, aroma, taste, colour, texture and overall acceptance using scorecard. The average of three trials for each attribute by each panel member was taken as the final score.

Physical analysis and Water activity determination

Physical parameters such as diameter, thickness and spread ratio were evaluated using vernier calliper on seeds enriched millet biscuit and control. The parameters were assessed three times and the mean scores were recorded for final evaluation. Water activity is an indicator of shelf life of the formulated products. Water activity of the biscuits was analysed for SEPMB and WBC using a water activity meter (novasina).

Proximate analysis

Seeds enriched millet biscuits (SEPMB) with highest score from sensory evaluation and control wheat biscuits were analysed for nutrients such carbohydrates using anthrone, sulfuric acid and hydrochloric acid, protein using Hartee-Lowry method, fat using Soxhlet Extraction method, dietary fibre using SOCS PLUS equipment, ash content using muffle furnace and hot air oven, moisture using hot air oven and desiccator, pH using pH meter, acidity using Soxhlet method and micronutrients such as zinc using colorimetric dithizone method and vitamin E using proposed fluorometric method.

Textural analysis

Textural properties of biscuits (SEPMB and WBC) such as hardness, fracturability, adhesiveness, springiness, cohesiveness, gumminess, chewiness and resilience were analysed using TA.TX. Plus Texture Analyser.

Results and Discussion

Sensory evaluation

Table 1: Sensory evaluation of WBC, SEFMB, SEKMB and SEPMB

Sensory characteristics	WBC	SEFMB	SEKMB	SEPMB	F value (Anova)	Sig. (Anova)
Appearance	7.33±0.37	7.67±0.34	7.43±0.58	7.87±0.46	0.267	0.849
Aroma	7.43±0.60	7.59±0.53	7.43±0.58	7.87±0.49	0.679	0.574
Taste	7.43±0.60	7.59±0.67	7.34±0.74	7.77±0.52	0.452	0.718
Colour	7.44±0.48	7.63±0.67	7.53±0.74	7.89±0.62	0.679	0.574
Texture	7.22±0.55	7.70±0.64	7.33±0.89	7.99±0.45	1.474	0.247
Overall acceptance	7.60±0.41	7.67±0.63	7.40±0.69	7.94±0.60	0.921	0.446

Values are mean± SD, CWB- Wheat biscuit (control), SEFMB- Seeds enriched Foxtail millet biscuit, SEKMB- Seeds enriched Kodo millet biscuit, SEPMB- Seeds enriched Pearl millet biscuit

SEPMB biscuits scored highest (Table 1) for all sensory characteristics and overall acceptability followed by SEFMB, WBC and SEKMB in that order. SEPMB scored highest for appearance (7.87), taste (7.43), colour (7.89), texture (7.99) and overall acceptability (7.94). These values were higher than the scores obtained by control wheat biscuits for appearance (7.33), taste (7.43), colour (7.44), texture (7.22) and overall acceptability (7.60). However results from analysis of variance done for sensory characteristics showed no significant difference between control and the seed enriched millet biscuit varieties.

Physical analysis and Water activity determination

Physical analysis

The unit weight of all the developed biscuits and control were found to be 15g per biscuit, with very slight variations. Diameter of all the biscuits: WBC, SEFMB, SEKMB, SEPMB was uniform at 6.07 ± 0.05 . Thickness of WBC, SEPMB were the same 0.78 ± 0.06 , whereas a lesser value for thickness was found in SEFMB (0.68 ± 0.02) and SEKMB (0.58 ± 0.02). Spread ratio for WBC, SEFMB, SEKMB, SEPMB was 7.78 ± 0.83 , 8.98 ± 0.29 , 10.59 ± 0.38 and 7.88 ± 0.22 respectively. Biscuits with increased spread ratio were found to have decreased thickness. The increased spread ratio in the developed biscuits could be attributed to the use of millet flour as the base.

Water activity

Water activity in SEPMB (0.432) is lower and close to the ideal recommendations than control WBC (0.568) indicating a longer and safe shelf life.

Proximate and Micro Nutrient analysis

Table 2: Nutrient Profile of WBC and SEPMB

Parameters	WBC (control) Per 100g	SEPMB Per 100g
Energy (Kcal)	406.12	397.8
Carbohydrate (g)	61.3	52.3
Protein (g)	18.9	19.7
Total fat (g)	9.48	12.2
Fibre (g)	2.63	3.52
Ash (g)	2.60	3.37
Moisture (g)	5.04	9.90
pH	7.30	7.10
Acidity (%)	0.25	0.30
Zinc(mg)	0.23	4.27
Vitamin-E (α tocopherol) (mg)	10.63	24.2

WBC-Wheat biscuit control, SEPMB-Seeds enriched pearl millet biscuit

From Table 2, it is evident that SEPMB biscuits had a better nutritional profile, with higher content of protein (19.7g), fat (12.2g), fiber (3.52g) and ash (3.37g) as compared to control WBC biscuits. Although moisture content is found to be higher in SEPMB than control WBC the water activity of SEPMB is lower than WBC which is the actual determinant of a longer keeping quality and desirable textural properties. SEPMB had twice the amount of vitamin E (24.2mg) as compared to control WBC (10.63mg) and twenty times more zinc (4.27mg) as compared to control WBC (0.23mg).

Textural analysis

Table 3: Texture analysis of SEPMB and WBC (control)

Different biscuits	Hardness (g)	Fracturability (g)	Adhesiveness (g.sec)	Springiness	Cohesiveness	Gumminess	Chewiness	Resilience
WBC (control)	34030.486	-	-2.654	0.765	0.080	12475.729	9542.080	-0.00
SEPMB	3231.168	3281.38	-8.077	0.381	0.367	259.129	98.777	0.027

WBC-Wheat biscuit (control), SEPMB-Seeds enriched pearl millet biscuit

From Table 3, it is evident that the hardness value was higher for control biscuits (34030.49g) than SEPMB (3231.17). The slight decrease in hardness of seed enriched pearl millet biscuits could be due to the high dietary fiber, water absorbing capacity and high fat content in SEPMB. An increase in fat content reduces the requirement for water, increases the lubricating function and provides a soft texture, according to Ganorkar (2014) who studied the effect of incorporating flaxseed in cookies on the physical, sensorial, textural and chemical attributes. Fracturability of SEPMB was 3231.168g indicating that high content of fibre enhanced its fracturability which corroborates with the findings of Parul (2015). Cohesiveness which reflects the ability of the sample to resist damage and maintain its integrity was found to be higher in SEPMB (0.367) as compared to control (0.080). Springiness of SEPMB and control were 0.381 and 0.765 respectively. Decrease in springiness could be related to the reduced number of air gaps and the presence of a denser matrix as reported by (Sanz, 2009) in a similar study on evaluation of texture in muffins made from four types of resistant starch. Resilience depicts the ability of the product to recover after deformation and resilience of SEPMB was 0.027 as compared to control which is -0.00. Higher resilience represents

a denser matrix of the product (Baixauli et al. 2008). Gumminess of biscuit in SEPMB is found to be considerably lower at 279.13 as compared to value of 12475.73 in control, Nirmala (2011) also reported a reduction in springiness and gumminess value of cookie dough with the addition of fenugreek and flax seed powder and attributed this to dilution of gluten.

Overall, desirable texturable properties such as decreased hardness and gumminess along with increased cohesiveness, fracturability, chewiness and resilience is found in SEPMB.

Conclusion

Seeds enriched pearl millet biscuit (SEPMB) is found to be the most acceptable biscuit among the biscuits formulated and developed. It had appealing sensory qualities, better nutritional composition, physical characteristics, water activity and textural properties. Thus, the developed seeds enriched pearl millet biscuits (SEPMB) could constitute an ideal food supplement that could be recommended for adolescents and women with Polycystic ovarian syndrome since the incorporation of seeds could add omega 3 fatty acid, vitamin E, zinc, selenium and phytoestrogens, all of which help mitigate the symptoms of PCOS .

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Formulation and Acceptability of a Food Product using Fox Nuts (*Euryale ferox*)

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Abstract

*Fox nuts (*Euryale ferox*) are the seeds of the lotus flower, and are referred to as 'makhana' in the Indian subcontinent. They are rich in protein, fibre, micronutrients such as calcium, magnesium, iron and phosphorus. Studies have indicated fox nuts to show a good antioxidant activity, and also help in the management of body weight, blood sugar, heart and digestive health. Therefore, the objective of this study was to formulate a food product using fox nuts as the main ingredient along with almonds, dates, flax seeds and clarified butter, and to test its acceptability. The design of the study consisted of an experimental design, and convenience sampling was used to select 15 participants aged 21-23 years for evaluating the acceptability of the formulated product. Sensory properties such as appearance, colour, flavour, texture and overall acceptability were evaluated for the formulated product, using a 5-point Hedonic scale. Results suggest that the overall acceptability of the formulated product was excellent, and can therefore be promoted for consumption on a daily basis. Thus, fox nuts when consumed as such or combined with other ingredients, can contribute to the nutritional value of a diet.*

Keywords : *fox nuts, super food, sensory evaluation*

Introduction

Fox nuts (*Euryale ferox*) are the seeds of the lotus flower, and are referred to as ‘makhana’ in the Indian subcontinent. They are rich in protein, fibre, micronutrients such as calcium, magnesium, iron and phosphorus. Studies have indicated fox nuts to show a good antioxidant activity, and also help in the management of body weight, blood sugar, heart and digestive health.

Fox nuts make for a healthy snack choice because they are low in calories and fatty acids. They are a healthy source of fibre, plant-based protein, and carbohydrates. Additionally, they include vital minerals such as magnesium, potassium, phosphorus, and zinc that are crucial for a number of biological processes (Liaquat et al., 2022). Magnesium and potassium content in fox nuts may support cardiovascular health by maintaining appropriate cardiac rhythm and blood pressure regulation, and thus can help maintain a healthy heart when consumed as part of a balanced diet (Liaquat et al., 2022). Flavonoids and phenolic compounds, among other antioxidants, have also been found to be higher. The antioxidant qualities of fox nuts may aid in lowering the susceptibility to illnesses such as cancers and cardiovascular diseases (Wu et al., 2013).

Fox nuts can be a good snack option for people with diabetes or in controlling blood sugar, because of its low glycemic index. Fibre content in the fox nuts can contribute to improved blood sugar control by slowing down the absorption of glucose (Liaquat et al., 2022). The high fibre content also encourages a healthy digestive system. It promotes regular bowel motions, helps to reduce constipation, and enhances overall gut health (Tehseen et al., 2020). Fox nuts have a high satiety value that can aid with weight

control because they are low in calories and high in fibre. The presence of fibre makes one feel fuller for a longer period of time, thereby lowering the propensity to overeat (Shamim et al., 2017).

Due to the above-mentioned health promoting properties of fox nuts, the objective of the present study was to popularize fox nuts as part of a healthy snacking option, and thus formulate a food product using fox nuts as the primary ingredient, and test its acceptability among young adult participants.

Methodology

The objective of the study was to formulate a food product using fox nuts as a main ingredient, along with almonds, dates, flax seeds and clarified butter, and test its acceptability. The design of the study consisted of an experimental design, which included the formulation, standardization and testing for acceptability of the product.

Procurement of ingredients: All ingredients (fox nuts, almonds, dates, flax seeds and clarified butter) were procured from local supermarkets in Chennai.

Formulation and standardisation of the food product: Popped fox nuts were first roasted and then powdered to a flour. The flour along with roasted almonds (with skin), roasted flax seeds, dates and clarified butter were made into balls.

Sensory evaluation of the formulated product: 15 participants aged 21 to 23 years were selected using convenience sampling for evaluating the acceptability of the formulated product. Sensory properties such as appearance, colour, flavour, texture and overall acceptability were evaluated for the formulated product, using a 5-point Hedonic scale.

Results

Sensory Evaluation of the Product

The participants involved in sensory evaluation of the formulated product were asked to collect the samples in person from the primary investigator. They were asked to drink plain water before the evaluation and to avoid discussing the sensory attributes of the product with other participants.

The results of the sensory evaluation of the formulated product are presented in Fig 1.

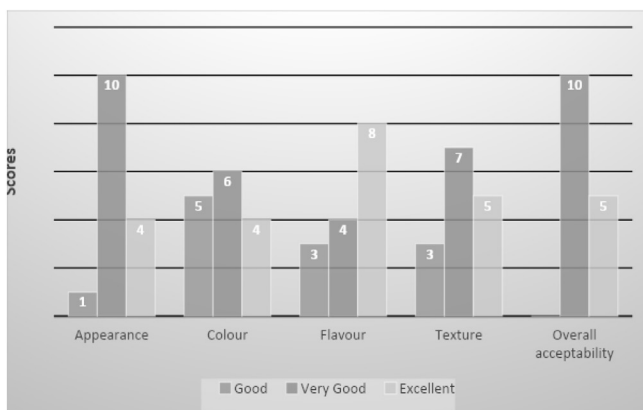


Fig 1: Sensory evaluation of the formulated product

Most of the participants scored the appearance of the product as 'very good'. Based on colour, most of the participants scored the product as 'good' and 'very good'. Based on flavour, the product was scored as 'excellent' by the majority of the participants. A majority of the participants scored the texture of the product as 'very good' and 'excellent'. Results suggested that the overall acceptability of the formulated product was 'very good' followed by 'excellent', and can therefore be promoted as a healthy snack.

Discussion

The results from this study were compared with similar products formulated with fox nuts, and are discussed below.

A study conducted in Allahabad in 2016 incorporated fox nuts and water chestnuts to formulate a food product called 'Pua'. The sensory evaluation of the newly developed product (85% fox nut flour and 15% water chestnut flour) revealed that colour, body and texture, taste and flavour and, overall acceptability were given high scores and well liked by the panel of judges (Shamim and Paul, 2017). Another study was conducted in Indraprastha University, New Delhi, wherein cookies were formulated using equal quantities of fox nuts and dates, along with ragi and wheat flours. The cookies were found to be chewy, crunchy and non-granular, thereby scoring well on the physical and sensory attributes (Arya et al., 2017). A similar study conducted in Dehradun in 2020 showed that fox nut flour incorporated into rabri made with buffalo milk and date syrup (95:5) had high acceptability in terms of colour, texture, sweetness, mouthfeel and overall acceptability, and also with a better nutrient content (Saxena et al., 2022). Thus, the above studies have shown the overall acceptability to be good, which is on par with the results obtained for the sensory evaluation for the product formulated with fox nuts in this study.

Conclusion

The incorporation of fox nuts with other ingredients such as almonds, dates, flax seeds and clarified butter to formulate a food product was found to be well acceptable in terms of sensory attributes like appearance, colour, flavour and texture. Fox nuts have a high nutrient profile and have been shown to possess good antioxidant potential. Thus, fox nuts when consumed as such or combined with other ingredients, can contribute to the nutritional value of a diet, and also provide healthier snacking options. When

healthy snack options can be made available for people across all ages, it may help promote better lifestyle choices for everyone. This will help create awareness about eating right to prevent or postpone lifestyle related disorders.

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Biomaterials derived from Polysaccharides: A Review

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Abstract

Biomaterials can be derived from proteins, polysaccharides and decellularized tissues such as collagen, gelatin, silk fibroin, cellulose, chitin etc. The potential use of polysaccharides as biomaterials has increased over the recent years. These macromolecules are naturally abundant in animals, plants, microbes and are considered as very propitious biomaterials due to their biocompatible, biodegradable, bio-inert, better tissue response. Polysaccharides mimic the properties of a human's extracellular matrix, hence they are non-toxic. Due to these properties, they are extensively used in the field of tissue engineering, drug delivery, scaffolding, as bone fillers, composites etc. This review paper would focus on some of the types of polysaccharides (Cellulose, chitosan, silk fibroin, pullulan and hyaluronic acid) with their properties, and some of their applications. The future perspective of the polysaccharides based biomaterials in the medical field would also be discussed.

Keywords: Polysaccharides, macromolecules, biomaterial, tissue engineering.

Introduction

Biomaterials are compounds that interact with the biological system to repair or replace the tissues, cells or organs. A reliable biomaterial would be recognized based on the properties such as biocompatible, bio-inert, stable, biodegradable, pharmacologically acceptable (non-toxic, non- carcinogenic, non-allergic, anti-inflammatory etc.) and feasible. There are two important groups of biomaterials, such as natural and synthetic biomaterials. The naturally obtained biomaterials are collagen, gelatin, silk fibroin, cellulose, alginate, hyaluronic acid, chitin, chitosan etc. Synthetic biomaterials are acquired from metals, ceramics, non-biodegradable polymers, and biodegradable polymers which are toxic to the system.

Table 1: Classification of biomaterials (Advantages, Disadvantages and their applications)

Type	Advantages	Disadvantages	Applications
Metals and metal alloys	* High material strength	* Corrosive	
E.g., gold, platinum, titanium, steel, chromium, cobalt	* Easy to fabricate and sterilize	* Aseptic loosening * Excessive elastic modulus	* Orthopedic implants, screws, pins, and plates
Ceramics and carbon compounds	* High material strength	* Difficult to mold	* Bioactive orthopedic implants
E.g., calcium phosphate salts (IIA), glass, oxides of aluminum and titanium	* Biocompatibility * Corrosion resistance	* Excessive elastic modulus	* Dental implants * Artificial hearing aids
Polymers	* Biodegradable	* Leachable in body fluids	* Orthopedic and dental implants
	* Biocompatible * Easily moldable and readily available	* Hard to sterilize	* Prostheses * Tissue engineering scaffolds
E.g., PMMA*, Polycaprolactone(PCL), PLA, polycarbonates, polyurethanes	* Suitable mechanical strength		* Drug delivery systems
Composites	* Excellent mechanical properties	* Expensive	* Porous orthopedic implants
E.g., Dental filling composites, carbon fiber reinforced methyl methacrylate bone cement + ultra high molecular weight polyethylene	* Corrosive resistant	* Laborious manufacturing methods	* Dental fillings * Rubber catheters and gloves

* PMMA—poly (methyl methacrylate).

Source : <https://pubmed.ncbi.nlm.nih.gov/29414913/>

Polysaccharides are long chain carbohydrates that are insoluble in water. These are extensively found in plants, animals, microorganisms (fungi, bacteria, sea weeds) and they play a key role in cell adhesion, cell signaling and other biological activities. The pharmacological properties of the polysaccharides include antioxidative, antitumor, antidiabetic, antimicrobial, anti-obesity, hypolipidemic, and hepato-protective properties (Ullah *et al*; 2019).

Table 2: Few Polysaccharides with properties and their major drawbacks: An overview

	PROPERTIES (Riha <i>et al.</i> ,2021)	DRAWBACKS (Riha <i>et al.</i> ,2021)
Cellulose (Tunicates, plant based, algae)	<ul style="list-style-type: none"> • Flexible • Easy processing • Biodegradable 	<ul style="list-style-type: none"> • High degree of variability, • complex extraction
Hyaluronic Acid (Microbes)	<ul style="list-style-type: none"> • Biocompatible • Biodegradable • Non-immunogenic • Fast gelation 	<ul style="list-style-type: none"> • Poor mechanical stability • Rapid degradation
Chitosan (Microbes, Crustaceans)	<ul style="list-style-type: none"> • Anti-bacterial • Bioadhesive material • Biodegradable • Non-antigenic • Biocompatible 	<ul style="list-style-type: none"> • Slow gelation • Poor mechanical properties
Alginate (Brown algae, Bacteria)	<ul style="list-style-type: none"> • Low cost • Fast gelation • Retains shape 	<ul style="list-style-type: none"> • Poor cell attachment • Easily clog at higher concentration • Requires cross-linking
Silk Fibroin	<ul style="list-style-type: none"> • Biocompatible • Strong mechanical properties 	<ul style="list-style-type: none"> • High brittleness

Source : <https://www.mdpi.com/2073-4360/13/10/1546>

Classification of polysaccharides

Cellulose

Cellulose is a homopolymer of glucose. These are abundantly found in plant fibres (seed, leaf, fruit, stem fibres etc.) (*Lavanya, D et al; Dec.2011*), microbes (producing pure cellulose). Bacterial cellulose is obtained from *Gluconacetobacter xylinus* (conventionally known as *Acetobacter xylinum*), *Agrobacterium* spp., *Acetobacter* spp., *Azotobacter*, *Rhizobium* spp., *Sarcina*, *Alcaligenes*, and *Pseudomonas* spp. (*Lahiri, 2021*). Some sources of algal celluloses are *Chondrus crispus*, *Gracilaria verrucosa*, *Chlorella*, *Oedogonium* spp etc. (*Zanchetta et al;2021*)

Table 3: Overview of the major polymer found in the extracellular covering of different algal taxa (*Zanchetta et al;2021*)

Algal taxa	Crystalline polysaccharides	Hemicelluloses	Matrix polysaccharides ¹
Chlorophyta (green algae)	Cellulose	Xyloglucans, xylans, mannans, glucuronan, (1 → 3)-β-glucan, (1 → 3),(1 → 4)-β-glucan	Ulvan, pectins
Charophyceae (green algae)	Cellulose	Xyloglucans, xylans, mannans, (1 → 3)-β-glucan, (1 → 3),(1 → 4)-β-glucan	Pectins
Rhodophyta (red algae)	Cellulose, (1 → 4)-β-mannan, (1 → 4)-β-xylan, (1 → 3)-β-xylan	Xylans, mannans, glucomannans, sulfated (1 → 3),(1 → 4)-β-glucan, (1 → 3),(1 → 4)-β-xylan	Agars, carrageenans, porphyran
Phaeophyceae (brown algae)	Cellulose	Sulfated xylofucoglucan, sulfated xylofucoglucuronan, (1 → 3)-β-glucan	Alginates, fucoidans
Dinophyta	Cellulose	-	-

Source : <https://www.sciencedirect.com/science/article/pii/S2211926421001077?via%3Dihub>

Hyaluronic acid

It is non-sulfated heteropolysaccharide composed of N-acetyl glucosamine and glucuronic acids. Tuber vegetables, greeny vegetables are the sources of hyaluronic acid and they are also found

in synovial fluids, cartilage. These are produced through microbial fermentation of *Streptococcus zooepidemicus*, *E.coli*, *Bacillus subtilis* with varying molecular weight based on UDP-N- acetylglucosamine concentration. Hyaluronic acid possesses great viscoelasticity, a strong ability to hold moisture, a high level of biocompatibility, and hygroscopic characteristics (Gupta RC et al; 2019).

Chitosan

A polymer with N-acetyl glucosamine and D-Glucosamine residues. Chitosan is a deacetylated form of chitin. These are exuberantly present in algae, crustaceans exoskeleton, fungal cell wall, cuticles of insects etc. Chitosan have mucoadhesive, anti-inflammatory, antihyperglycemic, wound healing, antitumor properties. The solubility of chitosan is based on their molecular weight (determined using viscometer), degree of acetylation (polydispersity), pH, temperature, and crystallinity of the polymer. (Aranaz et al;2021)

Table 4: Methods of Degradation

Methods/Modes of degradation	Level of degradation	Results
Ultrasonic degradation	Moderate degradation of the polymer	The degree of acetylation of the recovered polymers is not affected.
Hydrogen peroxide treatment	Random degradation; faster than ultrasonic method.	Considerable amount of monomers and chitooligosaccharides are produced.
Enzymatic degradation:		

Chitosanases	Endo hydrolysis of partially acetylated chitosan	Oligomers
Lysozyme	Cleaves glycosidic bonds	Trimers, tetramers
Neutral protease	Depends on degree of deacetylation	Low molecular weight chitosan

Silk fibroin

These are insoluble fibrous proteins having exceptional mechanical properties and controllable biodegradation (*Nguyen et al;2019*). A major drawback of the silk fibroin biomaterial is their susceptibility to bacteria. Hence, further research is required to produce biomaterial with anti- microbial properties. (*S. Ghalei et al;2022*).

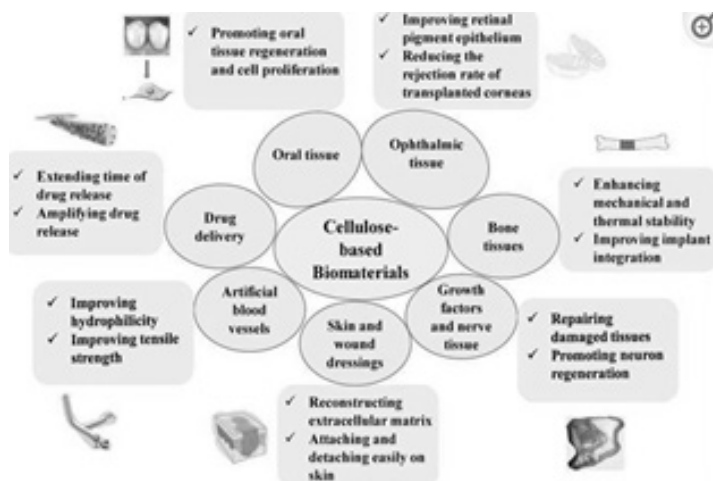
Pullulan

Pullulan is a polysaccharide of maltotriose units. These are produced by *Aureobasidium pullulans*. As pullulan is biocompatible, nontoxic, non-immunogenic and inert, it is progressively being used in biomedical and tissue engineering fields (*Reddy et al;2022*).

Applications of polysaccharides

Cellulose

Fig 1: Biomedical applications of cellulose based materials
(Fatema et al; 2022)



Source : <https://www.frontiersin.org/articles/10.3389/fbioe.2022.993711/full>

Hyaluronic acid and Chitosan

(<https://www.sciencedirect.com/science/article/pii/S2666138120300128?via%3Dihub>)

- Wound healing (Jammalamadaka et al; 2018)
- Ophthalmic treatments (artificial tear formulations, facilitate tissue healing) (Jammalamadaka et al; 2018)
- Anti-cancer therapy (ovarian cancer) (Jammalamadaka et al; 2018; Matthew Dovedytis et al; 2020)

- Scaffolds for regenerative medicine (Matthew Dovedytis et al; 2020)
- HA hydrogel for tissue regeneration (Matthew Dovedytis et al; 2020)
- Drug delivery (Matthew Dovedytis et al; 2020); as scaffolds, nanoparticles, sponges, hydrogel, aerogels etc.(Ahmed Omar Naïma et al; 2022, Pellis et al; 2022)
- Prevents biofilm formation (bacterial contamination) (Sudha et al; 2014)

Silk fibroin (SF)

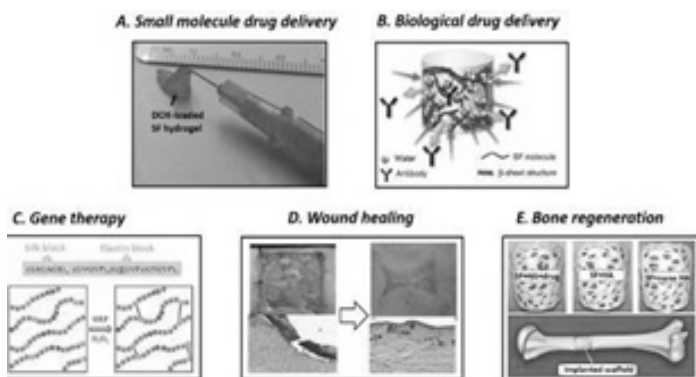


Fig 2: SF-based materials have been widely applied for important biomedical applications including small molecule drug delivery, biological drug delivery, gene therapy, wound healing, and bone regeneration. (A) For example, doxorubicin-loaded shear-thinning hydrogel can be prepared by SF aqueous solution (B) An entrapped monoclonal antibody can be released after water penetrating into the lyophilized SF network (C) Chemically cross linked hydrogel from silk-elastin like protein is applied for gene therapy (D) Positive in vivo wound healing efficacy can be

achieved using SF films (E) Scaffolds from SF and hydroxyapatite (HA) with/without drug are used for bone regeneration. (Lahiri et al; 2021) <https://doi.org/10.3390/ijms222312984>

Pullulan

- Targeted drug/gene delivery (liver targeted delivery) (*Ramesan et al; 2007*)
- Nanoparticles based drug delivery, cancer therapy (*Ramesan et al; 2007*)
- Medical imaging (detecting cancer) (*Ramesan et al; 2007*)
- Tissue engineering (conjugated scaffolds) (*Ramesan et al; 2007*)
- Blood-plasma substitute (plasma expander) (*Ramesan et al; 2007*)
- Wound dressing (*Elangwe et al; 2023*)
- Bone graft substitute, growth factor carrier, bone regeneration (*Ahmed Omar Naïma et al; 2022*)

Future prospectives

Technology for mass production of substrates and sterilization of biomaterials with improved characteristic features need to be focused. Studies needs to be carried out on substrates like pullulan which are less explored. Further research to be carried out on silk fibroin based biomaterial, with enhanced microbial resistant property.

Conclusion

This paper has shown light on some of the polysaccharides (cellulose, chitosan, pullulan, hyaluronic acid and silk fibroin). To use polysaccharides as biomaterials, the negative aspect needs to be addressed for making a better biomaterial. Further studies are required to fabricate these biomaterials with outstanding properties and functionality.

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Formulation of novel media for mass production of Cry protein from *B.thuringenesis*

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Abstract

Pest control in agriculture is vital to increase productivity of crops, currently 70-80% of agricultural practices use chemical pesticides which in turn causes serious environmental and health issues. The study focused on addressing the issue and increasing the production of CRY protein in Bacillus thuringiensis. It is a very important biological control of economical pests, the morphological characteristics were confirmed by Gram staining, Spore staining and Sudan Black B staining. The conformation of the species isolated was done by biochemical tests. The isolated organism was further mass produced using fed

batch culture in Erlenmeyer's flasks at 200 revolutions per minute at 37°C in Orbital shaker. The production media contained a glucose rich hydrozylate which is an industrial by-product of sugarcane hydrozylate along with many other salts like Calcium, Magnesium, Zinc, Iron, Copper, Manganese and Sodium. The growth parameters were standardized and checked for maximum yield of CRY protein and was estimated for Quality and Quantity. The Quantitative analysis of Protein was done using Lowry's Method. The cry protein was further purified using dialysis in a PBS Buffer. Molecular weight of the protein was determined using SDS-PAGE.

Keywords: *CRY protein, Bio pesticide, Bacillus, Lowry's method*

Introduction

Biocontrol is simply defined as the use of a biological agent or living organism to control the growth of an insect or pest (Köhl et al., 2019). Biocontrol agents suppress the plant pathogen population and help to control plant diseases. Living microbes are used as potential Microbial biological control agents (MBCA) by the cultivators, which are registered

Growers use Microbial Biological Control Agents (MCBA) containing living microorganisms, which are registered plant protection products produced by biocontrol companies, for commercial augmentative biological control of diseases. By hyperparasitism or antibiosis, MBCAs interact with pathogens directly. Hyperparasites kill fungal mycelium, spores, and resting structures, in some cases bacterial pathogens also. *Bacillus* bacteria are microorganisms that can be found in a wide range of environments. They are well-known for producing a diverse

range of antagonistic compounds with various structures, with 5 to 8% of their genes contributing to biosynthesize secondary metabolites. *Bacillus thuringiensis* (*Bt*) is a naturally available soil bacteria which produces Crystal (*Cry*) toxins. *Bt* is non-infectious and non-toxic to vertebrates, including humans, due to their mode of action due and insecticidal property and it has little or no effect on non-target aquatic and terrestrial invertebrates (Schnepf et al., 1998). *Bacillus* strains show their biocontrol potential primarily by inhibiting growth of plant pathogens, eliciting plant systemic resistance, and competing for ecological niches with plant pathogens. On consumption of *Bt* by larvae, the gut lining is destroyed, which leads to stop feeding and death in 1-2 days.

The present study focuses on formulation of a novel laboratory media for selection and growth of *Bt* strain. The use of media designed for a specific purpose can sometimes help with isolation from a mixture. Production of mixture of spores by developing a fermentation method can lead to high concentration with high productivity of cry protein by optimizing the parameter which can lead to cost-effective production of *B. thuringiensis* as biocontrol agents. *B. thuringiensis* on batch fermentation with high glucose level, can have negative consequences as the acids produced eventually, lowers pH value below 5.5, below which the bacteria are unable to grow, and leads to substrate inhibition growth consequences. Fed-batch culture is commonly used to produce a variety of bioproducts, including biocontrol. Because of the incomplete consumption of added glucose, productivity and toxin yields were significantly reduced. Excess substrate in the fermentation medium, as well as a lack of substrate, have been shown to inhibit cell growth and bioproduct formation. The goal of this study was to see if the exponential feeding strategy, which is commonly employed in industrial production, can supply glucose

and other nutrients to *B. thuringiensis* cells and increase cell growth along with increased bioinsecticide production.

Materials & methods

Collection of soil sample

Garden soil was collected at random at a depth of 15cm from the surface of the soil. The collected soil samples were brought to the laboratory in sterilized polyethene bags, handpicked and stored in containers for future use.

Isolation of bacteria from soil

10g sample of finely pulverized, air dried soil is added in 90 ml of sterile water blank to make 1:10 dilution (10^{-1}). Serial dilutions was carried out from 10^{-2} , 10^{-3} ,... 10^{-6} dilutions. 15 ml of nutrient agar media was sterilized (121°C , at 15 lbs for 15 minutes), cooled, molten (45°C) was poured in the sterile petriplates and was allowed to solidify. 0.1 ml aliquot of 10^{-4} to 10^{-6} dilutions were added to sterile petridishes, and was spread with the help of L-rod. The petriplates were incubated for 24-48 hours.

Morphological and Biochemical characterization of *Pseudomonas* spp.

Morphological and Biochemical characterization of the stored pure culture was carried out using the standard techniques based on Standard Microbiological Methods by Monica Cheesbrough, 2004 (Cheesebrough. M., 2006). Endospore staining and Sudan black staining was carried out to microscopically observe the endospores and detect the presence of fat granules in *Bacillus* spp.

Formulation and optimization of media for bacterial protein production

Lab media was prepared by modifying the media reported by Marzban, 2012 which included 1.5g/L $(\text{NH}_4)_2\text{SO}_4$, 0.2 g/L $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 2.5g/L NaCl, 1.5 g/L KH_2PO_4 , 0.02g/L ZnSO_4 and 1.5ml/L trace elements solution. A glucose rich hydrozylate of sugarcane hydrozylate (4 ml) was added and a pH of 7 was maintained (Marzban, R, 2012.). The organism was inoculated. The lab media was incubated on an orbital shaker for 48 hours at 37°C. The absorbance was checked at OD_{600} on a spectrophotometer. After the fermentation process, the production of bacterial proteins was further estimated. Bacterial extracellular protein extraction was done according to Lasf et al., 2005 and purified using ammonium sulphate precipitation using PBS (pH 6.8). Isolated and purified protein was estimated both qualitatively and quantitatively.

Protein estimation - Lowry's method

The BSA standard with a concentration of 4mg/ml was employed and various dilutions of this standard were created. The sample and standard tube were supplemented with 2ml of a complex forming reagent, followed by an incubation period of 10 minutes at RT . In each tube, 0.2ml of Folin – Ciocalteu reagent solution was introduced, and the mixture was incubated for a duration of 20-30 min. The absorbance at 660nm was measured using a spectrophotometer. Sample concentration was calculated using a standard graph as a reference (Peterson, 1977). The purification of obtained protein was done using ammonium precipitation method (Wingfield, P, 1998).

Protein profiling through SDS-PAGE

To detect the presence of δ endotoxin, crystal spore preparations were subjected to analysis using 10% SDS PAGE gels . A total of 1.5 ml of sporulated culture broth was collected via centrifugation and underwent a single wash with distilled water. The resulting pellet was then suspended in the T.E buffer. Approximately 45 μ l of the sample was combined with SSB (consisting of 1% w/v SDS, 0.1% v/v β mercaptoethanol, 10% v/v glycerol and bromophenol blue). The mixture was heated in a boiling water bath for 5 min prior to electrophoresis. Each well was loaded with around 50 μ l of the prepared sample, and electrophoresis was conducted at 50mV. By comparing the resulting cry protein with protein markers of known molecular weight, the unknown molecular weight of the Cry proteins can be determined. (Alper et al., 2016).

Results & Discussion

Morphological analysis of isolated organism by staining techniques:

Gram staining, Spore staining and Sudan black b staining:

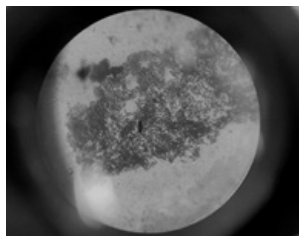


Fig. 1: Gram Staining

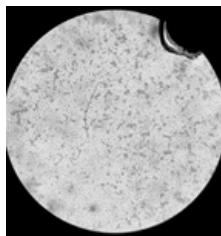


Fig .2: Malachite Green Staining

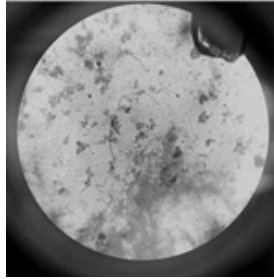


Fig. 3: Sudan Black B staining

Gram positive purple rods under the microscope at 100x in oil immersion (Fig 3). In the above figure the Gram positive purple rods showed sporulation, which is a characteristic of *Bacillus thuringiensis* due to the parasporal crystal present in it, which contained the cry gene of different protein toxic to the pest. (Bechtel & Bulla, 1976). On Spore staining the culture, the vegetative cells were stained in green colour and the spores were stained in red colour because of the Safranin (Fig 2). The presence of spores indicates the possibility of *Bacillus* spp. as it is a spore forming Gram-positive bacteria (Karava et al., 2019). In Sudan black B staining, the cytoplasm of the bacterial cell was stained pink, whereas the spores appeared to by greyish-black in colour (Fig 3). (Burdon et al., 1942.).

Biochemical Characterization of isolated organism

Table 1: Biochemical characterization of unknown isolate

S.no	Biochemical Tests	Results
1.	Indole	+++
2.	Methyl red	+++
3.	Voges Proskauer	--
4.	Catalase	+++

5.	Oxidase	+++
6.	Starch Hydrolysis	+++
7.	Carbohydrate fermentation	
	Sucrose	+++
	Dextrose	+++
	Lactose	--

The isolated organism was subjected to biochemical characterization, which showed Indole positive, Methyl red positive, VP negative, Citrate positive, Catalase positive, Gelatinase positive, Oxidase positive and it hydrolysed starch. On carbohydrate fermentation, it was positive for Sucrose and Dextrose whereas negative for Lactose (Barjac & Frachon, 1990) (Table :1) .

Protein Qualitative and Quantitative estimation -Xanthoproteic method and Lowry's Method

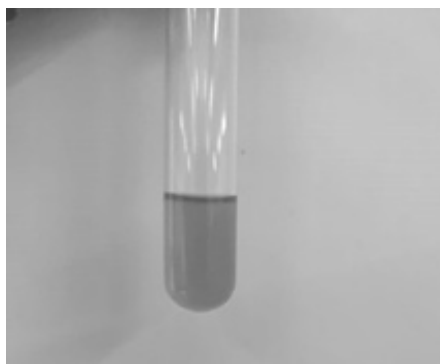


Fig 4 : Protein Qualitative Test Xanthoproteic method

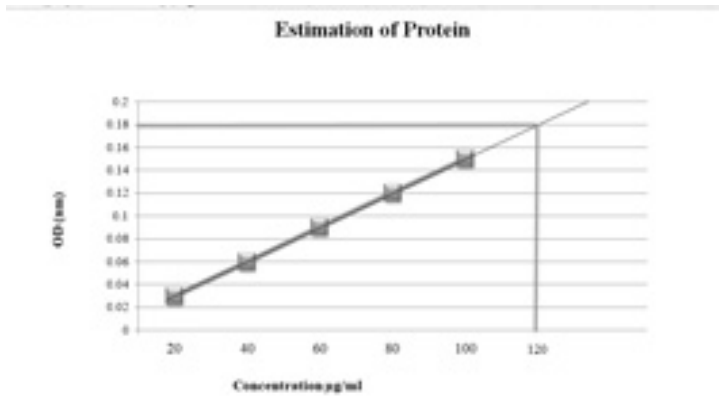


Fig 5: Graph for Estimation of protein by Lowry's Method

The yellow colour indicates the presence of protein in the isolated *Bacillus thuringiensis* Aromatic amino acids present in the CRY protein structure, when reacts with Conc.nitric acid gives nitro-derivatives which are yellow colored. On adding NaOH produces an orange color on reacting with the phenolic group causing ionization in the solution resulting in a yellow orange colour change of the solution (Fig 4) . (Shah Dhrumi et al., 2022.) Lowry's method was used to estimate the amount of protein in the sample. It was estimated to be 120 µg per ml using the standard graph (Fig5). The pore forming toxin known as 3D-Cry toxins have the ability to induce osmotic shock in larval epithelium midgut cells, resulting in their lysis and subsequent cell death. (Peterson, 1977).

Mass production of *Bacillus thuringiensis*

The below image shows the cloudy appearance of *Bacillus thuringiensis* (Fig 6).The growth was observed at OD₆₀₀, which was found to be 1.7. Similar results were shown in (Poopathi & Kumar, 2003) Sugar cane hydrozylate was proven to be a very

effective industrial waste by-product for the growth of *Bacillus thuringiensis* and could be a very good Carbon as well as Nitrogen source. Lab media was tried with Yeast extract, which showed better results than the one without Yeast Extract. Purification of the obtained Cry protein was carried out using dialysis, resulting in shrinking of bag which indicates the presence of *cry* protein which was achieved after 78 hours of dialysis (Fig 7). As the salts moved out of the dialysis bag through the small pores present in the bag. The salt molecules moved out in the dialysate which resulted in shrinking of the bag (Wingfield, 1998).

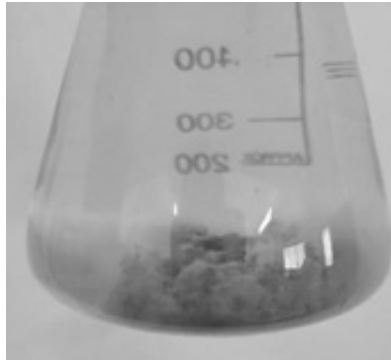


Fig 6 Mass production of *Bacillus thuringiensis*



Fig 7 Dialysis Bag with *cry* Protein SDS PAGE

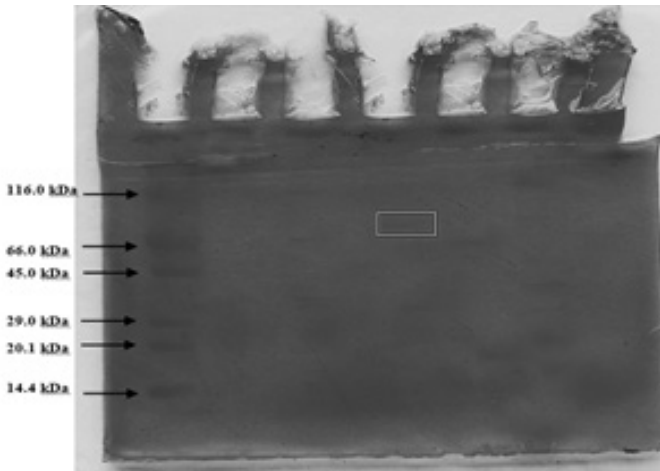


Fig 8: SDS PAGE analysis of purified protein

The blue band indicates the protein ladder and the marked band indicates the presence of protein present in the *Bacillus thuringiensis* with appropriate size of 120 kDa and 6. The *Cry2* protein is known to have a size between 65-90 kDa indicating it to be the *cry2* protein of the gene (Mukhija & Khanna, 2018) (Alper et al., 2016).

Conclusion

The formulation of novel media which is economical and easily prepared in a cost effective manner used to screen and increase the production of insecticidal protein which can be effectively used for biological control of pests. During this period, these products have not shown any adverse effects on human health or the environment. In view of certain economical benefits, *Bacillus thuringiensis* based biopesticide cost is lower than other chemical or synthetic pesticides

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Biofabric - A way to future sustainability in textile from *Acetobacter Sp*

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Abstract

Production of sustainable biofabric can be possible using bacteria. Bacterial cellulose plays a major role in the biotechnology industry by extrapolating its various usage. BC film can be obtained using Acetobacter sp that can synthesize Cellulose, a thin filament like structure. GYC medium used to culture the bacteria under specific conditions since they grow up to 5-7 days. Further examination and characterization bacterial cellulose confirmed by the presence of bacteria react with biochemicals. The biofabric was examined to test its functionality to perform as a sustainable textile fabric especially having environmental benefits without causing any toxicity or harm to the environment as well as the consumer. The results proved the potential ability of the bacterial Cellulose film as a Sustainable "Biofabric".

Key Words: *Bacterial Cellulose (BC), Biofabric, cellulose filament, Acetobacter, environment sustainability*

Introduction

Fashion and textile industry becoming the ultimate source for designing and innovating different fibers and designs for various couture. Though the textile industry reached its great height but still on the other side it remains questionable for the environment aspect. This leads to unsustainability which furthermore causes the accumulation of toxic chemicals on land that are all difficult to degrade. Due to the high demand for textiles, production the usage of chemicals and other harmful substances increases which directly or indirectly leads to “Environmental Pollution”. The textile industry stands as a major factor in causing a threat to the environment. Therefore, research and various inventions to control the threat and to bring sustainability in water consumption, effluent treatment, and energy demand are the focus of research to minimize the harmful effects on sustainability (Jain and Gupta, 2016). The quest to make the textile industry more sustainable has increasingly directed designers and scientists to focus on biomaterials, such as bacterial cellulose (BC), and their biocompatible properties. This led to breakthroughs in textiles and welcomed biomaterial-based products without toxicity (Costa A.F.S *et al.*, 2017). Bacterial Cellulose has more versatile properties than Plant cellulose, it is a high tensile, ductile, and water-holding ability. It is produced by certain bacterial species like *Acetobacter*, *Sarcina ventriculi*, and *Agrobacterium sp.* Bacteria that produce cellulose include Gram-negative bacteria species and rod-shaped aerobic and acetic acid-producing bacteria(AAB).

Cellulose is a linear polymer connected with a polymer of glucose molecules connected with β - 1,4 linkages by a glucosyltransferase with individual glucose chains.). Bacterial cellulose must possess biodegradable capacity since cellulose is a

natural biomaterial produced by bacteria. The degradation ability is high due to the presence of matrix polymers like lignin, and hemicellulose to facilitate degradation (Iqbal H.M.N *et al.*,2015). Bacterial cellulose is biocompatible without producing any toxic or allergic effects, especially towards mammalian cells and tissue (Klemm D *et al.*,2001).BC does not induce toxicity in the living cells .The presence of hydrogen bonding between the third oxygen of one glucose unit and the fifth oxygen of the preceding glucose unit. This leads to high viscosity and a tendency to be crystallize. Due to the fibrous network, biocompatibility supports the tensile strength and possesses high water holding capacity (WHC).

Materials and methods

Sample collection

Rotten Pineapple rich in bacteria was taken and kept for 3-4 days to facilitate *Acetobacter sp* Growth (Fig.1). They are acetic acid bacteria (AAB) that can produce acid from glucose and alcohol.

Culture media

2Ideal designing of the culture medium is essential for optimum bacterial growth and cellulose production. For the isolation and growth of *Acetobacter sp* HS media (Hestrin Schramm) a synthetic complex medium containing (Glucose-2g, peptone-0.5g, Citric Acid-0.2g, (NH₄)SO₄ - 0.27g, KH₂PO₄ - 0.3g, MgSO₄.7H₂O -0.3gand distilled water-80ml) (Zakaria, J.and Nazeri, M., 2012).The optimum pH of BC production was 7 and the optimum of temperature for production BC was 30 °C and it takes 5-7 days to grow.

Morphological characterization

Bacterial isolation & colony

Acetobacter colonies appear as Creamy, White, Smooth, Slimy, and cloudy colonies with coherent consistency. The *Acetobacter* colonies alone were isolated using the streak method and allowed to grow on a specific medium called GYC medium (yeast extract -1g, d-glucose-2g, calcium carbonate-1.5g). 7- 14 days for *Acetobacter* growth and subcultured using the same GYC medium

Gram staining

Gram staining technique used to differentiate Gram-positive and Gram-negative bacteria (Fig2) based on their cell wall constituents. The bacteria were identified as “Gram-negative rod-shaped”.

Differentiation of *Acetobacter* from *Glucanobacter*

Acetobacter changes the color of the medium from yellow to green in the presence of Bromocresol green vice versa for *Glucanobacter* making both organisms produce bacterial cellulose (Fig.3). Carrs's media composition include (Yeast extract 2%, Agar 1.5%, Bromocresol green 0.002%, Ethanol 2%, Distilled water 20ml)

Biochemical characterisation

Indole test

Tryptophan hydrolyzed to tryptophanase to produce indole, which is detected by Kovac's reagent to produce red colored compound. 5ml of tryptone broth was added to a test tube containing culture, and 1ml of Kovac's reagent was added. No formation of indole ring and the test tube remain yellow indicated a Negative result

Methyl red test & VP test

The culture medium contained acid produced by bacteria turning methyl indicator red (Cowan S.T.,1953) using 5 ml of MR-VP broth, and 2-5 drops of Methyl indicator added. The formation of a ring indicated a Positive result

MR-VP broth and VP reagent I - Barritt's reagent A: 5% (wt/vol) a-naphthol and VP reagent II - Barritt's reagent B: 40% (wt/vol) KOH added to the tubes (McDevitt S,2009). The change in color of the broth to yellow indicated Positive

Carbohydrate fermentation test

The biochemical method was evaluated by the drop in pH and production of the acid in different sugars with organisms. This confirmed Positive for Sucrose and Glucose

Catalase test

Catalase enzymes function as a catalyst by breaking down hydrogen peroxide into oxygen and water(Cheesebrough,2005). A drop of 3% of hydrogen peroxide was placed over the culture and the formation of bubbles showed positive results for catalase activity.

Oxidase test

Oxidase discs having Cytochrome Oxidase oxidizes tetramethyl -p-phenylene di-amine colorless reagent to purple color forming indophenols (Shields *et al.*,2010) . No color change was observed indicating a Negative for oxidase test.

Bacterial cellulose fabric extraction

From the Isolated culture media after the Incubation period of 6-17 days a thin layer of bacterial cellulose layer was formed (Fig.4 & 5). This was considered as a “Biofabric” which can be further evaluated to find its property and efficiency.

Antibacterial activity

The disc diffusion method was applied using sample (BC) films both Gram-negative and Gram positive.

Culture samples	Bacterial Cellulose film	Methicillin
<i>E.coli</i>	0.7cm	0.4cm
<i>S.aureus</i>	0.6cm	0.3cm

Table 1. The Zone of inhibition measured around Antibiotic disc(Methicillin) & the Bacterial cellulose film

Tensile testing

Bacterial cellulose film was subjected to Tensile strength testing using the UTM (Universal Testing Machine) –INSTRON MODEL. 3369/J7257. The film showed its tensile ability with increased stress level up to 43.27 MPa with a thickness of 0.15mm. The different stress levels plotted in a graph (Fig 6).

S.No	Maximum load	Tensile Strength	Elongation at Maximum load(mm)	Extension at Maximum load(mm)	Thickness	Sample Id
1	64.90	43.27	2.14	1.07	0.15	FILM
2	43.10	30.78	2.17	1.08	0.15	FILM

3	50.79	33.86	2.67	1.34	0.15	FILM
5	78.04	52.03	3.50	1.75	0.15	FILM
MEAN	59.21	39.99	2.62	1.31	0.15	FILM

Table. 2 Tensile Strength values measured and tabulat

Cytotoxicity

The VERO cell lines obtained from King's Institute Guindy Chennai, to conduct MTT assay Minimal Essential Media commonly used to maintain cells with appropriate atmosphere and CO₂ at 37 C(Fig7) The % cell viability calculated using the following formula: **% cell viability A570 of treated cell/A570 Of Control Cells×100 (80% viability)**

Scanning electron microscope

Structure and texture characterization of the film performed by SEM (TESCAN VEGA3XMU) with resolution of 1.2nm gold particle & high magnification of 5X to 1000,000 X.was observed and scanned under 20µm indicating the fibril networks as Bacterial cellulose.

Results and Discussion

The results are consistent with other research and studies about bacterial cellulose. From the microorganism, the production of fabric ensured prominent results showing its capacity and productivity to fully form into a biofabric. The SEM analysis (Fig8a &8b) shows a three-dimensional structure of the cellulose film and the tensile strength also reveals its tearing ability and withstand processes concerning temperature and stress. The below figures represent the resulting images on production of biofabric.

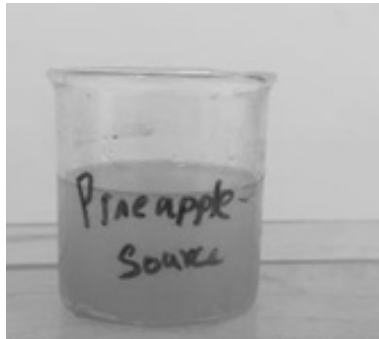


Fig .1 Rotten pineapple pulp

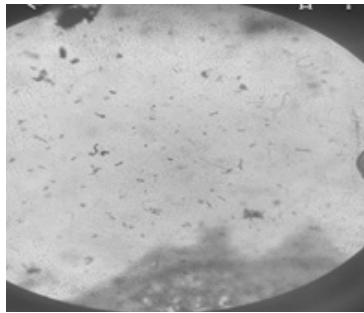


Fig.2 Gram Negative Rod-shaped bacteria was observed

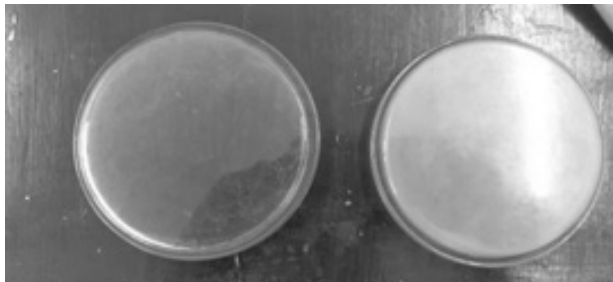


Fig.3 Color differentiation between Acetobacter and Glucanobacter

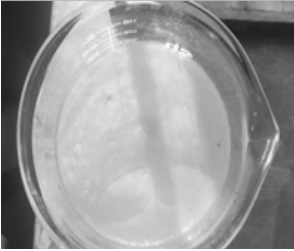


Fig.4 Formation of BC Film



Fig.5 Bacterial Cellulose film

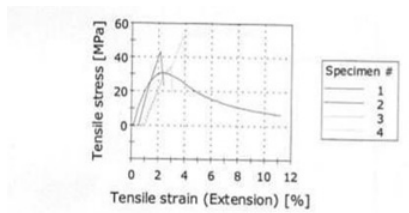


Fig.6 Graph indicating peak value of Tensile strength at Tensile stress for BC film

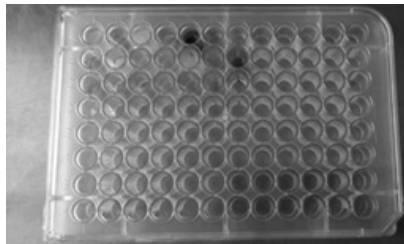


Fig. 7 Cytotoxicity test using VERO cell lines

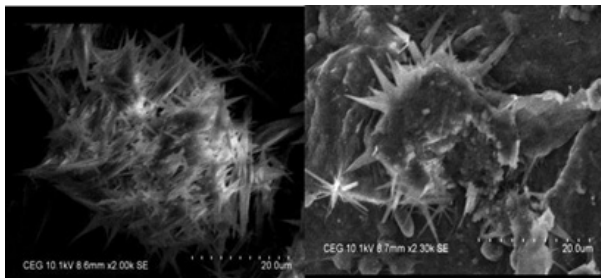


Fig. 8a & Fig. 8b SEM Image of Cellulose fibril network

Conclusion

The mission of the project was to develop a biofabric that could pave the way for future research and development in the textile industry which would emerge as a global sensation in fashion and textiles. To remediate the production of Sustainable “Biofabric” forms a basic outline for introducing microorganisms into the textile world. Further extension of the product in a large-scale biofabric. produced from bacterial cellulose which could develop as a couture and could lead to evolution in the textile and biotechnology sector.

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**Innovations in
Teaching, Learning and
Digitisation of Education**



Perceptions on Outcome-Based Education - A Qualitative Assessment Among Teachers and Students

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Abstract

Outcome-based education (OBE) is an educational approach that focuses on defining specific learning outcomes and designing educational programs around those outcomes. It strongly emphasizes what students should be able to demonstrate at the end of a course. This qualitative study aims to understand the perceptions of teachers and students about the implementation of OBE in the contextual teaching-learning model. Data is proposed to be collected through schedules and content analysis will be done to identify themes. The target sample groups for this study are students who have studied in the OBE pattern of evaluation for at least one year and teachers who have experience teaching for at least one year in the OBE pattern and one year in the non-OBE pattern. The proposed sample size is 15 from each group. OBE is considered to be a student-centered approach with a

scope for continuous improvement. This study will be a step toward identifying and bridging the gaps between students' expectations and teachers' implementation.

Keywords: *Outcome Based Education, Contextual teaching-learning model, qualitative study*

Introduction

Outcomes-Based Education (OBE) has drawn considerable interest and implementation in educational systems around the globe. It highlights the significance of defining and assessing measurable learning outcomes in order to ensure effective teaching and learning processes. This research paper seeks to investigate and compare teachers' and students' perspectives on the outcomes-based approach to education. The purpose of this qualitative study is to investigate the experiences, difficulties and benefits teachers and students encountered within the OBE framework. This study's findings will contribute to a comprehensive understanding of the effects of outcomes-based education on a variety of stakeholders, thereby facilitating informed decision-making and pedagogical enhancements.

Purpose and Objectives

This research paper aims to compare and contrast teachers' and students' perspectives on outcomes-based education. By examining their experiences within the OBE framework, we hope to obtain a better understanding of the potential benefits, challenges, and implications of this approach.

Methodology

This study employed a qualitative research design. Teachers (n=15) and students (n=15) were asked open-ended questions

(validated by experts) in order to gather data. Analysis of qualitative data acquired was conducted using content analysis.

Result

Table 1

Inductively developed thematic categories based on the responses from teachers

Category	Thematic category	Key terms	Characteristic responses
1. Effectiveness of Outcome Based Education	Application-oriented	Marked Improvements	1. Yes, there have been marked improvements in students' abilities to apply their learning to real-world situations. 2. OBE has fostered innovation and creativity in students to explore new ideas, think critically, and propose innovative solutions to real-world problems.
	Student-centric	Students' participation	1. Students tend to learn the concepts clearly and are able to explore their creative side and write answers on their own
	Effective assessment process	Yes, definitely	1. I usually test the students understanding in class by asking them to come up with their own examples. And, most of them are able to do that with great ease
2. Challenges of Outcome Based Education	Restrictive nature	Lack of autonomy	1. OBE is restrictive in framing assessments. It does not allow for teacher autonomy and creativity in assessing student performance.
	Irrelevance	Not applicable	1. The K-LEVEL words do not apply to the stream of Arts.

3. Requirement of additional resources	<p>Resources are adequate</p> <p>Materials for teaching</p> <p>Lack of flexibility</p> <p>Lack of clarity</p> <p>Time constraints</p>	<p>Yes</p> <p>ICT tools, books, training</p> <p>No freedom to adapt</p> <p>Clearer specific outcomes</p> <p>More time for learning</p>	<p>2. The compulsion to use K-level words in all disciplines without quite taking into consideration the kind of learning that is being done makes question papers silly and diluted.</p> <p>1. Adequate resources are made available for implementation of OBE.</p> <p>2. ICT tools for implementing OBE</p> <p>3. Training on how to do OBE style teaching was completely skipped. This is the challenge.</p> <p>4. Books on how to implement Outcome-Based Education and Bloom's Taxonomy can be provided by the college library.</p> <p>5. Guidelines for designing assessments aligned with OBE are essential.</p> <p>1. Allow teachers the freedom to implement OBE to suit their course needs without making it a standard form.</p> <p>2. The freedom to understand and implement OBE by adapting it to suit each course's needs.</p> <p>3. Greater flexibility is required.</p> <p>1. Need more Clarity on its use, especially the measurement with PSOs.</p> <p>2. Outcomes can be clearly defined. Sometimes outcomes can be overlapping and vague.</p>
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4.Challenges with the implementation of OBE	Learning outcomes	Yes No	1.Syllabus will have to be reworked to give more time for assimilation and focus 2.Time is required to learn and implement the pattern properly. 1.Yes, Discussions at the beginning of the semester where they understand the OBE system with specific outcomes. 2.I may have to assign varied learning tasks related to the content to ensure that these outcomes are achieved. I cannot claim that this is being done as of now.
5. Communication with students	Feedback	Rubrics based Constructive feedback Opportunities to improve	1. Rubrics-based feedback is given 2. Constructive feedback is provided to students, wherein areas of strength and areas for improvement is highlighted. 3. Provide opportunities for students to address the identified areas for improvement.

From Table 1, the thematic categories based on the responses from teachers can be observed.

Table 2

Inductively developed thematic categories based on the responses from students

Category	Thematic category	Key terms	Characteristic responses
1. Familiarity with OBE	Learning outcomes	Yes	1. Familiar with OBE & learning outcomes of the courses.
		No	1. Learning outcomes are not referenced in classes regularly.
2. Challenges with OBE	Pattern of evaluation	Specific	1. Specific answers are expected, not much room for experimentation. 2. Assessment techniques are not directly related to the application of the course.
		Lack of guidelines	1. No clear guidelines on how our performance will be assessed based on the learning outcomes were given.
		Teaching methods	1. Teaching methods used do not support the achievement of learning outcomes always.
3. Effectiveness of OBE	Increased motivation and engagement	More motivated	1. Yes, as I look forward to getting a positive and good outcome, and learn efficiently making me feel more motivated and put in the efforts
	Real-world applications	Reflect and apply	1. By making me reflect on what is taught/learned, it did give me an idea of how to apply various concepts in real-world settings.
	Career prospects	Area of interest	1. OBE allows one to discover one's specific area of interest based on the outcomes around which one can centre their career.
4. Feedback	Rubrics	Ambiguous	1.No clear rubrics pertaining to K levels are not given

From Table 2, the thematic categories based on the responses from students can be observed.

Discussion

Outcome-based education has proved to be effective as it is application-oriented, student-centric, and aids in an efficient assessment process. It has shown marked improvements, increased students' participation, and helped teachers' evaluation of student performance. In accordance with the student perspectives, OBE has increased motivation and classroom engagement. It also allows the discovery of future career prospects and specific areas of interest. The approach emphasises critical thinking, problem-solving, and the acquisition of practical skills, all of which are essential for success in the quickly evolving world of today. Students take an active role in their own education by defining objectives, keeping track of their progress, and accepting accountability for their learning results. This increased participation can lead to a deeper understanding of the subject matter and a more meaningful learning experience. OBE helps students explore different fields of study and potential career paths. Students have the opportunity to apply their knowledge and skills in practical contexts and gain a better understanding of their own strengths and interests. In conclusion, the advantages of OBE include enhanced educational outcomes, increased student involvement, and improved teacher appraisal of student achievement.

The challenges of Outcome Based Education are explained by its restrictive nature, irrelevance, lack of autonomy, and the inability to apply these course outcomes to certain streams (eg. Arts). Students express that the evaluation pattern is rigid with not much room for experimentation, a lack of guidelines, and

appropriate teaching methods. OBE emphasizes predefined outcomes which may hinder educators' ability to address the diverse learning needs and interests of students. This rigidity may limit the exploration of alternative approaches and curricular content that could potentially enhance the learning experience. The lack of autonomy is also identified as a challenge in outcome-based education. OBE often involves the top-down implementation of standardized outcomes and assessments. This may not effectively address the diverse needs and contexts of different educational settings. Outcome-based education may struggle to capture and assess the full range of skills and knowledge that are developed through artistic disciplines. The arts often involve subjective and creative expression, which may not easily fit within the framework of predefined outcomes and standardized assessments. In conclusion, these challenges highlight the need for a balanced approach that considers both the benefits of outcome-based education, as well as the importance of flexibility, relevance, and autonomy in addressing the diverse needs and interests of students.

The responses also indicated the requirement of additional resources to help teachers understand the complexities of OBE. The material resources (eg. ICT Tools) provided by the educational institutions prove to be useful in implementing OBE. However, training the teachers to execute the teaching style and providing them with supporting literature will give them a comprehensive understanding of outcome-based education. To effectively implement OBE, teachers need support and resources that can provide them with a deeper understanding of the underlying principles and strategies involved. In addition to training, providing teachers with supporting literature is mentioned to give them a comprehensive understanding of OBE.

The implementation of OBE also has its challenges such as the lack of flexibility, clarity, and time constraints. The responses indicate that there is a reduced ability to adapt, unavailability of specific outcomes, and limited learning time. This rigid structure may limit the ability of educators to adapt their teaching methods. The lack of clarity in outcomes can lead to ambiguity in instruction and assessment, potentially compromising the effectiveness and reliability of OBE.

Teachers indicate that appropriate student communication regarding the learning outcomes and integrating constructive feedback based on rubrics and opportunities also pave way for improvement of OBE. The adaptation of specific learning outcomes is ensured by assigning varied tasks that are mapped to these outcomes. Constructive feedback based on rubrics helps students understand their strengths and areas for improvement, guiding them towards achieving the desired outcomes.

Conclusion

In conclusion, outcome-based education (OBE) has demonstrated its effectiveness in promoting application-oriented learning, student engagement, and efficient assessment processes. However, the implementation of OBE is not without challenges. These challenges include the restrictive nature of predefined outcomes, lack of flexibility, and difficulty in applying OBE to certain disciplines. To successfully implement OBE, clear guidelines, appropriate teaching methods, training for teachers, and access to supporting resources are crucial.

Implications of the study

This research sheds light on the influence of OBE on student learning, motivation, and overall satisfaction, allowing educators to refine their instructional practices and enhance the educational experience.

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A Conceptual Framework of Digital Instructional Design for Blended Learning

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Abstract

Traditional classroom settings and teacher-centred learning environment have become a taboo in this modern era. The digital world with ubiquitous computing has brought the learners and teachers together to learn and share their experiences. Since the researcher firmly believes that ubiquitous devices cannot replace a teacher in the learning process, she opted to choose Blended learning, where the teacher incorporates the ubiquitous devices with face-to-face learning to enhance the learning experience and bring about a holistic learning. The abstract maps out a conceptual framework for designing a digital instructional material that can be used for blended learning. The framework guides one through various stages, by initiating the process with needs analysis, then, designing the learning pathway to blend and curate the contents, leading to content selection and organization, furthermore, integrating the multimedia content, creating the interactive activity, collaborating facilities, implementing assessment, and collecting feedback for the production of content. By employing features and templates of any graphic design software educators can design engaging and visually appealing instructional materials that cater to multiple learning needs. The conceptual framework helps the educators to construct digital instructional materials for blended learning that keep the learners engaged, gain real-life experience, hone their skills to achieve whole-person education.

Keywords: Digital Instructional Design, Ubiquitous Computing, Blended Learning

Introduction

Teaching Zen generation learners is a difficult task and keeping them engaged is even more difficult. With ubiquitous computing, (Weiser,1991) modern learners prefer to use ubiquitous devices for both entertainment and learning. Prototype tabs, pads and electronic boards are just the beginning of ubiquitous computing (the interaction between people and computers) but today modern learners are familiar with digital learning that uses latest digital technologies and resources to facilitate and enhance the learning process. A teaching pedagogy which makes use of this should be practised but without the teacher, learning process is incomplete. So, the concept of Blended learning, which combines face-to-face pedagogy with online components, has gained prominence in the current educational system.

This paper focusses on bringing a conceptual framework of digital instructional design for blended learning. It is divided into four sections and the first section analyses the need for blended learning in the current scenario, reviews relevant papers to draft the conceptual framework. The second section lists the various stages of designing digital instruction such as needs analysis, learning pathway design, content selection and customization, integration of multimedia and online resources, interactive activity creation, collaboration facilitation, assessment implementation and feedback collection. It also discusses the various graphic design software to create content. Third section finalises the conceptual framework of Digital Instructional design for blended learning. After reviewing relevant papers, the researcher designed the stages of Digital Instructional Design.

Stages of Digital Instructional Design

Needs Analysis

A needs analysis is the first step to figure out the learner's requirements in learning and an apt teaching methodology to achieve it. This can be done by collecting data through questionnaires, surveys and quizzes, determining the learning outcomes by applying Bloom's taxonomy, classifying the learner's level of proficiency using rubrics at the micro level and finally implementing the plan by selecting an appropriate pedagogy.

Learning Pathway Design

The objective of designing a learning pathway is to plan the way how learning takes place before the initialisation of teaching/training. Learning pathway provides a roadmap in acquiring knowledge in a systematic way. Based on the needs analysis, lessons with learning objectives and outcomes (syllabus), learning resources (offline and online), learning activities (synchronous & asynchronous), a pedagogy to match the learning outcome are finalised for an effective learning process.

Content Selection and Customisation

Preparing effective teaching materials is similar to the processes involved in planning and teaching a lesson. The goal is to create materials that can serve as resources for effective learning. (Richards, 2001) The materials provide the "basis for the content of lessons, the balance of skills taught, and the kinds of language practice students take part in. (Richards, 2001)" "Content selection is the act of choosing from a universe of possibilities, a sample of subject matter judged suitable for teaching and learning in the circumstances of a course or subject in a school, and it includes

the arguments over what is worthy of inclusion. (Lo, 2016)” “Teaching materials may take the form of printed materials, non-printed materials, also materials comprising both and materials not designed for instructional such as magazines, newspapers, and TV materials. (Richards, 2001)” Richards (2001) quotes Shulman’s “transformation phase of this process that consists of Preparation, Representation, Use of a representational repertoire, Selection, Adapting and tailoring to student characteristics.”

Selection of Content can follow the seven criteria self-sufficiency, significance, validity, interest, utility, learnability and feasibility in the selection of content for micro curriculum, and for the content, subjects needed for the curricular program or course, of the macro curriculum. Once the material selection gets over the next step is integration of multimedia content in the instructional design.

Integration of Multimedia content

In education, Multimedia technologies enable the learners to integrate and manipulate information from diverse sources such as video, images, graphics, animation, audio, text, simulation. It also increases the learning effectiveness, holds the attention of the learners, teaches more appealingly and involves integration and interaction among the learners.

Interactive Activities

Teachers/ Trainers can decide on what kind of interactive activities to implement in the classroom based on the topic and objectives of the course. Activities paves way for the learners to test their comprehension of the content through quizzes, to create a realistic learning environment through simulations, to explore

the new avenues in a safe scenario in virtual labs. Discussions in classroom or online discussion in any Learning Management System motivates the learners to interact with their peers to exchange ideas and clarify their doubts by asking appropriate questions. The art of roleplaying brings out the creativity skills and allows the learners to apply the skills learnt as theory. Multimedia presentations incorporates learning modules in mobile/ computer games, learning apps and embedded videos as a means of extrapolatory exercise for the learners. Group work or collaborative work promotes soft skills such as communication, team work, problem solving, decision making and leadership skills. Technologies can facilitate collaborative learning by providing students with vital opportunities to create and build knowledge.

Collaboration

Collaborating the ubiquitous devices and classroom teaching at the right time offer interactive and engaging learning experiences.

Assessment & Feedback

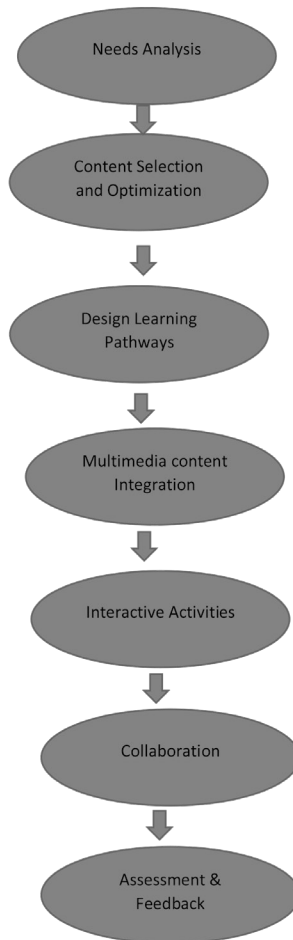
Various forms of assessment and feedback could be done through online quizzes, automated grading systems, instant feedback mechanisms, and data analytics that enable timely and constructive feedback, facilitating learner progress and understanding.

Graphic Design Applications

The graphic design software tools that help in making make images, videos, and other types of media or art for brand marketing, education and other creative pursuits. Graphic design software refers to apps and programs used by the graphic designers to create, edit, and manipulate digital images. The popular ones are

Adobe Illustrator, Adobe InDesign, CANVA, Microsoft publisher, Foxit PDF Editor, Pixlr and Sketch. Learning Management content materials are prepared using this graphic design software and could be uploaded in the Learning Management System to for the learners to experience a lifelong learning.

Conceptual Framework of Digital Instructional Design for Blended Learning



Conclusion

A holistic approach in learning process can be achieved by adopting digital learning. Davis (2019) suggests that “digital learning ‘can enhance learning experiences, save teachers time, enable teachers to better tailor learning to student needs, aid in tracking student progress, provide transparency into the learning process for all stakeholders, and much mor.” One of the digital learning types is blended learning, which provides students with necessary opportunities to gain knowledge and experience their learning with appropriate digital tools. This article has designed a conceptual framework of the various stages in Digital Instruction for blended learning helping the teachers for an effective teaching. When teachers follow the steps of the framework, the learners are likely to perform better, provided the teachers assure a balanced blend of digital and face-to-face pedagogies in the process of student learning.

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Formulation of Digital Content for e- Math Teaching and Learning

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Abstract

In this study we have developed e- Math content through a few mechanisms such as animation, explanatory videos, short documentaries, gamification and virtual reality. We have applied it online, to teach students and to analyze the student perception regarding e-Math teaching and learning and to assimilate information using these e-learning platforms.

Introduction

In a simple way, e-learning means using information and computer technologies and systems in order to build and design learning experiences. Similarly, e-learning is a concept that uses electronic media represented by the technical tools such as storm board, jam board and other software tools. The e - learning mechanism are represented by individual courses, that people take on their own without having classmates, virtual classes, that are constructed similarly to a traditional, face to face course, learning games, where the process of understanding and assimilating information is done through activities that are simulated, blended learning, that combines traditional and online classes, mobile learning, or knowledge management, which refers to the online

distribution of documents and materials that are meant to educate not just individuals, but large numbers of students and Institutions.

Objectives

The main objective for the formulation of digital content for e- Math teaching and learning is to create an innovative platform for teaching and learning using technical tools. The digital content provides the learners a general framework on how to apply academic knowledge in real- life situations by using the e- Math learning mechanism. When they are taught how to use academic skills in real life, they learn the values of life and the purpose of learning is achieved. Especially e-Math learning promotes commendable creative and innovative skills in students and faculty.

The objective is to focus on how to initiate e- Math teaching and learning, by making it suitable for digital instruction. The digital instruction material was prepared for each unit by integrating teacher's lectures, animation and mock classroom activities into a video lesson. The Educational app was used to create the instructional material digitally by recording the teacher's lecture and including appropriate teaching aids. Canva for education is a friendly app which integrates with core classroom tools including blackboard, Moodle, Google classroom and it is also easily connected to any Learning Content. Plenty of ready-to-use templates are available and the study made use of those for the creating instructional materials.

The study's utilisation of open sources and software programmes helped integrate the teacher's lecture with the powerpoint presentation, animation, videos, and links to YouTube in order to impart e-math learning and learning. To give the students a realistic experience, the teacher's lecture was linked with

the google classroom, practical activities were recorded integrated with to make the learners get the real life experience.

As mentioned, the e-math will be highly beneficial for aspiring teachers of the postgraduate department and also the students of the department of Mathematics. It is not only caters to the needs of the budding Mathematics teachers but also to any postgraduate who would like to take teaching as their profession. Thus, this e-Math content for teaching and learning would help the young learner to become a better teacher in their teaching career.

Methodology-Statistics Parameters

Descriptive statistics

The bivariate a sample correlation coefficient, which assesses the strength and direction of linear correlations between pairs of continuous variables, will be utilised in correlation analysis. Eventually these findings will support our hypotheses.

Hypothesis testing

The standardised values of the path coefficients and their levels of significance will be reported, together with the results of the structural equation modelling that was carried out to test the hypothesis that were put forth. The Objective is to connect academics to ideas to develop a digital content on higher level mathematics for the postgraduates using technical tools. The prepared digital content would highlight two branches of Mathematics such as abstract and applied.

Outcome of the study

This study benefits not only the postgraduate Mathematics students in particular, but also the other Humanities and Sciences in

general. The digital content provides students a general foundation for adopting the strategies to apply their academic knowledge in practical settings. They acquire the values of life and the goal of learning is accomplished when they are taught how to use the academic skills in real life. The institution can develop knowledge management, to analyse how students can learn and to foster higher order cognitive abilities, particularly the promotion of creative abilities. This study focuses on the use of technical tools and software for e –Mathematics teaching learning mechanism.

Conclusion

The study of e-Math Teaching and Learning is currently growing. The use of e-Math to explain mathematical ideas utilising methods like animation, explanatory films, short documentaries, gamification, and virtual reality offers a rich arena for programmers and designers to develop their creative skills. In this research, we found that the study created more interest for mathematics students to understand the concepts.

Acknowledgement

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Digitisation of Education in India: A Public Policy Perspective

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Abstract

By 2047, India is posited to move from Medium to High in the human development category index, and education is an indispensable variable for this. The last few decades have increasingly focused on technology being the harbinger of the four E's of the education sector - Effectiveness, Economy, Efficiency and Equity. The New Education Policy 2020 also integrates Information and Communication Technology (ICT) vertically and horizontally throughout the education scenario in India. On this backdrop, this paper traces the trajectory of ICT related reforms in education in India. It examines the various theoretical underpinnings of ICT policies worldwide and makes certain suggestions regarding their use in the planning and execution of E-governance in the education sector in India.

Keywords: NEP 2020, ICT, Education, India, Public Policy

Introduction

“Education is the most important lever for social, economic and political transformation.”

- 12th Five Year Plan, India, Volume III

In 1976, the 42nd amendment to the Constitution of India shifted the subject of education to the concurrent list, whereby both, the Center and State could legislate and execute on education policies. This undoubtedly, created a hiccup in the quasi-federal structure of the Indian polity removing education solely from the purview of the State. However almost 5 decades since, and India has made remarkable progress in the enrollment of students in primary and secondary education. The launching of Midday Meal Programs, Sarva Shiksha Abhiyaan, Right to Education Act 2009, Beti Bachao-Beti Padhao, Sukanya Samridhi Yojana and various other schemes and scholarships have had a seminal impact on literacy rates in India. The Census 2011 reports that 71% of the Indian population is literate (81% males and 65% Females). Contrast this to the 1951 statistics which were 27% (overall literacy rate), 18% (Male literacy) and 9% (Female literacy). (Note that any person aged seven or above, who can read and write in any language, with understanding, is treated as literate as per the Census) A more recent estimate is provided by the Annual Status of Education Report 2022 which states that despite school closures during the pandemic, overall enrollment figures have increased from 97.2% in 2018 to 98.4% in 2022.

While these are all laudable estimates indeed, the issues of high dropouts (National Statistical Organization reports that 12.6% of students drop out of school and 19.8% drop out of secondary education in India), poor infrastructure, lack of access, gender disparity, lack of good teachers are just few of the ground realities of the education sector in India. India has been combatting these challenges at various levels, including the largest ever allocation to Education so far in the 2023-24 Union Budget. (While the NEP 2020 recommends 6% of GDP to be spent on education, the current public spending on education averages at 3% from the Center and States.)

A major focus area to address the aforementioned challenges has been the role of ICT in education. Right from the National Education Policy 1986 which recognized for the first time, the ‘use of computers in education’ until the New Education Policy 2020 (NEP 2020) which recognizes the role of Artificial Intelligence in education, India has traversed a long way in digitization of education. The following section briefly discusses this journey.

Digitization of Education in India: A trajectory of the policies and initiatives

Until the 1980’s digitization of education in India included educational programs broadcasted on TV and All India Radio, and establishment of certain technology educational centers. In 1982, with the help of UNDP, the INSAT for Education project was launched to use the satellite for instructional purposes. A Central Institute of Educational Technology along with State Institutes of Educational Technology were set up in the participating States of AP, Bihar, Gujarat, Maharashtra, Orissa and UP.

After the 1986 National Education Policy, computers started being slowly introduced in schools in India. The NCERT and Ministry of Human Resource Development launched a computer literacy and studies in school program– CLASS program- in a few select schools. This program aimed at introducing the students to computers at a basic level. In 2000, under the Information Technology Action Plan, the CLASS program was revised and expanded to develop 100 model smart schools.

That same year, the National Curriculum for Schools framework mooted for large scale implementation of ICT in schools through infrastructure development, training of teachers and development of syllabi which would incorporate the potential

of ICT in education. Following this, in 2001, the NCERT brought out the Curriculum guide to ICT in Schools, which recognized ICT as an agent of change and released three volumes titled ‘Learning with computers’.

In 2012, the National Policy on ICT in School Education gave a comprehensive roadmap for financing, monitoring and evaluation of ICT based education in Indian schools. The policy envisaged the role of the private sector to provide infrastructural and financial support through various PPP models. The 12th Five Year Plan (2012-2017) propelled the Mission Mode Project on School Education under the National e-Governance Plan.

The NEP 2020 recognized the bilateral relationship between education and technology. It integrates technology at every stage and process of education in India, right from bridging language barrier gap between students and teachers, through coding being made part of school curriculum to its focus on Artificial Intelligence. For higher and professional education, the policy proposes a National Educational Technology Forum which will be a free and open-source platform for ideas for the use of ICT in education. On this backdrop it is useful to note that the 2022 ‘UNESCO Report on State of Education in India: AI in education’ states that AI market in India is expected grow at the rate of 20.2 per cent compound annual growth. This translates to 55% coverage by 2025.

Theoretical underpinnings of digitisation in education in India

E-Governance as a concept incorporates two components – the ‘e’ meaning electronic and ‘governance’ being the manner of governing. Hence the theoretical base of E-governance is itself multidisciplinary drawing from theories of information systems, management and also from public administration and sociology.

The following discussion delineates some of the most common theoretical bases for ICT policies worldwide.

Stakeholder Theory: This approach asks organisations to shift from a shareholder perspective to a stakeholder perspective; stakeholder being a person with an interest in that organization, be it monetary or otherwise. Stakeholders then will include the back-end support, the employees, the end users, shareholders and the like. According to Donaldson & Preston (1995) this theory has a descriptive component which first delineates who the stakeholders are and what is the extent of their interest. Then there is a normative (the value based) component which asks decision makers to incorporate these interests while planning, and, finally an instrumental component which actually merges the stakeholder interest into organizational outcome (not output).

Structuration Theory: Anthony Giddens (1984) proposed that there exist social structures within organisations, and they shape the outcomes of that organization. Every time an actor in the organization encounters the structure, the interaction is known as structuration. In other words, success of ICT initiatives which are a technological intervention will depend on how actors will accept, modify and use that technology.

Orlikowski (1992) succinctly puts it as “*Technology is physically constructed by actors working in a given social context, and technology is socially constructed by actors through the different meanings they attach to it and the various features they emphasize and use*”

Actor Network Theory: Unlike the above theories, here, the actor is not just a human person but also includes every element which regulates action. For instance, the organization’s charter, rules, communication channels, ideas are all actors.

There is constant interaction between the human and non-human actors. Once these interactions have resulted in a stable relation, a network is developed. As new actors (such as technology) get added, networks will change and thereby organizational outcome.

Socio Technical Systems Theory: Drawing from the system's theory which states that an organization system is a sum of its independent and interdependent parts, the Socio Technical Systems Theory add the sociological and technological sub systems to it. Since its predominantly the human actors who will be using the technology, it is pertinent to identify and understand their value systems, behaviours, motivations, limitations and strengths.

Concluding remarks

There is much to appreciate about the focus on ICT in education by the Center and the State, especially under the NEP 2020. However, there are certain concerns which need to be understood before deploying technology extensively and generically across education scenarios in India.

First, while most ICT policies and programs in India have focussed, and rightly so, on creation of ICT Infrastructure, there is little to no discussion on upgrading the systems and their regular maintenance. This has resulted in several outdated laptops being given to students, or computer hardware lying in institutions without being used. In some cases, internet access is limited, or none at all which means that e-classes cannot be conducted, despite having 'smart' phones or tablets- a situation which was reflected during the pandemic.

Second, though the term 'stakeholder' factors in policy discourses, there is no effective discussion on how stakeholder concerns are to be incorporated in the digital educational set up.

For example, teacher training is part of ‘Change Management exercise’. Once the training is completed, the goal is marked as complete. This superficial understanding of ‘change management’ ignores that introduction, acceptance and use of ICT requires consistent behavioural, motivational and systemic changes – and especially so when technologies keep changing.

Third, ICT projects in education while focussing on literacy rates, learning outcomes and retention of students, certain crucial policy questions such as the difference between literate and educated, how ICT can change administration of education itself, will ICT gradually result in downsizing or rightsizing India’s education sector, does ICT create newer functional authorities – need more deliberation.

Fourth, most of ICT policies have adopted a ‘one size fits all’ approach. India is a typical example of Riggs Prismatic Society (1964) where caste, gender, religion, region, language are determining factors not just in accessing education but in framing policies themselves.

Finally, most e-Governance initiatives mirror the implicit assumption that ICT policies are State driven. Citizens are regarded as beneficiaries or end users who participate only as a feedback actors in case of non-delivery or mal-delivery of service. Thus, if the technology set up does not produce the outcomes predicted, then the State needs to redesign the policy. This is an erroneous assumption because technology operates in an ecosystem of several non-State actors. These actors constantly shape the use and outcome of a program and thereby they need to be involved in the policy making and execution process.

To conclude, before India embarks on ambitious plans to further harness technology in education, it is necessary to pause

and evaluate on which theoretical base and long-term objectives do we propose to base further reforms on. Otherwise, we will just be 'mudding through' with incremental changes – a disastrous time-wasting consequence for a country hoping to harness its demographic dividend.

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**Research for
Green Initiatives and
Sustainable Development Goals**



Investigation of Physico Chemical parameters of compost and its effect on growth of *Solanum lycopersicum* (Tomato plant)

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Abstract

Organic manure is an important source of essential nutrients that increases the fertility of the soil and has a positive impact on the growth of plants. Plants and vegetables are known to have different compositions of essential nutrients and minerals. Hence, compost was prepared using peels of melon, leaves of leafy vegetables, and peels of underground vegetables. Quantitative and qualitative analysis of compost were carried out and results have shown that concentrations of essential nutrients and minerals were found to vary with the nature of the compost.

Keywords: *Domestic waste, waste management, compost, Qualitative & Quantitative analysis*

Introduction

Land pollution is a process of deteriorating soil or the earth's surface by unsustainable agricultural practices, natural calamities like volcanic eruptions, domestic garbage, oil spill accidents, and many other factors (Mashwood *et al*; 2012). The environmental pollution particularly in developing countries was caused due to the greater extent human activities rather than industrial emissions

or nuclear waste. As a result, solid waste and sewage become a threat to mankind. The disposal of the incessant piling of such waste requires proper Solid Waste Management

Municipal Solid Waste (MSW)

All solid or semi-solid materials disposed of by residents and businesses, excluding hazardous wastes and wastewater, is Municipal Solid Waste (MSW). The nature of MSW depends on the way of living, economic situation, and waste management regulations. Appropriate waste management systems can be adopted only after assessing the nature of the MSW Domestic garbage includes food waste, paper waste, textile waste and plastic waste, etc. It is reported that the municipal solid waste that is generated in developing countries is mainly from household activities (55–80%), followed by commercial activities (10–30%). (*Edward Martey; 2012*) About 40% of MSW which is not collected properly are the main cause for the blocks in drains and a major pollutant of surface water.

Waste Management

Waste management is an emerging crisis discussed for solutions all over the world. A lack of proper waste management may lead to waste accumulation. This can clog drains, create habitats for mosquitoes and attract disease vectors. Waste management activities and especially the disposal of waste in landfills contribute to global Greenhouse Gas (GHG) emissions approximately by 4%. Organic matter naturally gets decomposed in the presence of oxygen. But in landfills this happens anaerobically, resulting in methane gas, a potent GHG. Municipal Solid Waste Management (MSWM) greatly depends upon the composition of the MSW. Landfilling is an integral part of any planned MSWM

system, and a final place of MSW disposal after considering all available MSWM techniques. Landfill is the most usual MSW disposal practice in the world, probably because it is the most economical and does not require skilled workers. To reduce these adverse effects of solid food waste in soil, it is better to convert the waste to energy. The suitable and most useful way is to compost the waste. This compost supplies humus for plants. Proper management of domestic garbage involves waste segregation, recycling, composting, and responsible disposal methods to minimize environmental impact. Bio composting is one such effective method to reduce land pollution. Bio compost is a result of the combination of aerobic decomposition and microbial activity. The resulting bio compost is a dark, crumbly, and earthy-smelling material that is rich in organic matter and nutrients. It improves soil structure, enhances moisture retention, promotes beneficial microbial activity, and provides essential nutrients to plants. (J.C. Hargreaves *et al*; 2009) Recycling waste at the domestic level will reduce the burden on the Government and also people will learn to segregate the waste and use it effectively. This can reduce domestic waste significantly, and also waste is converted to energy. In the present work, the domestic waste was segregated into bio and non-biodegradable waste, the bio waste was subjected to microbial composting, and the effect of the resulting compost on the growth of tomato plants was investigated.

Materials and methods

For the present study, a small area was chosen at Women's Christian College, Chennai. A plot of 1 m was ploughed and tomato seeds were sown. After 3 weeks few of the plants were transferred to ten identical plastic pots containing compost and soil. The pots were numbered from one to 10. 10 pots in total were

taken tomato plants were planted in it in the following order; Pot 1, 2-compost from fruit peel and soil. Pot 3, 4 contains compost from leafy vegetables and soil. Pot 5, 6 contains compost from underground vegetables and soil. Pots 7, 8- compost from mixed waste compost. Pots 9, 10- only soil. The plants were watered regularly. The growth of the plant was regularly monitored by measuring the height of plants.

Composts

Microbial compost prepared from kitchen waste is an eco-friendly way to produce organic manure. In the present study, domestic waste has been segregated into 4 categories; peels of the melon family, leafy vegetables, peels of underground vegetables and unsegregated domestic waste. Four identical plastic bins with perforated plate to leach out the extract and a tap to collect the leachate were used for the production of compost. First a 1 inch layer of microbes purchased from Mygreenbin company was spread for and over the segregated domestic wastes (Table 1) over which layer of microbes was spread and the bin was closed. It was kept in a semi-shaded place and left for composting.

Table 1: Types of domestic waste

Fruit waste	Peels of family Cucurbitaceae i.e muskmelon, watermelon
Underground vegetables	Peels of onion, potato, ginger, yam
Leafy vegetables	Leaf and stem of mint, coriander, amaranthus
Mixed waste	Peels of various fruit and vegetables

To investigate the effect of compost on the growth of tomato plants, the physico chemical parameters such as conductivity,

pH, and presence of different minerals were analysed separately for soil and compost. The growth of the plants was monitored by measuring the leaf length, the extent of chlorophyll content, and also the height of the plants.

Results and Discussions

The different nutrients present in the compost prepared were investigated qualitatively and quantitatively by relevant techniques. Qualitative analysis was carried out as follows; for Nitrate ion- brown ring test, Phosphate ion- ammonium molybdate test Potassium ion-tartaric acid test and FTIR spectroscopy. Quantitative Analysis was carried out as follows; Atomic Absorption Spectroscopy for micro nutrients, estimation of chlorophyll by UV visible spectroscopy, Conductivity measurement, and estimation of nitrogen by Kjehldahl Method. Various cations present in the extract were qualitatively analysed by the procedures reported earlier.

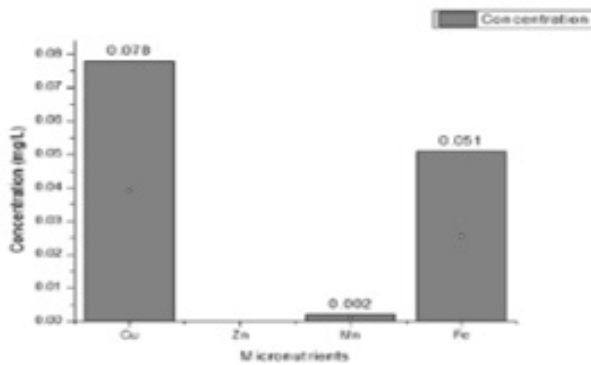
Quantitative Analysis

Atomic Absorption Spectroscopy

Micronutrients present in the different composts and soil were analysed by Atomic Absorption Spectroscopy. The extract from soil and different composts were prepared by mixing 2 g of soil/composts in 25 ml of water. The experiments were carried out and results were calibrated with 0.1 ppm concentration of the standard for compost and soil. The results are tabulated below for soil and different composts.

Table 2: Concentration of micronutrients in soil

Elements	Concentration (mg/L)
Copper	0.078
Zinc	0
Manganese	0.002
Iron	0.051

**Fig. 1: Concentration of micronutrients in soil**

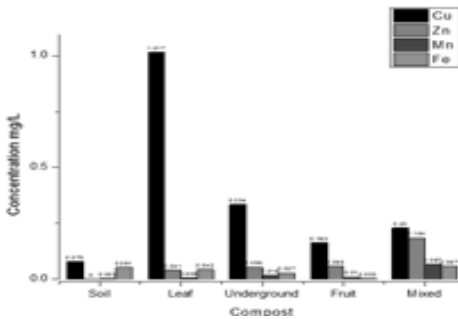
The results in Table 2 and Figure 1 show that soil has only a very low quantity of the essential micronutrients with Copper dominating other nutrients. Even some of the essential nutrients are not even found in trace amounts.

Table 3: Concentration of micronutrients level for different compost

Elements	Leaf compost Concentration (mg/L)	Compost–underground vegetables Concentration (mg/L)	Compost - Fruit Concentration (mg/L)	Compost–Mixed plant waste Concentration (mg/L)
Copper	1.017	0.334	0.163	0.23
Zinc	0.041	0.053	0.058	0.184
Manganese	0.005	0.016	0.01	0.067
Iron	0.042	0.027	0.003	0.057

From AAS results in Table 3 and Figure 2 it is clear that the micro nutrients are comparatively present in a higher concentration in the composts than in the soil.

Fig. 2: Comparative bar graph for the concentration of micro nutrients level for different compost and soil without compost.



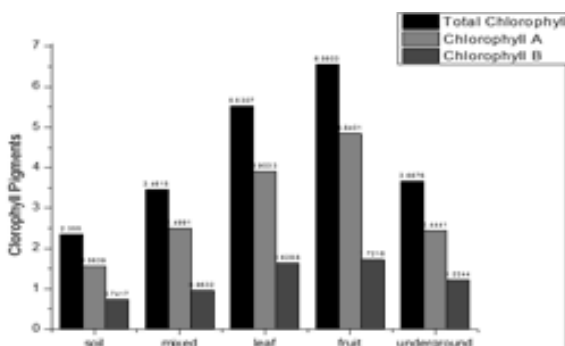
On comparison, it was found that leaf compost contains more copper, mixed compost contains more of Zinc, Manganese, and Iron

Estimation of Chlorophyll- UV-Visible Spectroscopy

To find the variation in the chlorophyll pigments present in the plants grown with compost, UV- Visible spectra were recorded as per the procedure reported earlier. (Li, Y. et al; 2019)

Table 4: Amount of chlorophyll

Chlorophyll Pigments	Total Chlorophyll	Chlorophyll A	Chlorophyll B
Soil	2.355	1.563	0.7417
Mixed	3.4615	2.49991	0.9632
Leaf	5.5307	3.9033	1.6288
Fruit	6.5603	4.8401	1.7218
Underground	3.6676	2.4441	1.2244

**Fig. 3: Comparative bar graph for chlorophyll pigments present in plants**

From Figure 3 and Table 4 it is clear that chlorophyll A and B are found in higher concentration in leaves from the plants grown using fruit compost. The results clearly show that the concentration of the chlorophyll pigment was found to be much higher in leaves from the plants grown using composts than in soil. The increase in chlorophyll concentration will certainly have a positive impact on the growth of plants.

Conductivity measurements

Conductivity is the measurement of the ability of a solution to conduct electricity. When the extract prepared from the

different compost was subjected to conductivity measurements the following results were observed. (*Amir Khan et al; 2011*)

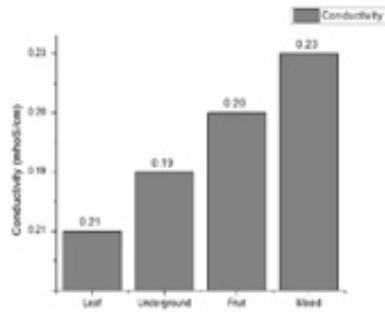


Fig. 4: Bar graph for conductivity of compost extracts

From the conductivity measurements carried out with extract from various compost it is clear that compost prepared from mixed vegetable waste showed better conductivity than other compost Figure 4.

Macronutrient Analysis

Table 5: The comparative value for NPK in various compost and soil NPK Analysis

Samples	Nitrogen (%)	Phosphorous (%)	Potassium (%)
Soil	0.00204	0.002446	0.0092
Underground	0.25	0.3	0.23
Fruit	0.36	0.47	0.34
Mixed	0.27	0.34	0.18
Leaf	0.24	0.25	0.25

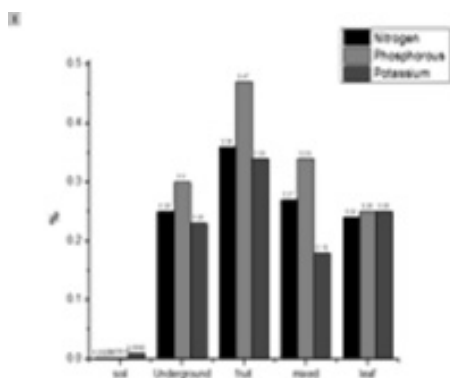


Fig. 5: Comparative value of NPK for various compost and soil

From Table 5 and Figure 5, it is clear that the amount of NPK is higher in fruit compost followed by underground, leaf and mixed compost. Fruits belonging to the melon family are rich in minerals Magnesium, sodium, phosphorus, potassium etc. The results of the quantitative analysis also show that the compost obtained from fruit peels of the melon family had a higher concentration of potassium ions.

FT-IR Studies

The FTIR studies were carried out to find out the presence of nitrate ions in the compost. Although nitrogen might be present in the soil, plants can absorb nitrogen only in the form of nitrates. The peak is between 1700- 1790 cm^{-1} . IR spectra peak corresponding to N=O was observed.

Plant growth analysis:

Table 6: The length of the plants grown using compost and soil

	Total length(cm)	Root length(cm)	Number of Twigs
Soil	35.4	14.5	8
Mixed	59.5	27	9
Fruit	72	37.8	12
leaf	64.3	25.3	11
under	64.2	28.3	11

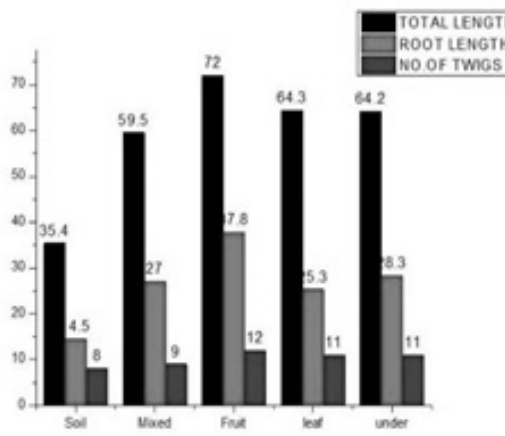


Fig. 6: The comparative length of Plants grown using composts and soil

The effect of nutrients on the growth of plants has been monitored by measuring the total length of the plant, the length of the roots, and the number of twigs. The results from the above Table 6 and Figure 6 show that the compost prepared from fruit peels has a better impact on the growth of plants than the other composts.



Fig. 7: The leaf of plant grown using soil without compost

Figure 7 shows the picture of a leaf with yellow spots that indicate nutrient deficiency in a plant grown in soil without adding any compost; such spots were not found in the plants grown with compost.

Conclusion

The domestic waste was segregated into fruit peels, underground vegetable peels, leafy vegetables, and mixed waste and organic manure was prepared with the help of microbes. This study was conducted only for a very short period of around roughly four weeks. This study was carried out to investigate the possibility of preparing organic manure rich in some specific nutrient. Melon family is generally known to be rich in potassium and the results clearly indicate that organic manure prepared using melon peels was rich in potassium and dark leafy greens are the rich sources of copper and organic manure from leafy vegetables showed high concentration of copper. Although this is a very preliminary investigation the results clearly show that organic manure can be prepared to suit the nature of the soil or the places where a particular kind of domestic waste is generated can be used to prepare organic manure rich in specific nutrients.

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Bioenergy and its Role in Climate Change Mitigation

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Abstract

Climate change has emerged as a critical contemporary concern in international relations in the twenty-first century. Long-term temperature and weather patterns changes are referred to as climate change. According to the COP27, the ongoing war in Ukraine, along with the failure of COVID-19, prompted many countries to restart coal-fired power generation, increasing carbon emissions to historic highs. The geopolitical crisis has also highlighted our vulnerability to energy shortages and the importance of developing alternate energy sources. Bioenergy is one of the various energy sources that can be utilised as a replacement. One of the many resources available to meet our energy needs is bioenergy. This form of renewable energy, known as biomass, is derived from recently living organic matter. Bioenergy is a carbon-neutral source of energy that may be generated by utilising agricultural residues and industrial wastes. It also has a more promising economic future because it is less expensive than fossil fuels. Nonetheless, this sort of energy is not without its challenges. The reason behind this is that bioenergy is not a clean energy and is not as efficient as fossil fuels, and that deforestation is increasing and having an impact on the environment. This paper discusses several questions as to the

future prospects of the use of bioenergy alone with its positive and negative aspects. This paper concludes by analysing bioenergy and the recommendation of the use of bioenergy as an alternative energy source, As a strong solution for the contemporary issue – climate change.

Keywords: *Climate Change, Bioenergy, United Nations, Electricity, Fossil Fuels.*

Introduction

The repercussions of climate change are widespread in the twenty-first century, making it one of the most urgent and perilous issues we face today. Many ecosystems are already being put under stress by climate change and sea level rise, which has an effect on people's quality of life. The fundamental cause of climate change is human activity, specifically the combustion of fossil fuels. As a result of burning fossil fuels, greenhouse gases are released into the atmosphere, and because these gases cover the earth and trap heat, they cause the temperature to rise. With about 75% of greenhouse gas emissions and 90% of carbon dioxide emissions coming from fossil fuels, they are the biggest cause of climate change in the world (United Nations, n.d.-c). As a result of the Russian and Ukrainian wars, as well as the COVID-19 pandemic issue, there has been a devastating lack of energy resources, forcing many countries to restart coal-fired generators. Because of the energy crisis, Asian pacific countries such as China and India are expected to be the largest consumers of coal in 2022. The use of fossil fuels as a source of energy will ultimately have a disastrous impact on our environment and cause long-lasting changes to our climate. Bioenergy is one of many alternative energy sources that can be employed in a variety of ways. Bioenergy is one of the many diversified options accessible to meet our energy need

and can be viewed as a potential alternative and replacement for non-renewable energy resources. The fact that this energy source is derived from living organic matter, such as industrial wastes and agricultural residue, makes it a renewable energy source that is also economically sound because it is less expensive than fossil fuels. This can be seen as both an imposing and advantageous solution in terms of mitigating climate change. Bioenergy is one of the viable options for combating climate change.

Bioenergy

The term ‘bioenergy’ refers to electricity and gas generated from organic material, often known as biomass. Bioenergy is a seemingly carbon-neutral source of energy which with the utilization of Biomass, a plant based material can generate an energy source. Utilising agricultural waste, industrial waste, energy crops, and other materials can help produce this energy. The usage of bioenergy is divided into two categories: “traditional” and “modern.” In the past, wood, animal dung, and regular charcoal have been used to burn biomass. Modern bioenergy technology includes, among other things, the production of liquid biofuels from plants like bagasse and others, bio-refineries, biogas from anaerobic digestion of waste, and wood pellet heating systems (Bioenergy and Biofuels, n.d.-c). About 6% of the world’s energy needs are met by modern bioenergy, which also makes up 55% of all green energy sources. Between 2010 and 2021, the use of contemporary bioenergy rose by an average of nearly 7% per year and is currently on the rise (Bioenergy - Fuels & Technologies - IEA, n.d.-b). Bioenergy has a few different varieties such as Biogas, Bioethanol, Biodiesel etc.

Biogas

Biogas is a clean, renewable energy source that is created when organic materials including food scraps, municipal trash, plant material, food waste, sewage, and animal waste decompose. Biogas is a naturally occurring source of energy. The first human usage of biogas is estimated to have occurred around 3,000 BC in the Middle East, when the Assyrians utilised it to heat their baths (What Is Biogas? n.d.-b). Biogas is a fuel that is created through a process known as anaerobic digestion. The waste materials need to be in an enclosed space without any oxygen for this process to happen. The two main components of biogas are methane and CO₂. A small amount of moisture, siloxanes, and hydrogen sulphide may also be present. Depending on the kind of waste used to create the resulting biogas, these are present in varying amounts.

Bioethanol

Bioethanol is a liquid biofuel created through ABE fermentation of a variety of feedstock, including corn, soybeans, and, more recently, microalgae. The main fuel utilised in cars used for road transportation as an alternative to petrol is bioethanol. Although ethylene and steam can be used to create bioethanol chemically, the fermentation of sugar is the primary step in the production of this fuel. Ethanol (C₂H₅OH), a chemical molecule also known as ethyl alcohol, is a clear, colourless liquid that is non-toxic, biodegradable, and does not affect the environment when spilled (Biofuel Basics, n.d.). When ethanol burns, it produces carbon dioxide and water. The high-octane fuel ethanol has taken the position of lead as an octane enhancer in petrol. We can also oxygenate the fuel mixture by mixing ethanol with petroleum, making the fuel mix burn cleaner and more thoroughly. Bioethanol performs similarly to conventional fuels and can be used directly in automobiles.

Biodiesel

Made domestically from vegetable oils, animal fats, or used restaurant grease, biodiesel is a sustainable, biodegradable fuel. Pure vegetable oil, animal oil/fats, tallow, and waste cooking oil can all be used to make biodiesel. Transesterification is the method used to turn these oils into biodiesel. Esters and glycerol are created when an alcohol and a triglyceride (fat/oil) combine. This process is known as transesterification. The base of a triglyceride is glycerol, to which three long chain fatty acids are connected. Using vegetable oil as fuel in his engines was a test that Rudolf Diesel ran in 1897, the year he invented the diesel engine. Because it is usually used in diesel engines, the biodiesel fuel made from vegetable oils and animal fats is named after him.

(Biofuels Explained - Biodiesel, Renewable Diesel, and Other Biofuels - U.S. Energy Information Administration (EIA), n.d.-b). The term “neat biodiesel” or “B100” refers to biodiesel in its purest, unadulterated form, which is a liquid fuel. Biodiesel, like petroleum diesel, powers compression-ignition engines (Alternative Fuels Data Center: Biodiesel Fuel Basics, n.d.-b).

Advantages and Challenges

The COVID-19 pandemic highlighted the dangers of global supply chains and the importance of a more regionally focused, diversified supply, which was brought on by rising energy prices. With energy security once again becoming a significant concern, bioenergy has the potential to improve the resilience of societies worldwide. Evapotranspiration is increased by biofuels, which benefits the environment. The use of biofuels can help boost soil carbon sequestration, which is the process of capturing, extracting,

and storing carbon dioxide from the earth's atmosphere (What Is Carbon Sequestration? | U.S. Geological Survey, 2022). It is also estimated that bio biofuels can reduce overall CO₂ life cycle emissions by up to 80% when compared to fossil fuels. Bio-inert materials are those that do not evoke a response from the host and are biodegradable and renewable, reducing the danger of soil pollution and contamination of subsurface water during transportation or storage. The cost of producing biofuels such as biodiesel is lower than that of fossil fuels, and it is also a less expensive fuel for automobiles than petroleum.

However, several challenges remain, such as the high cost of producing bioenergy. The price of growing the right kinds of energy crops, including the work involved, the cautious transportation of the harvested materials, as well as the storage facility and the expense of preparing the storage environment to be a good place to keep the gathered resources. Bioenergy production also necessitates a large amount of space, limiting the locations where biomass energy plants can be developed. All of these steps are more expensive than other types of renewable energy. Bioenergy is well-known for its clean energy component. However, biomass still emits carbon dioxide as well as a variety of other greenhouse gases such as nitrogen oxide, carbon monoxide, and methane. These GHGs are known to produce significant pollution, particularly methane, which traps 30 percent more heat than carbon dioxide (Greenhouse Effect 101, 2023). The acquisition of the resources is not environmentally friendly and could result in catastrophic deforestation. Other serious effects, such as monocultures of crops, which reduce biodiversity and deplete soils of nutrients, leaving places more vulnerable to

erosion, would result from increased demand for bioenergy, in addition to deforestation. When compared to other energy sources, biomass energy is less effective because it is not a completely clean source of energy. As an energy source, bioenergy is currently less efficient than fossil fuels.

Conclusion

Bioenergy can be taken into serious consideration as a solution for an alternate energy source. The International Energy Agency is one of the several bodies that have taken actions and initiatives. The International Energy Agency (IEA) established the IEA Bioenergy Technology Collaboration Programme (TCP) in 1978 with the goal of enhancing communication and cooperation among nations with national bioenergy research, development, and deployment programmes. There are 42 active Technology Collaboration Programmes right now, and IEA Bioenergy is one of them (Bioenergy, 2023). However, it should be noted that bioenergy has both positive and negative effects on the environment. Many low income countries would rather choose the option of a low cost energy source which may have negative effects on the environment than choose something expensive and environmentally friendly. This is one of the major challenges for bioenergy in this present time due to the economy. Still we can see that Bioenergy is a better energy source than fossil fuels as fossil fuels are effective but continue to cause irrevocable effects to the earth's atmosphere and climate but bioenergy will have a positive effect in the future with regard to climate change mitigation. This paper concludes by strongly suggesting bioenergy as an alternate energy source for climate change mitigation.

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Pedagogy Incorporating Biomimicry Design Spiral for Achieving Sustainable Development Goals

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Abstract

The urgent need to address global sustainability challenges has led to the development of innovative approaches that integrate nature-inspired design principles with education and pedagogy. This paper presents a pedagogical framework that incorporates the Biomimicry Design Spiral methodology into teaching biology as a means to achieve Sustainable Development Goals (SDGs). The Biodesign Spiral approach combines principles from biology and design thinking to create sustainable solutions that are inspired by nature's strategies. The proposed pedagogy aims to empower learners with a deep understanding of biological systems, designs and biomimicry principles, fostering a mindset that embraces sustainability and responsible innovation. It emphasizes an interdisciplinary approach, encouraging collaboration across various fields, such as biology, engineering, architecture, and social sciences. By integrating the Biodesign Spiral methodology into education, students of Biology are challenged to identify and solve complex real-world problems in a sustainable and environmentally conscious manner. The suggested teaching

methodology highlights the potential benefits and outcomes of adopting the pedagogy incorporating the Biodesign Spiral methodology. It discusses the positive impacts on students' critical thinking, problem-solving skills and creativity, as well as the potential for generating sustainable and eco-friendly solutions that contribute to the achievement of the SDGs. By emphasizing the importance of implementing such pedagogical approaches, academicians can nurture a new generation of student entrepreneurs inquiring into nature's design to address the pressing challenges of the 21st century.

Keywords: *Biomimicry, Modified Biomimicry Design Spiral, Bloom's taxonomy, Pedagogy, Innovation*

Introduction

Nature has evolved over billions of years to become inherently sustainable as it operates within a delicate balance, adapting and renewing itself to ensure the continuation of life on Earth. It has developed intricate systems and processes that promote sustainability. "Nature runs on sunlight, uses only the energy it needs, fits form to function, recycles everything, rewards cooperation, banks on diversity, demands local expertise, curbs excess from within, and taps the power of limits" (Benyus 2002). The rich floral and faunal diversity in certain forest ecosystems makes them more resilient to disturbances, by assigning the roles of nutrient cycling (Smith and Read (2008); Fierer and Jackson (2006); Vitousek and Howarth (1991) and McNaughton, (1985) pollination (Ollerton, Winfree, and Tarrant, (2011), Boggs and Inouye (2012), and MacGregor *et al.*, (2015) and pest control, to the most suited group of organisms (contributing to the overall health and sustainability of the ecosystem. These organisms in turn maximize their survival and efficiency by adopting several

morphological, physiological, and behavioral adaptations that capitalize on the conditions available to them within the ecosystems.

Current teaching and evaluation methodologies are based on “Bloom’s taxonomy”, the objective of which is to provide a framework for categorizing educational objectives and learning outcomes. It was created by Benjamin Bloom and his colleagues in the 1950s as a way to classify different levels of cognitive skills and knowledge acquisition. This research article aims to devise strategies to apply the biomimicry design spiral in teaching biology and training the student community to derive inspiration from nature to realize sustainable development goals.

Biomimicry -an overview

Biomimicry, as defined by biologist Janine Benyus (1997), involves drawing inspiration from nature’s forms and processes to address human problems. It goes beyond replicating natural objects or systems and focuses on understanding the underlying design principles found in nature’s solutions. It encompasses three levels of mimicry: form, process, and ecosystem. Mimicking form involves reproducing physical characteristics. Biomimicry also involves emulating the processes and functions employed by nature to achieve desired outcomes. Additionally, it recognizes the interconnectedness and sustainability of natural ecosystems. By studying and learning from nature, biomimicry harnesses the imaginative and ingenious solutions that exist in the natural world. Ultimately, it is the application of nature’s wisdom to solve human design challenges sustainably.

Bloom's taxonomy

Bloom's Taxonomy consists of a hierarchical model that organizes learning objectives into six levels, which progress from lower-order thinking skills to higher-order thinking skills (Anderson and Krathwohl 2001; Bloom 1956). The objective of Bloom's Taxonomy is to encourage educators to design learning experiences and assessments that target different levels of cognitive skills (Kellaghan and Greaney (2001). By using this framework, teachers can promote higher-order thinking and intellectual development in their students, moving beyond simple knowledge acquisition and towards deeper understanding, critical thinking, and the application of knowledge in real-world contexts (Anderson and Krathwohl 2001)

The proposed teaching methodology aims to incorporate design thinking into the Zoology program by integrating the tenets of the Biomimicry design spiral into Bloom's taxonomy. This would encourage students to conceptualize biological solutions to real-world problems. Currently, the concepts of Biomimicry are explored only in the doctoral and post-doctoral research programs. The authors propose this integration of biology and technology at the undergraduate level by initiating a seamless integration of the latest research in the area of biomimicry into Bloom's taxonomy at the undergraduate level of the zoology program using a case study as an example

Insects arguably have one of the finest and most optimized olfactory sensory modalities that are structurally and functionally diverse. The olfactory system in insects is highly specialized and can be much more sensitive than that of humans. They can detect minute quantities of odor molecules and distinguish between different odors with remarkable accuracy. The olfactory receptors

in insects are responsible for detecting and interpreting chemical signals in the environment. This ability is crucial for their survival and success in various ecological niches. Extensive molecular and cellular research has been Modelled in insects such as *Drosophila melanogaster*, *Musca domestica*, and several moth species as they provide an opportunity to address a broader range of questions about pheromone biology, detection of potential predators and biocontrol of pests (Stephen, Anandasankar, and Zwiebel 2021). In recent years the spotlight has turned toward the structural complexities in these sensory receptors and harnessing them in technology to improve human lives sustainably. Table 1. Depicts the topic of chemoreception taught at the undergraduate level with the learning objectives prescribed in Bloom's Taxonomy.

Table 1. Bloom's Taxonomy of Learning Objectives used to teach Chemosensory receptors

Bloom's taxonomy of learning objectives	Bloom's taxonomy of learning objectives incorporated in teaching a topic on chemoreception in animal physiology
Knowledge: This level involves the recall of factual information and the demonstration of basic understanding.	Know that Insects have well-developed chemosensory systems. Their olfactory systems are greatly modified to detect relevant chemical cues in the environment which facilitate the detection of chemical odors in food and pheromones produced by mates
Comprehension: At this level, learners demonstrate a deeper understanding of concepts by interpreting, summarizing, or explaining information.	Comprehend a wide variety of olfactory receptor structurally and functionally diverse chemoreceptors/ olfactory receptors /mediate the detection of structurally diverse odorant molecules and convert them into a neuronal signal.

<p>Application: Learners apply their knowledge and understanding to solve problems, perform tasks, or use the information in new situations.</p>	<p>Apply knowledge to understand Three known families of insect olfactory receptors: odorant receptors (Ors), ionotropic receptors (Irs), and CO₂-sensitive gustatory receptors (Grs). review its evolution, structure/function, and role in insect behavior.</p>
<p>Analysis: This level involves breaking down complex information into its constituent parts and examining the relationships between them.</p>	<p>Analyze the roles of a few protein families involved in supporting roles of odor detection and clearance are also discussed</p>
<p>Synthesis: At this level, learners combine different elements or ideas to create something new, such as generating hypotheses, designing experiments, or creating original works.</p>	<p>Synthesise and process the potential use in modifying the behaviors of disease-transmitting insects and agricultural pests.</p>
<p>Evaluation: This highest level of Bloom's taxonomy involves making judgments, forming opinions, and assessing the quality or value of concepts, ideas, or materials.</p>	<p>NOT yet incorporated into the undergraduate curriculum for students learning Zoology Introduce biomimicry design spiral to develop viable technologies as capstone projects encouraging entrepreneurship</p>

Biomimicry design spiral

The Biomimicry Design Spiral is a step-by-step process for turning nature's reiterative design process into innovative and sustainable design solutions developed by Carl Hastrich, (Hastrich, 2006; Benyus 2002) an Industrial designer, to guide innovators (Fig.1). This pedagogy incorporates The Biomimicry Design Spiral into the Bloom's taxonomy (Table 2). The research used to include this pedagogy is discussed below.

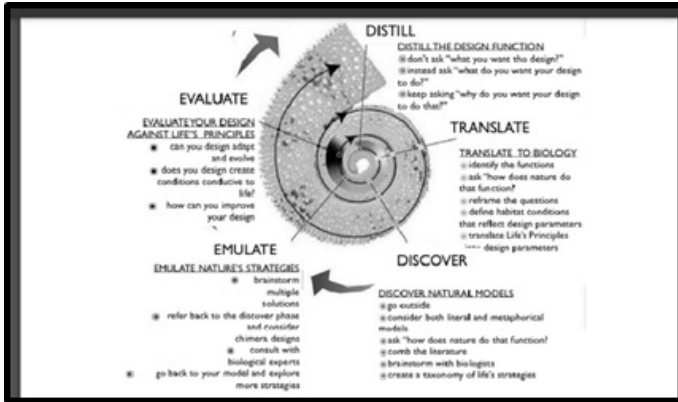


Fig. 1: The challenge to biology design spiral.

Source: www.biomimicryinstitute.org/about-us/biomimicry-a-tool-forinnovation.html.

Table 2: Biomimicry Design process chart analysis incorporating the case study

Biomimicry design process	Case study using a research article on smelicopter drone to teach biomimicry design principles in chemoreception
DISTILL – identify real challenges and develop a design brief of the problem “What do you want your design to do” not “What do you want to design?”	DISTILL - I want my design to identify victims of earthquakes trapped in the rubbles
BIOLOGIZE – into biological terms biologize and ask questions from nature’s perspective. How does nature do or not do this? How does nature achieve this function?	BIOLOGIZE : How does nature detect smells?

<p>DISCOVER - biological models and look for champions who answer/resolve your challenges. Abstract to find repeating patterns and processes within nature that achieve success. Create a taxonomy of life's strategies</p>	<p>DISCOVER-biological models in Moths and Flies Find out the similarities in patterns used in olfactory reception across insects that can detect human smells.</p>
<p>EMULATE- nature's strategies, develop concepts and ideas that apply the lessons from your Natural teachers and apply as deeply as possible in your designs; mimic form, process, and ecosystem morphology, scale, biological process...</p>	<p>EMULATE: Check for the structural and functional design in moths of the genus <i>Calyptra</i>, 8 species have been observed feeding on the blood of mammals including humans in their natural habitat. <i>Calyptra fletcheri</i> and <i>C. thalictri</i>, have been documented to feed on human blood. The design of smellicopters can be reiterated with these to check if they specifically identify humans entrapped in debris and mines</p>
<p>EVALUATE - review solutions against life's principles "...is it built to shape? what role does water play? is it locally attuned? use life-friendly materials? enhance the bio-sphere? ...create conditions conducive to life?"</p>	<p>EVALUATE- is it built to shape? How long can this design work? Can it be designed to withstand adverse climatic conditions? Can we use biomaterials that are conducive to the design</p>
<p>ASSESS - develop & refine the design brief based on lessons learned from Life's Principles. Identify ways to improve your design.</p>	<p>ASSESS- Refine the design by incorporating CRISPR- based genetic modification to breed moths with antennae that do respond to useful smells</p>

Case Study: How Does Nature Smell Predator or Mate?

Research Article: A bio-hybrid odor-guided autonomous palm-sized air vehicle - IOPscience

Biomimetic attributes: Structurally sound olfactory receptors to detect specific odors Inspiration: *Manduca sexta* hawkmoth. One scent molecule can trigger lots of cellular responses. Once separated from the anesthetized live moth, the antenna stays biologically and chemically active for up to four hours. (Fig.2)

Practical applications: Does not need GPS, hence can help track earthquake victims, and those trapped in caves, mines, and plumes.

Design Problem: sensors created by people are not sensitive or fast enough to be able to find and process specific smells while flying through the patchy odor plumes these sources create.

Biomimetic Solution: An autonomous drone that uses a live antenna from a moth to navigate toward smells. Smellicopter can also sense and avoid obstacles as it travels through the air.

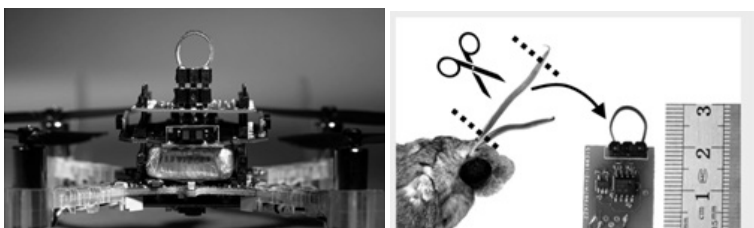


Fig 2: Smellicopter Drone Using Live Moth Antenna To Detect Odours. The drone's sensor, called an electroantennogram, consists of a 'single excised antenna' from a *Manduca sexta* hawkmoth and a custom signal processing circuit.

Source: <https://spectrum.ieee.org/smellicopter-drone-live-moth-antenna>

Photo credit: MARK STONE/UNIVERSITY OF WASHINGTON

This suggested pedagogy for teaching biology focuses on analyzing a research article relevant to the topic, identifying a need in society that can be mitigated by understanding how nature solves this issue, and transposing the modified biomimicry design spiral

(Fig.3) to the issue to be solved. This method can also be used to fine-tune and improvise already existing technological solutions by reiterating and optimizing nature's design and solutions. In this case in point, students can be asked to research the Hawk moth species in India and other similar moths that detect mammalian blood to develop drones that are more specific to improvise this design. They could also be guided to refine the design by incorporating CRISPR-based genetic modification to breed moths with antennae that do respond to useful smells.

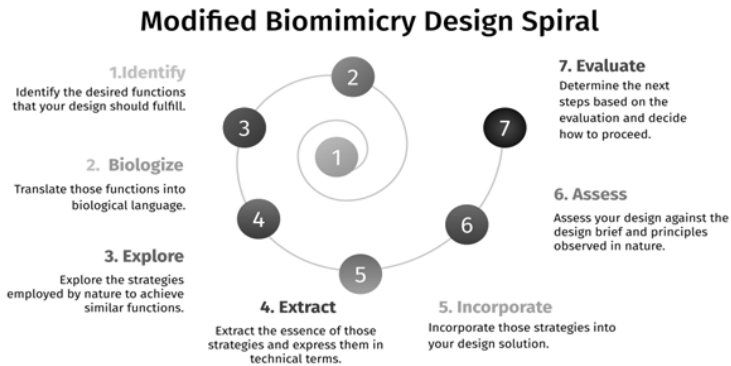


Fig 3: The Modified Biomimicry Design Spiral

Conclusion

The application of biomimicry design principles can be extrapolated across topics in biology and Environment such as Cell Biology, Environmental Biology, Environmental Biotechnology, and Physiology after understanding the progress made in research in the respective fields. Climate Change, population explosion, and a consumerist approach to development have had disastrous consequences for individuals in microcosms and for society at large. The global challenges we face include those related to climate change, environmental degradation, inequality, poverty,

peace, and justice. The Sustainable Development Goals are set as targets by the United Nations to address and mitigate these global challenges by 2030. All these goals are interconnected, therefore, the role of the academician in ideating and training the student community to meet and achieve these goals cannot be ignored. This teaching pedagogy outlined in this paper can usher biologists into a new era of sustainable applications, technologies, and approaches.

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Developments and Research initiatives in the journey of achieving green goals

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Abstract

The world is set for a green transition heading towards a sustainable and resilient future. Herein we have put forth the green measures that are vital for various sectors in India, their current trends and developments.

Introduction

“There is no planet B. We have to take care of the one we have.” – Richard Branson rightly quoted. This article reviews our actions towards the restoration of the world's climate, for saving our ecosystem and environment. The recent natural disasters that remind us about climate restoration are the East African drought, the wildfire in Australia, the floods in South Asia, longer dry season in Central America, and the Kenneth and Idai cyclones to name a few. As per recent reports the major contributors to the carbon dioxide emission (76% of greenhouse gas) are due to Electricity and Heat (25%), Agriculture (24%), Industry (21%), Transportation (14%), Buildings (6%) and others (10%). The Intergovernmental panel on climate change, United Nation Organisations along with governments are keen on immediate action for the mitigating climate. There are also global inter-governmental organisations: European Environment Agency (EEA), Global Alliance on Health and Pollution (GAHP), Green

Growth Institute (GGGI), School strike for climate or Fridays for Future (FFF), Global, United Nations Environment Programme (UNEP), Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) working for achieving green goals. Herein we will discuss the steps and measures that have been adopted.

Green goal

Green goal is a self-sufficient term that comprises of policies and regulations towards

- i. Conservation of natural resources,
- ii. Adapting Green energy and environmental technology,
- iii. Green Infrastructure development,
- iv. Green Health,
- v. Green fiscal measures,

Conservation of natural resources:

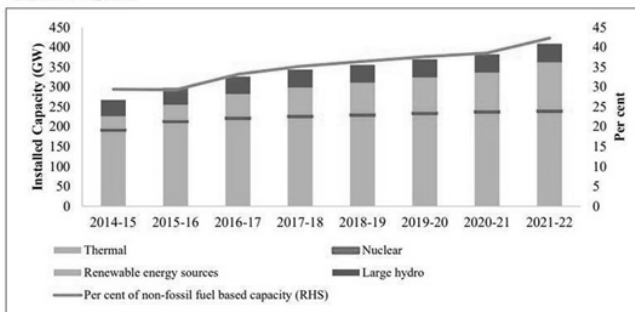
Conservation of the natural ecosystem, land as well as marine living system is considered as a stepping stone for green initiatives. The Indian government has passed acts such as Wild Life (Protection) Act, 1972, Wetland (Conservation and Management) Rules 2010, Wildlife Crime Control Bureau, Integrated Development of Wildlife Habitats, Recovery of Endangered Species, etc. The Wildlife Institute of India, Salim Ali Centre for Ornithology and Natural History and Bombay Natural History society are research institutes that dedicate their work on the research of vegetation, natural resources, ecosystem and native habitats of various regions. Based on their analysis report, strategies for restoration and conservation are taken. Recently, the Indian government's measures towards pollution and rebuilding

of green India include the Namami Gange Programme, Swachh Bharat Abhiyan, Swachh Bharat Mission and many more.

Adapting Green energy and environmental technology

Adapting green technologies in all walks of life like agriculture, transport, industrial as well domestic sectors is a vital aspect. Energy is the determining factor of economic growth of a country. Hence achieving green energy transition at the risk of the country's economic growth is still a challenge. It can be thought of in two ways, first the idea of increasing energy efficiency of the current conventional sources and the latter is adapting alternate renewable energy sources. India has generated 400 GW of electricity and globally ranks in seventh place due to increase in the utilisation of solar energy, biomass, geothermal, and wind energy sources (Fig 1). Electric vehicles, subsidies for solar panels, hydrogen fuels in industries, public transport, carpooling, fuel efficient cooking instruments, retrofitting facilities for light and heat management, smart energy efficient alternates in industries are other ways to attain sustainability.

Increasing installed Electricity Generation Capacity with a rising share of non-fossil fuel-based capacity



Source: Based on data from the Ministry of Power.

Fig 1: (a) India's power generation contribution from fossil fuels and renewable energy sources

Environmental restoration emphasizes reuse, recycle and restore. Integrating sustainable green practices such as minimal waste generation, segregation and waste management and eco-friendly supply chain practices also helps in sustainability. Upscaling green technologies from pilot scale to manufacturing throughputs can be achieved through the interface of industry and academic research.

Green infrastructure development

Green infrastructure is an emergent accord that encourages further urban growth. Pawan *et. al.* reports the types of infrastructure that has evolved gradually (Pawan *et. al.*, 2023). They are rainwater harvesting and downspout disconnection where the rain water is harvested through pipelines to the soil or into cisterns. Planter boxes collect the rainwater from roads, pathways and parking lots. Permeable pavements and green roofs are the roofs covered with vegetations, Tree canopy in urban areas, self-sustainable buildings with solar panels on roof and walls etc. India's ecological preservation in the 4th five year plan (1964–69) highlighted the significance of green infrastructure as crucial for environmental preservation.

Green Health

Health care sector has detrimental effects on the environment and biodiversity due to varied reasons such as tonnes of waste, toxic dioxin pollutants, mercury, paper, cotton, plastics etc. The green restoration mission in this sector is advocated through waste management programmes, reduced usage of toxic, infectious and radioactive wastes etc. Green health care is compelling and has direct benefits on the environment to heal our planet. The Indian Ayush ministry as part of the UN's Sustainable Development Goals

(SDG) 2030 is working on holistic healthcare for sustainability. This aims at capitalising and channelising India's ancient wisdom of traditional practices and treatment with that of modern medicines.

Green fiscal measures

Green fiscal spending eventually leads to a holistic development of the environment – economic and social welfare. O'Callaghan et. al. has identified five green investment sectors that are expected to give tremendous returns (O'Callaghan et. al., 2021). Renewable electricity generation and upgrades in electricity distribution and transmission, alternate energy sources for coal and crude oil, clean cooking, natural capital investment such as afforestation and marine restoration, and finally on sustainable agricultural investment as India's air pollution is caused due to conventional agricultural practices. Sovereign green bonds, crowding-in private ventures, and green financial incentives are advised financial tools. The United Nations Framework Convention on Climate Change (UNFCCC) has predicted that \$125 trillion in climate investment is necessary to achieve net zero on a global scale. Recently it was found that \$561 billion nearly 75% of the total investment for energy transition is constituted by only ten countries *viz* China, US, Germany, UK, France, Japan and India.

Garima Patel has listed the corporates and their green policies that made them attractive and well established in the Indian Market (Garima et. al., 2022). Few are Dabur – waste management, solar energy source, rainwater management, Wipro – Green computing, e-waste management, zero carbon emission, green supply chain, ITC – Afforestation, farm and animal husbandry services, waste legislation, and many more companies including Mother Dairy, HCL, Hindustan Unilever, Godrej etc.

Conclusion

We are amidst the global march towards the green goal of net zero emission by 2050 which demands the synergistic effect of green research initiatives, implementation and development for sustainability. It's the responsibility of government, private and public sectors, as well as each individual's contribution to adapt energy efficiently, alternate renewable energy sources, embrace green economy, sustainable transport, agriculture and health care practices.

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Exploring Service-learning as a Pedagogical Tool towards Promoting Green Initiatives

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Abstract

The aim and purpose of holistic education emphasises a comprehensive and integrated approach to imparting knowledge which is not only of academic importance but also to ensure the cultivation of intellectual, emotional, physical and social development of the learners. This approach enables the learners to be equipped to apply their acquired theoretical knowledge into praxis in order to give back to the society and the environment at large, dialectically contributing to their own well-being and a sustainable future. This research focuses on understanding the importance of service-learning as a pedagogical tool in order to promote environmentally sustainable green initiatives in educational institutions. At the outset, the research explores the contextual framework of service learning which will highlight the different facets of service learning that includes academic and civic perspectives that can be applied to practicing environment-friendly, action-oriented projects. Towards this end, a multi-pronged model (SEED) is suggested for the successful implementation of pro-environment service learning projects. This model can serve as a template for institutions planning to include green initiatives within the service learning component of their curriculum.

Keywords: *Service-learning, environment, green initiatives, education, pedagogy.*

Introduction

Service-learning is a pedagogical tool that integrates parts of course curriculum in educational institutions to service activities that address social problems of target communities chosen by the students themselves. The students are involved in active and collective forms of socially and environmentally relevant activities to provide real time solutions to these problems while reflecting on their methodology, perspectives and goals. This integration of knowledge and praxis could be best understood as a form of experiential learning which emphasizes on enhancing the civic responsibilities amongst the student community within a structured learning environment. According to Kendall (1990), Service learning is a philosophy that revolves around the “human growth and purpose, a social vision, an approach to community, and a way of knowing”. Applying this philosophy into the educational system, the aim of the Service learning modules is to create socially and environmentally responsible students, and to also inculcate significant skills within them such as team building, discipline, empathy and responsibility. Service learning as a pedagogical tool encompasses three important elements namely Observation, Application and Learning. As an educational philosophy, Service learning would fall under the umbrella of radical/critical pedagogy where the abstract theoretical concepts are translated into concrete experiences (Mikelic Preradovic, 2015).

Service learning as a pedagogical tool cuts across a broad horizon of social and environmental aspects. For the purpose of this research, the vertical chosen for study is the ‘promotion of green initiatives’ through service learning programs. Green initiatives are

those actions or activities that are being carried out to minimize or reduce the environmental impact. The promotion of green initiatives amongst the student community has become imperative under the current educational system. Knowledge to students regarding the pro-environment practices has moved beyond just sensitization but it rather translates into a comprehensive way of living in the present times. Students are required to be sensitive and responsible towards the natural environment along with actively engaging themselves in a nature friendly form of lifestyle. In order to achieve these goals through education, the Service Learning component plays an eminent role in transforming the student's learning process into a process of holistic development. Promotion of green initiatives and sustainable living, range from creating awareness, encouraging participation, taking part in relevant activities and reflecting upon the outcomes. The above mentioned levels of promotion of green initiatives can be successfully achieved through the implementation of these initiatives through service learning modules in the educational institutions. This paper focuses on providing a contextual understanding of service learning and to apply the understanding into a working module to promote green initiatives amongst the student community (Mikelic Preradovic, 2015).

Contextual Framework

As a type of teaching and learning, service-learning uses social constructivist methods, including inquiry and project planning, to help students meet community needs while at the same time deepening their content area and civic understanding and skills. Service-learning and other social constructivist approaches to teaching and learning place “less emphasis on rote memorization, comprehensive curriculum coverage, and

information transmission,” stressing instead the active construction of knowledge through engagement with the practices (e.g. of knowledge discovery, problem solving) central to academic disciplines. However, for service-learning to be successful, teachers must intentionally design it to meet desired academic, civic, and social emotional outcomes and demonstrate best practice (Root, 2017).

The democratic model of problem solving by Briggs, 2008 suggests that the structure of inquiry for service learning includes the IPARD model ie, Investigation to identify and observe the problem, Plan, Prepare and Deliberate on the possible solutions to the problem, Apply the solutions to the given problem area, Reflect on the outcomes and Demonstrate the learning to future learners. The IPARD model can be further broken down into independent competencies that will include both the academic and civic goals of service learning. The academic goals of service learning will include selecting a problem, defining the learning outcomes, designing the course of action, evaluating the activity and providing feedback regarding the outcomes. Civic competencies include advocacy of critical thinking skills, learning problem solving methods, practicing values such as team work, accountability and responsibility to achieve the desired outcome. The academic competencies provide the curricular aspect of education service learning, and the civic competencies enhance the significance and relevance of service learning to students in a formal educational set up (Root, 2017).

The United Nations has identified education as the “primary way to achieve sustainable development.” The overall goal of the United Nations Decade for Sustainable Development (UNDES) is to “integrate the principles, values and practices of sustainable

development into all aspects of education and learning. This educational effort will encourage change in behaviour that will create a more sustainable future in terms of environmental integrity, economic viability, and a just society for present and future generations” (UNESCO, 2005). The concept of Education for Sustainable Development (ESD) was emphasized by the United Nations with an objective to ensure that education plays an important role in imparting practical knowledge to create socially and environmentally conscious citizens.

The foundational definition of ESD is outlined in the UNDESD International Implementation Scheme (UNESCO, 2005). Here ESD is seen as being fundamentally about values, with respect at the centre – respect for others, including those of present and future generations, for difference and diversity, for the environment, for the resources of the planet we inhabit. Education is seen as enabling us to understand ourselves and others and our links with the wider natural and social environment, and this understanding serves as a durable basis for building respect (UNESCO, 2005). The pedagogy needed, therefore, is one that is focused on real world tasks, is community-oriented, values-centred and has a strong future’s perspective. (Root, 2017). This paper focuses on using the principles of ESD in order to promote Green initiatives within educational campus premises through active student engagement (Root, 2017).

Service Learning Model for the Promotion of Green Initiatives

For the purpose of study, we have designed a sample module (Figure 1) in order to implement green initiatives in an educational institution. SEED – Service for Educational and Environmental Development is a service cum learning module which ensures

academic as well as service oriented outcomes focussing on promoting a greener and a sustainable environment. Let us understand this model through a diagrammatic representation.

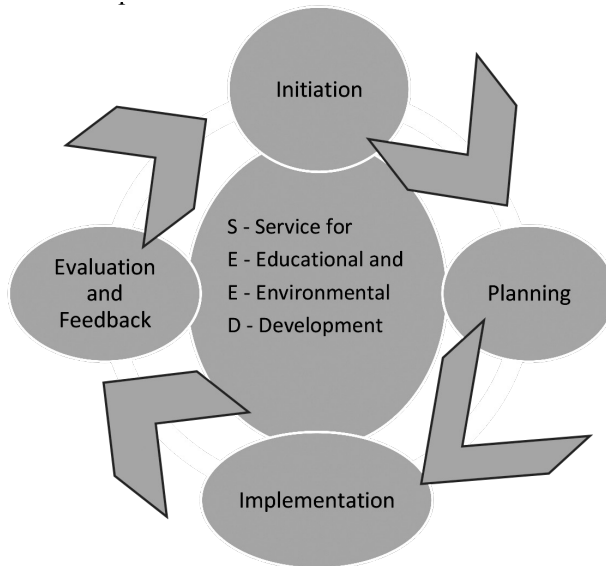


Figure 1 – Author’s compilation

Initiation – The first phase of learning will involve sensitizing the students about their environment and the various challenges pertaining to it. Creating awareness will range from organizing workshops, seminars and lectures led by field experts for students. The initiation stage will ensure student’s willingness to participate in SL projects, and their willingness to participate in activities promoting green initiatives. Following their initiation sessions, supervisors can be assigned to the student groups to oversee and guide the entire process of planning, documentation and implementation of their individual projects.

Planning – Following the initiation stage, the students can be guided with the help of the assigned faculty advisors to identify their area of interest to work on, following which the students will begin their assignment. The process of planning will also include the documentation process where the students will be guided to record their aim, objectives of study, time frame, and nature of their regular activities.

Implementation – The process of implementation will involve the students taking part in actual field work for their respective projects. The process will include participation, documentation and reflection.

Evaluation and Feedback – At the end of the project duration, the students will be evaluated on the basis of the essential skills that they have acquired during the period of their service and their successful completion of their projects will also be taken into consideration. Following the evaluation process, the students can make an audio visual presentation to the college community and also to the target population if any who have been the beneficiaries of the service learning project. The following case can be considered as an example to understand the above mentioned SEED model.

The Green Campus Initiatives with special reference To MACFAST

MACFAST - Mar Athanasios College for Advanced Studies Tiruvalla (MACFAST), Kerala, India, a Post graduate and research institution, was started in 2001. The college has successfully initiated and implemented a project named Clean and Green City Tiruvalla, along with the Tiruvalla municipality for making the public aware of keeping the surroundings clean and hygienic by

adopting their own methods of waste disposal (G.Ajai, 2016). The Green Hour was an innovative program introduced in the campus. A complete hour in a week on Thursdays has been allotted for environmental awareness which includes all staff and students. A 20 minutes lecture on an environmental topic was followed by sharing of ideas on innovative waste management/energy conservation/personal hygiene strategies. The Biocampus is an initiative by the research wing where the use of biodegradable plastics was encouraged to make buckets, mugs, dashboards, chairs, tables, cutlery, bathroom doors etc. The Bio Harvest initiative envisaged attracting local populace to sustainable practices in the agriculture sector. The initiative gave utmost importance for continuous awareness and training through radio, and focussed on the student community to develop in cluster farming. Kalpakavadi was a student initiative where the students developed a tropical fruits orchard “Kalpakavadi” in connection with the National Environmental Awareness Campaign”. Students of Management Studies took initiative to prepare the garden as part of their Green Hour initiatives (G.Ajai, 2016).

Way Forward

Service Learning provides an opportunity to the student community to apply their education and knowledge in a socially conscious pursuit which impacts both personal and professional growth trajectories by synergising academic rigour with praxis. The above mentioned case of creating a green campus is an example of how students can be involved in implementing sustainable practices within their campus. The translation of this model must be viewed in terms of the temporal and spatial contexts of particular educational institutions. In particular contexts, the overarching principle can be retained with due consideration to

specific limitations and other constraints. In addition, the suggested SEED model in this paper can also be applied to service-learning projects involving students at the level of middle and high school. Therefore, the inference drawn from this paper is that Service learning components promoting green initiatives form an indelible part of today's education system in order to equip the current generation to ensure for a better tomorrow.

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Community Gardens as a Green Initiative

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Abstract

An increase in global urbanization has led to numerous challenges. Community gardens are seen as a way to improve health from an ecological public health perspective. Participating in community gardening has numerous benefits and has been shown to improve health, wellbeing and social outcomes. This is because community gardens provide organic produce, increase physical activity, enhance the environment so as to foster team spirit, and enhance social interaction which in turn builds a flourishing student community. As education policymakers rethink the curriculum and adopt different strategies to teaching and learning, the community garden provides students with hands-on skill based educational experience (Lloyd and Paige, 2022). This paper advocates the positive impact of

a community garden as an effective pedagogical tool which leads to physical, mental and spiritual benefits.

Keywords: *Community garden, health, students, pedagogical tool.*

Introduction

Community garden is an area of land collectively utilized for the growing of fruits, flowers, herbs and vegetables. Now-a-days, community gardens are often established by volunteers in urban, suburban and rural areas as alternatives to the existing foods, providing opportunities for healthy foods and sale of cultivated products. Hence, with twenty-six students from Shift I this Community garden project was initiated by the Centre for Environmental Studies, Women's Christian College in August 2019. The number grew to thirty- three in the same academic year. The total plot area 29x18m located near Holyoke hostel under the Community Garden Project was shared by a small group of students or an individual student to grow plants of their choice. Usually, at the beginning of each academic year, students volunteer themselves to participate in this project. This Community Garden Project involves volunteering, garden and project management, social contact, physical activity, production of cultivated crops, distribution of products and training other lay individuals about the known skills. The harvested crops like lady's fingers, brinjal, red amaranth were either sold on campus or taken home by students. The skills of the students in sowing and maintaining the plants were also monitored by faculty.

Benefits of Community Gardening

Literature shows that the benefits of a community garden can be grouped into main categories such as physical, mental and spiritual benefits.

Physical Health

In order to investigate the impacts of community gardening on product consumption, food security, and relationships within households in a rural setting, Carney *et al.* (2012) undertook a study in the United States. According to their findings, both the participants' general health and their intake of produce both dramatically increased. According to studies by Van den Berg *et al.* (2010) and Twiss *et al.* (2003), participation in the community garden is associated with an increase in physical activity, which promotes a healthy lifestyle, and a decrease in health problems.

Body mass index (BMI), demography, degree of physical activity, and other factors associated with health have all been studied in relation to one another. According to Litt *et al.* (2011), people who engaged in a lot of outdoor activity had a significantly lower BMI. Gardening activities have been associated with a significant decrease in obesity.

Mental Health

According to research by Carney *et al.* (2012), engaging in gardening activities can help people feel less stressed, more relaxed, more confident, and have a better sense of passing the time. Similar findings are presented in studies by Mecham and Joiner (2012), Okvat and Zautra (2011), and Van den Berg *et al.* (2010). According to Stuart (2005), gardening can reduce stress, absorb negativity, offer a tranquil escape, and give participants hope as they see their plants thrive. The study also revealed that growing food and nurturing plants offered empowerment, a link to one's cultural background, and served as a bridge between other civilizations.

In a similar vein, Gonzales *et al.* (2011) and Unruh and Hutchinson (2011) have demonstrated that taking part in

community activities can lessen some depressive symptoms and give people a purpose.

Spiritual Benefits

Finally, community gardening has some important spiritual advantages. Cultivating the soil is a way to strengthen the link that gardeners have with Mother Nature and with their surroundings. Additionally, it is a vital tool for helping people understand who they are. According to Flachs (2010), participating in group urban gardening fosters the growth of one's own identity. According to the study, community gardening fosters creativity, shows a person's love of nature, and has a positive effect on both the environment and their community. Similar to this, participating in gardening activities encouraged a sense of connection to nature (Litt *et al.* 2011). This relates to Turner's (2011) idea of embodied sustainability, which captures the perception of many gardeners who see soil as an active collaborator in the growing process. Unruh and Hutchinson (2011) published similar findings, which showed that gardeners felt a connection to their garden and good feelings were tied to their gardening activities. In addition to determining the demand, this study shows how the community garden has affected the area. The impact of the garden on the community is thus connected to the assessed need and stated advantages in the article.

Community Garden: A context for sustainable educational practice

The Community garden was initiated on WCC campus as several students cited that they did not have any land to grow flowers and vegetables at home.

The main objectives were to

- To connect with Mother Earth
- To inculcate a love for organic farming amongst students
- To provide space to our students to demonstrate the pleasure of gardening
- To access fresh fruits/vegetables/herbs/flowers
- To see the fruits of their hard work from own hands
- To stimulate social interaction
- To promote environmental consciousness amongst students

Students now have a great opportunity to learn about the value of sustainability while managing their local environment in the campus community garden. Students' main task is to plant vegetables in trenches (Fig 1). Students sow seeds as part of the process, which teaches them about plant needs. Digging trenches in groups of two or three, they next spread their seedlings or seeds evenly apart according to the instructions on the seed packaging. We elucidate the requirement for nutrients and fertilizers, as well as the proper application methods and dosages for vegetables. When measurements and calculations are undertaken to dilute liquid fertilizers, mathematical thought is involved. Acidity, alkalinity, and neutrality, or pH, are significant aspects of chemistry. Their own eating habits—alkaline, acidic, and neutral—bitter, sour, and neither—connect them to these concepts. We explain in the garden that while certain plants prefer acidic soil, most vegetables prefer alkaline or neutral soil, which leads to discussions on soil management and the requirements of specific vegetables. To keep off pests and insects that lay their eggs on their plants, the students can cover their garden beds with netting if needed. Snails must also be controlled. The teachers make a connection between this

process and the diets of their students, emphasizing that all living things require nourishment and that the vegetables they eat provide them what their bodies require to live and develop. Through the in-class curriculum, there is a connection between plant nutrition and human nutrition.

Among the many learning possibilities offered to participants are organic gardening, plant propagation, weed and insect control, composting, and bed construction. Students' experiences at the garden are brought back, examined, and subjected to more research. The option to learn how to cook is provided by either taking the produce home or cooking it and eating it (Figure). Students continue their study of gardens by researching and writing narratives about their gardening experiences to develop their literacy abilities. These tales are told to parents, instructors, teachers, and other students. According to Brown *et al.* (2017), student experiences help them make connections between Earth, their curriculum, and the interdependence of the areas they study in transdisciplinary learning. It benefits your health, mind, soul, and spirit to learn new things. The WCC community garden turns into a space for relaxation, introspection, and physical activity as well as a place to interact with nature and have conversations and make decisions as a group.



Fig.1 : WCC students digging up trenches, germination of the vegetable seeds, lady's finger, greens in a pot and Balsam – an ornamental in bloom.

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