

PHYSICS

**Mechanics and Properties of Matter
Heat and Thermodynamics**

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PHYSICS For B.Sc. First Year (Semester I)

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- **Publisher:**

K.S.Atkare

Kailash Publications

Chhatrapati Sambhajnagar

- **Type Setters:**

Kailas books

- **Printers:**

Print point, Pune

- **Cover Design:**

Vinod Atkare

- **Edition: First**

MARCH 2023

ISBN :

978-93-93623-68-3

Price:

Rs. 300

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Kailash Publications
Chhatrapati Sambhajinagar
9325214191, 8055555500



ISBN: 978-93-88901-71-0

**RESEARCH TRENDS IN SCIENCE
AND TECHNOLOGY
VOLUME II**

EDITORS

MS. DILSAR GOHIL

DR. K. K. UPADHYAY

DR. D. R. NAGAPURE

DR. PARASHURAMA T R



Bhumi Publishing, India

First Edition: July 2023

First Edition: July, 2023

ISBN: 978-93-88901-71-0



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Published by:

Bhumi Publishing,

Nigave Khalasa, Kolhapur 416207, Maharashtra, India

Website: www.bhumipublishing.com

E-mail: bhumipublishing@gmail.com

Book Available online at:

<https://www.bhumipublishing.com/book/>



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USE OF REMOTE SENSING TECHNIQUE IN AGRICULTURE

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Abstract:

Agriculture field plays crucial role in food supply to us. But there are many issues disturbing agriproducts. Climate change, water shortage, improper value of agriproducts in market, population growth, low-income levels are the key factors influencing agriculture field. In such situation remote sensing can be the best tool to agriculture field. Various applications of remote sensing play a vital role to detect problems in agriculture and gives insight to overcome these problems. This review article discusses role of remote sensing in agriculture field.

Keywords: Agriculture, remote sensing, sensors, vegetation cover, soil mapping

Introduction:

In 1960 A.D. Fischer devised the term remote sensing. Remote sensing is defined as the art and science of gathering information about objects or areas from a distance without having physical contact with objects or areas being investigated. Use of electromagnetic spectrum is the principle used in remote sensing. It is the science and technology of making inferences about material objects from measurement made at a distance without coming into physical contact with the object under study. It is a tool to monitor the earth's resources using space technology in addition to ground observations. Such examinations can be carried out using ground-based instruments as well as sensors or cameras mounted on ships, aircraft, satellites, or other spacecraft (Prabhakar *et al.*, 2011). This collection of basic data involves monitoring of crop growth, soil moisture condition, irrigation drainage and outburst of pest, disease infection. Remote sensing collects data without destroying the crop, which can be used to provide vital information for precision agriculture.

Types of remote sensing

There are two main types of remote sensing, passive remote sensing, and active remote sensing.

Passive remote sensing depends on natural energy bounced by the target. It makes use of seasons that detects the reflected/emitted electromagnetic radiation by natural sources. Active remote sensing: It makes the use of seasons that detects reflected responses from object that are

irradiated from artificially generated energy sources. In this remote sensing, instruments operate with their own source of emission or light.

Remote sensing platforms

There are three main types of remote sensing platforms. These are the vehicles that carry remote sensors to collect data from a distance.

- 1. Airborne platforms:** These remote sensing vehicles operate in Earth's atmosphere. These include airplanes, helicopters, and drones.
- 2. Ground borne platforms:** These are remote sensing vehicles that operate on the Earth's surface. Infrared thermometer, spectral radiometer, pilot balloons, & radars are some of the ground based remote sensing tools.
- 3. Space borne platforms:** These are remote sensing vehicles that operate in space. These include satellites, which are the most used space platforms for remote sensing. The satellites are subdivided into two classes. (a) Polar orbiting satellites-These satellites operate at an altitude between 550 & 1600 km along an inclined circular plane over the poles. LANDSAT (USA), SPOT (France), & IRS (India) series are some of the remote sensing satellites. (b) Geostationary satellites- These are satellites that orbit the Earth at an altitude of approximately 36,000 km. The INSAT series satellites are launched from India for the above purpose.

Sensors used in remote sensing

- a. Photography:** It is the most used sensing systems. The film records the energy reaching in at the time in the visible and near infrared ranges of the spectrum. The range of any individual system is governed by a particular film characteristics and use of films.
- b. Line scan and related system:** It uses the visible and near infrared portion of the spectrum. In this system a mirror is rotated parallel to the direction of the movement of the aircraft or satellite. The mirror reflects the radiation received on to a detector and the data are recorded.
- c. Microwave system:** Microwave radiation is emitted from the earth's surface is very small quantities. These microwaves are used by microwave sensors in a wavelength of about 1 mm to 1000 mm. The sensors record the microwave radiation through complex antennae. These are used in weather satellites (Ray, 2016).

Basics of agriculture remote sensing

Using remote sensing farmers observe their fields to assess the condition of crops. Observing the colors of leaves or the overall appearances of plants can determine the plant's condition. Remotely sensed images taken from satellites and aircraft provide important

information to assess field conditions without physically touching them. Exploring Information from remotely sensed images allows farmers to treat only affected areas of their field. Remote sensing is very important tool for farmers. Energy from sunlight is called the electromagnetic spectrum shown in fig.1.

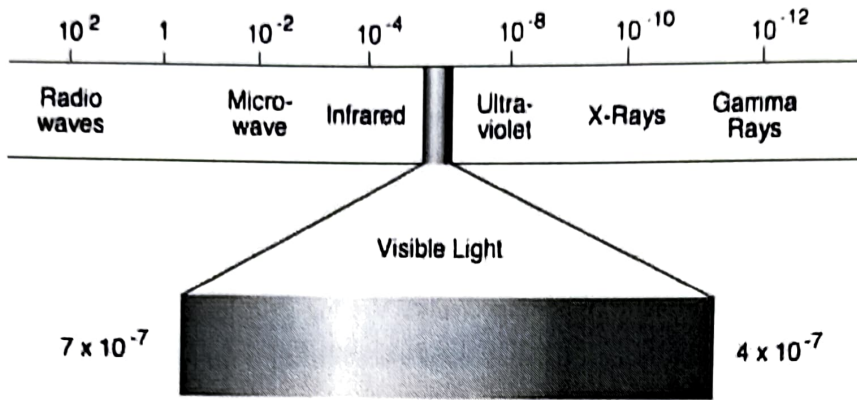


Figure 1: Electromagnetic spectrum (Wikimedia Commons, 2019)

Wavelengths used in agricultural remote sensing cover only a small region of the electromagnetic spectrum. In a satellite remote sensing process used in agriculture. This process is depicted in fig.2.

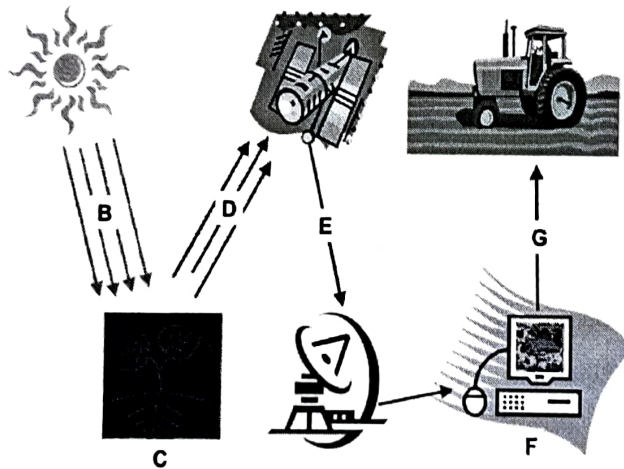


Figure 2: Satellite remote sensing process (Anna Jakomulska *et al.*, 2002)

Electromagnetic energy from Sun strikes the plants. A portion of this energy is transmitted through the leaves. Reflected energy is detected by the sensor on the satellite. The data is then transmitted to the ground station. The data is analyzed and displayed on field maps. Alterations in leaf colors, textures, shapes or even how the leaves are attached to plants, determine how much energy will be reflected, absorbed, or transmitted. Spectral signatures of an individual plant are obtained by using the relationship between reflected, absorbed, and

transmitted energy. The radiation reflected as a function of the wavelength is called the spectral signature of the surface as indicated in fig. 3.

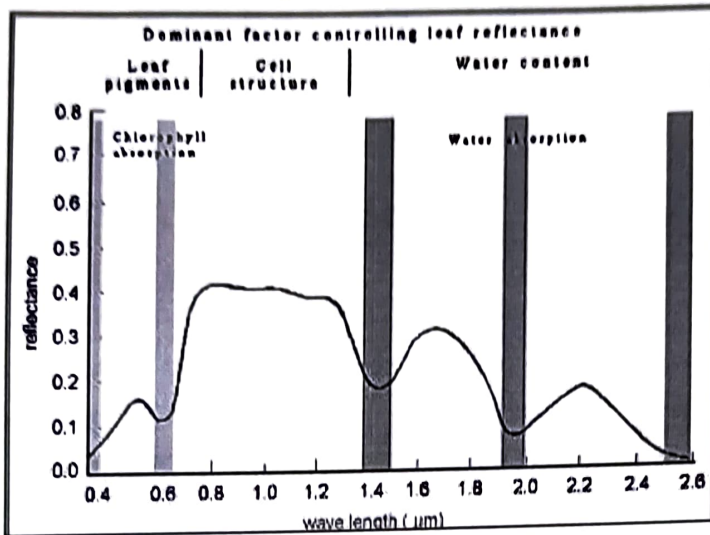


Figure 3: Spectral signature of planets (mcbburney.wixsite.com)

Spectral signatures are unique to plant species. The spectral signatures of unhealthy plants appear changed from those of healthy plants. Interpretation of the reflectance values at various wavelengths of energy can be used to evaluate crop health (Nowatzki *et al.*, 2017).

Remote Sensing in agriculture

Most researchers have focused on the use of data for classification of land cover types with crop types in agricultural applications during early stages of satellite remote sensing. In recent years, focus was on characterization of plant biophysical properties. Remote sensing of agricultural canopies has provided valuable insights into various agronomical parameters. It provides repeated information for providing valuable information for precision agricultural applications without destructive sampling of the crop (P. Shanmugapriya *et al.*, 2019). Some agronomical parameters have been discussed here.

Monitoring of vegetation cover

Vegetation cover indicates the percentage of soil which is covered by green vegetation. Remote sensing is an outstanding technique to monitor the earth's surface cover. The Normalized Difference Vegetation Index (NDVI) is the most accurate method of digital processing of spatial visualization in the presentation of vegetation. Main fact used in this technique is that the plants show a high reflectivity in the wavelength range near the red wavelength range. NDVI values are in the range of -1 to +1. Positive result indicates the cell has a plant cover and the negative values indicate the non-green surface parameters (Allawai and Ahmed, 2020).

Crop condition assessment

Remote sensing gives us timely spectral information about the crops. This information provides physiological information of plants. Physiological changes are reflected in spectral characteristics of plants. Evaluation of crop condition will help monitoring of the crop at frequent intervals. Remote sensing is perfectly suited for crop condition monitoring. The condition of the crop depends on moisture stress due to drought, nutrient stress due to insufficient availability in the soil, flooding, saltiness, disease, and pest doses (Ray, 2016).

Nutrient and water status

Remote sensing gives water status over the land to farmers. Nutrient and water stress management can be done using remote sensing applications. Using this technique farmers can reduce cultivation cost and proper use of fertilizer to increase the yield. The spectral reflectance in visible region of electromagnetic spectrum can give intuition of diseased and healthy crops. Remote sensing also gives us the soil moisture availability in the field. Remote sensing has been playing a major role in understanding the crop soil characteristics. Such information when linked with GPS will provide promising results which are more helpful in precision farming (Shanmugapriya *et al.*, 2019; Sinha *et al.*, 2018).

Soil mapping

Remote sensing plays an important role in soil mapping. Through soil mapping, farmers can get information about ideal soil for the crop and know irrigation requirement for the crops. This information helps in precision agriculture (Priya and Raman Kumar, 2020).

Weed identification and management

Remote sensing united with precision agriculture is a hopeful technology in nowadays. Some methods for weed detection are very time-consuming and labor-intensive. However, image-based remote sensing has potential applications in weed detection for site-specific weed management. Difference in the spectral reflectance properties between weeds and crop, remote sensing technology helps us to identify the weeds in the crop (Shanmugapriya *et al.*, 2019).

Detection of plant stress

The chlorophyll and other pigments react to the visible radiation. Infra-red region is a region of high reflectance. Using remote sensing technology, we can identify stressed and non-stressed leaves. Water stress, nutrient stress, and disease outbreak lead to reduction in plant pigment in red band. The reflectance measured in the visible and near infra-red bands indicates plant health (Ray, 2016).

Atmospheric dynamics

Use of meteorological satellites in weather forecasting is the tool given by remote sensing. These satellites are used to measure cloud cover, wind, moisture, temperature, and wind

speed. Variation in canopy temperature is used to determine water availability in the field. The use of remote sensing data for drought assessment plays a significant role in agriculture. NDVI produced by NOAA-AVHRR data is used to assess and monitor droughts at the district level, allowing timely preventive and corrective measures to be taken (Adhikary *et al.*, 2022).

Crop evapo-transpiration

Crop productivity is influenced by soil moisture. Soil moisture depends on temperatures and rainfall. The relationship between water stress and a plant's thermal characteristics is described by vegetation indices such as Crop Water Stress Index, Surface Temperature, Water Deficit Index, and Stress Index. Evapo-transpiration estimates are crucial for evaluating irrigation scheduling, calculating water and energy balances, determining crop water stress indexes, and determining climatological and meteorological conditions. Temperature influences soil water availability and crop evapo-transpiration which is essential in assessing crop water stress (Saju Adhikary *et al.*, 2022).

Crop yield and production forecasting

Remote sensing plays vital role forecasting crop yields. Statistical– empirical relationships between yield and vegetation indices gives forecasting of crop yields. The information on production of crops before the harvest is significant for national food policy planning. Crop yield depends on factors such as crop variety, water and nutrient status of field, influence by weeds, pest and disease infestation, weather parameters. The spectral response curve is dependent on these factors. Nature of the spectral response curve indicates the crop condition and its performance (Shanmugapriya *et al.*, 2019).

Precision agriculture

Remote sensing technology is a key factor of precision farming and is being used by number of scientists, engineers, and large-scale crop growers. It gives information about cultivation of healthy crops which guarantee farmers to harvest crop after an ideal period (Shanmugapriya *et al.*, 2019).

Conclusions:

With population growth in the world the natural resources and agriculture food resources are not adequate. Most of the farmers do their farming without the help of technology. Many natural factors such as less rainfall, temperature, floods, plant diseases etc. hamper agriculture produce. Farmers should get information about how to increase agriculture produce by proper knowledge of the factors affecting their crops, yield. This is possible by using remote sensing technique in agriculture. It is necessary to obtain reliable data on not only the types of resources, but also the quality, quantity, and location of the resources. Remote sensing is an important tool in improving the present system of agriculture.

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First Edition 2023

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ISBN: 978-93-5857-321-3

Price : Rs. 300.00

Published & Printed by:

Nitya Publications, Bhopal MP India

Web: www.nityapublications.com

Email: info@nityapublications.com

Mob. 9009291840

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ISBN: 978-93-5857-321-3

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National Education Policy 2020: Challenges and Solutions In Higher Education In India

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Abstract

Good education policy is very important for Nation's overall progress. According to the tradition and custom many countries adopted education system and acquired various stages in their life cycle to make it effective at school and college education level. Union Cabinet of India started the National Education Policy of India 2020 (NEP 2020) on 29 July 2020 replacing the previous National Policy on Education, 1986. This policy is a complete outline for elementary to higher as well as vocational training in both rural and urban India. The policy aims at producing engaged, industrious, and contributing citizens for building an impartial, comprehensive, and plural society as predicted by our constitution. NEP 2020 aims to transform India's education system by 2030.

Keywords: National Education Policy 2020, features, challenges, solutions, higher education

Introduction

Education is the basic thing to gain full human potential. The world is experiencing fast changes in the knowledge landscape. With revolution in science and technology in conjunction with multidisciplinary abilities across the sciences, social sciences and humanities, there is need of skilled workforce. There is need of skilled labor to tackle the things like climate change, pollution, and exhausting natural resources. To handle situation like epidemics and pandemics collaborative research is needed. Multidisciplinary learning is also very crucial to deal with social issues arising by any situation. There will be greater demand for humanities and art as our country is becoming developed country as well as largest economy in the world. Pedagogy must be modified to make education creative, holistic, integrated, learner centered, flexible, experiential, discussion based and multidisciplinary. New education policy will transform our nation into an equitable and vibrant knowledge society. To adopt this new education policy 2020, challenges and solutions in higher education has been discussed in this article.

Features of NEP 2020 for Higher Education in India

New Education Policy has following features [1].

1. Institutional Restructuring and Consolidation
2. Holistic & Multidisciplinary Education
3. Optimal Learning Environment and Support for students
4. Motivated, Energized and Capable Faculty
5. Equity and Inclusion in Higher Education
6. Teacher Education
7. Reimagining Vocational Education
8. Catalyzing Quality Academic Research in All Fields through a new National Research Foundation (NRF)
9. Transforming the Regulatory System of Higher Education
10. Effective Governance and Leadership for Higher Education Institutions
11. Professional Education
12. Adult education and lifelong Learning
13. Promotion of Indian Languages, Arts and Culture

14. Technology use and Integration

15. Online and Digital Education: Ensuring Equitable Use of Technology

Challenges and solutions in the Implementation of National Education Policy 2020 in Higher Education:

Following are some of the challenges and solutions in front of higher educational institutions to implement NEP 2020.

1) Implementation

If we want effective implementation of NEP 2020, there should be proper coordination and collaboration among various stakeholders, including the central and state governments, education institutions, teachers, and parents. Capacity within the Ministries of Education, State and Center, and other regulatory bodies should be adequate to accommodate such changes[2].

2) Funding

Aim of this policy is to increase Gross Enrollment Ratio in higher education including vocational education from 26.3 % (2018) to 50 % by 2030. About 3% of GDP (2023) is spent on education in India. Implementing NEP 2020, GDP is expected at around 6%. Both State and Central Government must allocate sufficient funds to channelize this policy [3].

3) Internationalization and Foreign universities

In NEP 2020 importance is given to Internationalization of higher education to attract international students to Indian universities. HEIs will play important role in attracting foreign students in India. Provision be made so that Indian students can avail education in abroad. More MOUs be established with foreign universities. The universities will also have to be attentive and keep themselves prepared to accommodate foreign students[4].

4) Teacher training

Learning must be enjoyable rather than boring task. In new education policy stress is given on holistic multidisciplinary education rather than learning by rote. Various tools and methods must replace present system. For applying various modern ways in education system teachers should be familiar to such trends which will happen by continuous training. There should be institutes, educators, and official staff to facilitate NEP 2020 [5].

5) Adequate teachers

By 2030, it is aimed to increase Gross Enrollment Ratio in higher education as 50 %. In present higher education system teacher- student ratio is not satisfactory. To meet this increasing student number situation, there should be adequate teachers. Education field is assumed to be low paying profession. To attract more people to this profession, they should be given handsome salary [6].

6) Assessment & evaluation

In NEP 2020, continuous assessment is encouraged to track the learning outcomes. This policy may face challenges, including the capacity of assessment agencies and the need for trained teachers and students [2]. Teachers must come up with creative assessment and evaluation methods and brainstorming assignments in order to meet the expectation of this policy. Such assessments would require the institutions to invest significantly in conducting these exams [6].

7) Infrastructure and Technology

NEP 2020 expect complete overhaul and energized higher education system. For such move there is need of sophisticated and modern infrastructural facilities. ICT enabled infrastructure with Wi-Fi connection is very important thing. But incurrent situation there is lack of infrastructural facilities to meet demand of complete and all-inclusive education. In order to keep pace with the fast-changing technology, ultramodern infrastructural facility is the prime necessity [7].

8) Weekly university opening

The higher education system in India includes both private and public universities. There are currently about 1,000 universities in India. It is a difficult task to establish new universities to accommodate more students as expected by NEP 2020 recommendations. Population growth in our country is also the concern in opening new institutions. State government and Central government should work very fast to open new universities [6].

9) Curriculum & content

The NEP seeks a change from 10+2 structure to 5+3+3+4 structure, where early childhood education will be a part of formal education. This policy focuses on developing the curriculum content to ensure critical thinking and develop social-emotional skills among students. Hence curriculum and content need to be updated to attain goals of NEP 2020. All educators need to reconsider the course content as per policy and alter the resources accordingly [8].

10) Inter-disciplinary education

Holistic and multidisciplinary education would aim to develop well-rounded individuals. NEP 2020

will provide flexibility to the students to study the subjects of their choice. In current situation educators are engaged in their specific area. This culture is deep-rooted with very few exceptions and the new policy aims for shifting the same to multidisciplinary approach. To implement this new education policy in higher education the teaching faculty need to develop inter-disciplinary approach. Also, availability of faculty to implement this policy is the main issue [8].

11) Digital divide

This policy stresses the use of technology, digital literacy, and coding from an early age. This strategy widens the digital rift between the urban and rural area. During covid-2019 period we have experienced, students from rural areas were not able to attend classes online because they did not have access to mobile phones and high-speed internet. Use of internet and electric gadgets in the remote rural area will be a difficult task. In rural area local authority should look into this matter to make available new technology [4].

12) Quality

The quality of students in higher education is not so satisfactory. This low quality of education may be due to some corrupt practices in higher education system. All stakeholders are responsible for this low-quality education. It is a big challenge to implement the new education policy. All stakeholders should sincerely work for implementing and making this new education policy successful [3].

13) Inclusion & equity

NEP 2020 is based on the principles related to diversity, equity, and inclusion. Every child should get opportunity to learn and excel. Stress will be given on socially and economically disadvantaged groups [7].

Conclusions

NEP 2020 is more comprehensive and visionary policy document. It has potential to transform the country. Co-operation among the government and stakeholders is very crucial factor in implementation of this policy. This policy aims at holistic development of the student. It will make our education system healthier. But there are many challenges to implement NEP 2020 successfully in our country but it is possible by devotion of every factor.

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New Education Policy- NEP 2020, Challenges, Opportunities, Issues and Solutions (Multidisciplinary Subjects)

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Published & Printed By :

NITYA
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Nitya Publications, Bhopal MP India

Web: www.nityapublications.com

Email : info@nityapublications.com

Mob. : +91-9009291840

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MRP Rs.300.00

ISBN 978-93-5857-321-3



9 789358 573213

ABOUT THE BOOK

Rapid technological developments inevitably bring multiple risks and challenges. Today the world is focusing towards Artificial Intelligence (AI) and it is also a challenging platform for budding researchers in all branches of science and technology. Each new material discovered by science led to new applications which meant a growth in technology. In this era there is a great development in interdisciplinary research in all branches of sciences and technologies. Advances made in the use of materials involving scientific knowledge. However, it is the application of this science to create objects for our use i. e technology, which makes the new material popular. This book, entitled, "Interdisciplinary Research In Science and Technology" is published on the occasion of National Science Day by the National Publisher, RUSHI Publication, Chhatrapati Sambhajinagar (M.S.) India which may be a guideline for promoting the researchers in various disciplines of Science, Engineering and Technology. The Authors have contributed their research work for the motivation of new researchers. Maximum numbers of the manuscripts are related to current scientific research carried out by researchers while doing their research work and also, they have written it in simple and lucid language with tables and graphs. In this book, the chapters from various research fields are included, also, each and every care has been taken to cover more branches of science disciplines.



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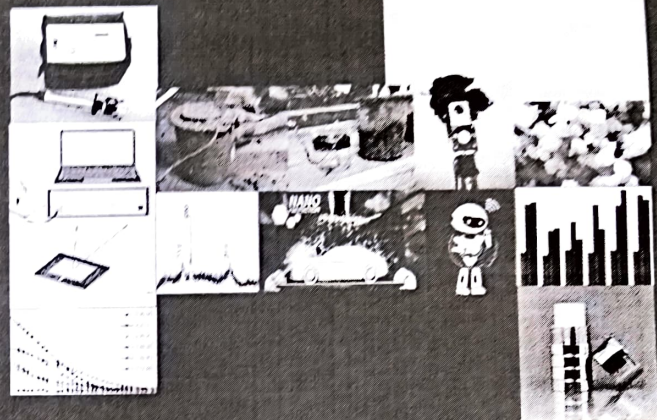
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Interdisciplinary Research in Science and Technology



Interdisciplinary Research in Science and Technology

Editor: Dr. C. M. Kale

Interdisciplinary Research in Science and Technology

An Edited Book (ISBN: 978-81-970491-2-5)

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☐ Edition

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☐ Typesetter

Shravani Graphics, Sillod
Dist. Chhatrapati Sambhajnagar

☐ Publisher

Rushi Publication
Chhatrapati Sambhajnagar -431005
E-mail: rushipublication27@gmail.com
Contact: 9975080017

☐ Printed at

Rajkamal Print, Chikalthana
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☐ Total pages

194

☐ Price

Rs. 455 /-

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☐ Cover design

Rushi Arts, Chhatrapati Sambhajnagar

ISBN: 978-81-970491-2-5



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Innovative Pedagogical tools in Science Education: A Review

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ABSTRACT

Digital education has replaced the conventional education system to some extent but it cannot replace the teacher's role in teaching. Information and communication technology (ICT) in education has become an integral part of today's education system. Tools such as YouTube, Google quiz, Quick Response Code (QR code), Podcasts, PowerPoint presentation, and mind mapping etc. have been employed in today's education system to make education more flexible so that students can learn according to their pace. Teachers are taking the help of digital technology to make teaching more effective and easier so that student can grasp the topic thoroughly. This article aims at how technology has impacted the teaching practices, perceptions of students about the use of technology in the classroom.

Keywords: *ICT, QR Code, Mind mapping, You tube, PowerPoint, Google Quiz*

1. INTRODUCTION

Our educational system has completely changed because of the incorporation of technology into traditional teaching methods. It has completely transformed the global educational environment and is now a necessary component of most educational procedures. The use of technology in the teaching and learning process is now emphasized in the New Education Policy as well. Choosing the right pedagogical resources for a lesson improves its effectiveness and increases learning outcomes [1]. In the past students had to depend upon teachers and libraries. But nowadays students rely on digital platforms and can access information widely. Using innovative pedagogy in the classroom we can increase students' enthusiasm [2]. There are many challenges to employ innovative pedagogy in the educational system. First, the educational institutes must have necessary infrastructure for implementation of ICT based pedagogy. Second, teachers must become accustomed themselves with this advanced technology. Educational institutes do not have the same ability and student situation. Taking these challenges into account the institute must plan the appropriate pedagogical strategy [3]. There are some complex concepts in science. Using innovative pedagogy, we can make these complex concepts easier for students. Some very complicated mathematical concepts can be made interesting using some innovative pedagogical tools. In this article we will discuss some of the important pedagogical tools to be used in science education.

2. SOME PEDAGOGICAL TOOLS

Pedagogical tools such as YouTube, Google quiz, Quick Response Code (QR code), Podcasts, PowerPoint presentation, and mind mapping have been discussed here.

You tube

One of the online modes of teaching is you tube. It can be used as an effective platform in the teaching and learning process. Lectures are recorded and these video lectures are uploaded to you tube

platform. These pre-recorded video lectures are shared with the students instead of taking live lectures. Students can attend the lecture at their convenient time. They can use the you tube videos for revision purposes and to resolve their doubts. Videos with various effects help to understand the complex concepts of science which are not possible by chalk and talk method. Many teachers across the world post their video lectures on you tube. This is very effective to understand the basic concepts of science taught by various tutors. Students find the use of you tube delightful which enhances the understanding of the academic materials [4]. Students can use these videos as educational tools by taking notes and motivating them to utilize it in the classroom [5].

Google quiz

Assessment is also very important in the teaching and learning process. Google form is the web-based app used to collect and process information to evaluate the performance of students. In classroom teachers find it very difficult and time consuming in assessing students. Previously assessment was based purely on paper work but now it is shifted to technology-based. Google quiz is very simple, easily accessible, and free to use. It can be shared with students by sending a link via email, message, or embedding it into a web page or blog post. Data gathered using the form is typically stored in a spreadsheet. Audio, video, text, animations, and images can be used to prepare google quiz. It also gives the students the facility to view their scores once they submit the quiz [6].

Quick response code

Quick Response Code is a form of 2D barcodes. Information such as URL, SMS, contact information and plain text can be embedded into the two-dimensional matrix. In science education, using QR code is very crucial. Naturally, the students are very curious about new techniques employed in teaching and learning rather than routine processes. A piece of information such as information about experiments, equipment labels consisting of information, theory of scientific terms, book information in library, information of students etc. can be embedded in QR code [7]. Using QR Codes on printed materials like subject books may enhance the attractiveness and make the aspects clear.

Podcast

The word podcast is a combination of the word iPod with broadcast. Podcasts are audio broadcasts distributed via the internet. Podcasters create digital media files and upload them to their websites where users can listen to them directly or download them [8]. Audio learning plays a crucial role in learning. By listening the content, students can understand ideas that are two to three grade levels higher than their normal reading level. Podcasts permit students to access educational materials at home. Students can play the recordings at their convenient time. Podcasts are created using audio recorders and commonly available free compression software [9].

PowerPoint presentation

Microsoft PowerPoint is a presentation program developed by Microsoft. It improves the presentation skill of students. PowerPoint enhances the effectiveness of teaching and learning processes [10]. PowerPoint can facilitate understanding of students. Various concepts of science can be made easy to understand by using animations, images, videos etc. in the slides. It is very helpful rather than using traditional teaching methods.

Mind mapping

While studying science subjects one encounters many complicated concepts, ideas which are not easy to remember using the old teaching process. Mind mapping is a visual form of note taking which offers an outline of a topic and its complex information that helps students to understand, create new ideas and build connections. It is a visual representation of hierarchical information in which the central idea is surrounded by connected branches of connected topics. It organizes ideas and concepts into graphic patterns. It gives you powerful control over multiple documents from a single place. Using mind mapping in the teaching and learning process we can increase the retention, enhance thinking of students [11].

3. CONCLUSION

In this article we have discussed various pedagogical tools used in science education. These tools cannot replace traditional teaching and learning processes. But these innovative pedagogical methods can largely improve the teaching environment. The uses of YouTube, google quiz, quick response code, podcasts, PowerPoint presentation, and mind mapping are multifold and increase the understanding of the educational concepts by supplementing the study material.

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ISBN: 978-93-95847-32-2

Research and Reviews in Nanotechnology Volume I

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BHUMI PUBLISHING, INDIA
FIRST EDITION: FEBRUARY 2024

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Title: Research and Reviews in Nanotechnology Volume I

Editors: Dr. Yogesh Deswal, Mrs. Priyanka, Dr. Neeraj Mohan Gupta, Dr. Laxmi Deswal

First Edition: February, 2024

ISBN: 978-93-95847-32-2



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REVIEW ON NANOFERTILIZERS FOR BETTER AGRICULTURE

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Abstract:

Nanotechnology has transformed today's world tremendously. It has numerous uses in a wide range of societal fields, including engineering, agriculture, food, medicine, and polymer technology. The greatest and most promising remedy for issues with conventional fertilizer in the agricultural system is nanotechnology. The main challenge of current agriculture is to fulfil food demands efficiently. This paper will highlight the use of nanofertilizers in the field of agriculture and discuss the impact of nanofertilizers on agriculture.

Keywords: Nano fertilizer, nanotechnology, nanoparticles, nutrients, crop yield

Introduction:

Agriculture plays a vital role in economic foundation of developing countries. Key factors affecting agriculture field are water, climate, and fertilizers. Fertilizers contribute more to increase agricultural production. But use of chemical fertilizers greatly affects soil health and its efficiency. Due to the growth of high-yielding crop types, greater cropping intensity, and decreasing use of organic manures, macro and micronutrient deficiencies in crops and soil have increased intensely over the past several years worldwide [1]. Application of nanomaterials in agriculture is to reduce the amount of spread chemicals, minimize nutrient losses in fertilization and increased yield through pest and nutrient management. Numerous possible advantages include improving the safety and quality of food, lowering the number of inputs used in agriculture, improving soil absorption of nanoscale nutrients, etc. [2]. Due to numerous advantages of nano-fertilizers gained attention of the soil scientists and environmentalists.

Nanoparticle

A nanoparticle is a small particle with at least one dimension less than 100 nm. 1 nanometer = 10^{-9} m = 1 billionth of a meter. Nano sized particles can even penetrate through the cell wall in plants and animals. This process is used by nanotechnologists to deliver at the cellular level, which is more efficient than using the traditional approach. Nano particles are regarded as atoms or molecules and eventually relate to bulk material, which causes substantial changes in the material's physicochemical characteristics.

Nanofertilizer

Fertilizers are used to improve plant growth and output. These fertilizers are artificially synthesized inorganic chemical compounds. A material known as nano-fertilizer has the capacity to store a large quantity of nutrients for gradual and consistent release. When compared to conventional fertilizers, nano fertilizers can have higher use efficiencies and are expected to be needed in significantly smaller quantities. Three primary categories of Nano-fertilizer are suggested [3].

1. **Nanoscale fertilizer:** These are nanoparticles used as inputs containing nutrients. This increases absorption and overall effectiveness while providing a potentially nutritious amount in a less harmful way. This group includes fertilizer nano-objects made of urea, ammonium salts, peat, and other conventional fertilizers.
2. **Nanoscale additives:** These are traditional fertilizers with nanoscale additives. In this case, a nanomaterial replaces a little portion of macroscale inputs as an additive to enhance the macroscale inputs' qualities rather than acting as the nutrient itself. It may act some role in the plant growth, or it may be a supplement substance that can provide a binder or water holding material. Nanoscale additives give plants anti-microbial or insect resistance.
3. **Nanoscale coating:** These are traditional fertilizers coated or laden with nanoparticles. In this type the macroscale fertilizer is encapsulated by the nanoscale coating or a film. There could be nanoscale pores in the coating which can facilitate the slow release of nutrients solubility. The encapsulation of advantageous microorganisms, which can effectively enhance plant root growth and serve health objectives, is another fantastic application of this type. Some clays, such as kaolinites, smectites, halloysites, and palygorskites, are used in fertilizer products.

Nanoscale fertilizer inputs

A nano fertilizer is a product that carries nutrients to crops in one of three ways. The nutrient can be supplied as nanoparticles or nano-emulsions, contained inside nanomaterials like nanotubes, or coated with a thin layer of protective polymer film on the surface. Nanoscale fertilizer inputs are discussed here [3,4,5].

1. Nitrogen-based nanoparticles:

Nitrogen is the most important nutrient available for plant growth. Nitrogen utilization efficiency (NUE) can be enhanced by nitrogen based nano fertilizers as traditional fertilizers have less NUE. Urea is used to get ample amount of nitrogen. Slow release of nitrogen to the plant is needed. These fertilizers improve crop productivity. Urea-Hydroxyapatite Nanohybrids fertilizer, Urea coated nanohydroxyapatite composite, urea-silica nanohybrids, N bio-fertilizer

and Khazraa K chelate Nano-fertilizer, Urea-hydroxyapatite nanohybrid, Urea coated nano calcium carbonate (Urea-CC) nanocomposite, are some of the nitrogen based nano fertilizers.

2. Phosphorus nano fertilizers:

The second major nutrient for the plant is phosphorus (P). Certain commercially available water-soluble phosphate salts, as triple superphosphate, diammonium phosphate, mono ammonium phosphate, (NH₃, or Ca (H₂PO₄)₂), are used as fertilizers. Phosphorus-based nano fertilizer would enhance agronomical production, use efficiency of P, and improve the surface-water quality. Synthesized HA nanoparticles (A), and urea surface-modified HA nanoparticles (B) are also used. By adding nitrogen (N), phosphorous (P), and potassium (K) to chitosan nanoparticles, the NPK nano fertilizer is formed.

3. Nano silica:

Additionally, silica material is used to distinguish between components that are important to a plant's existence and those that are not. While most plants do not require silica to survive, plants that are exposed to various environmental stressors can adapt and benefit from its presence. Nanomaterials like nano-SiO₂ or nano-ZnO are used.

4. Titanium nanoparticles:

Materials that are photocatalytic are becoming more and more recognized as valuable resources for agriculture. TiO₂-PN has been applied as a growth-regulating, antibacterial, and fertilizer-like substance. Light absorption and photoenergy transfer were both enhanced by titanium nanoparticles. TiO₂ nanoparticles can promote the plant growth.

5. Zinc oxide nanoparticles:

In areas where there is a zinc shortage, the most common zinc fertilizer given to crops is zinc oxide. ZnO nano fertilizers can proceed novel solubility option of Zinc oxide nanoparticles to improve the efficiency of Zn fertilizers.

6. Copper oxide nanoparticles:

While beneficial for germination, copper oxide nanoparticles are phytotoxic during seedling growth. A visual representation of the many advantages of metal nanoparticles demonstrates the potential contribution of copper nanoparticles to improved plant growth and yield.

7. Iron nano-fertilizers:

Iron is an essential element for metabolic functions in the plant. It influences yield of the crop. These fertilizers are the ideal alternative sources, especially in iron-deficient soils. These fertilizers improve seed germination and promote the crop growth parameters, promote many growth parameters, chlorophyll, and protein levels.

8. Manganese nano-fertilizers:

Manganese is involved in ATP (Adenosine triphosphate) and protein and fatty acids biosynthesis, photosynthesis, and metabolism of nitrogen. Application of these fertilizers give a high rate of nitrogen assimilation and metabolism comparing with conventional Manganese fertilizer. Various researchers revealed that in some plants growth, productivity, efficiencies of photosynthesis is enhanced by these fertilizers.

9. Boron nano-fertilizers:

It has important role in pollen grains and tubes elongation, formation of cellular walls, photosynthetic products transfer from leaves to active sites, and increases in flowers and fruits yields.

10. Zeolite-based nano-fertilizers:

It is used as a slow-release fertilizer in farming. It normally helps in slow release of the fertilizer to the plant, this way of doing makes the plant to grab entire amount of nutrients from the applied fertilizer rather than the minimal uptake.

11. Potassium nano- fertilizers:

This fertilizer enhances all physiochemical functions of plants. It is very important in opening the stomata of the plant, Photosynthesis, translocation of photosynthates, protein synthesis, ionic balance, water relationships, and the activation of more than 60 enzymes. These fertilizers are very important for seed yield and oil content in peanuts.

12. Carbon nanotubes:

Single-walled carbon nanotubes, multi-walled carbon nanotubes, PBMC nano fertilizer are used in agriculture. Study reveals that use of carbon nanotubes enhances plant growth, provide higher moisture uptake, seed growth, induce changes in metabolic function, increase in biomass, and yield of plants, increases the electron transfer rate of light-adapted chloroplasts.

Advantages of nanofertilizers over conventional fertilizers

Nano fertilizers are very crucial for eco-friendly and sustainable crop development. Some of the advantages are as follows [6, 7].

1. Provides effective nutrient absorption and utilization.
2. Lowers the danger of environmental pollution by reducing nutrient losses.
3. They have a greater diffusion than traditional synthetic fertilizers.
4. Offers controlled and slow distribution of nutrients to crop plants.
5. Helps plants to absorb nanoparticles through root exudates, molecular transporters, and nanosized porous materials. They absorb more nutrients from nanoparticles through a variety of ion channels.
6. Smaller volumes of them can do because of modest nutrient losses.

7. Shield the soil and water from early exposure, minimizing nutrient loss.
8. Increases soil fertility and provides favorable environment to microorganism growth.

Conclusion:

This review article focusses on advantages of nano fertilizers over traditional fertilizers. It showed use of nano fertilizers in agriculture is beneficial regarding plant growth, effective nutrient absorption, and utilization, reduction in nutrient loss and survival of plants in environmental stresses. Benefits of categories of nano-fertilizers with inputs are discussed here. The agriculture sector will indeed see tremendous change for the better future of agriculture.

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