Al-Mustaqbal University

College of Science

Scientific Thinking and Research Skills

Third Year Students / 1st Semester

INTRODUCTION TO RESEARCH METHODOLOGY, ***continued***

2025-2026

Biochemistry Department

By

Prof. Dr. Naser Abdulhasan Naser

What is Methodology?

A set of procedures for the purpose of answering a research question(s) that describes:

- How to study (object /participants) will be selected?
- How you will analyze the data?
- How and when you will collect data from your work or participants?

Defining Research

Methodology

Methodology means the systematic study of the methods, principles, procedures, and rules applied within a discipline

Research Methodology

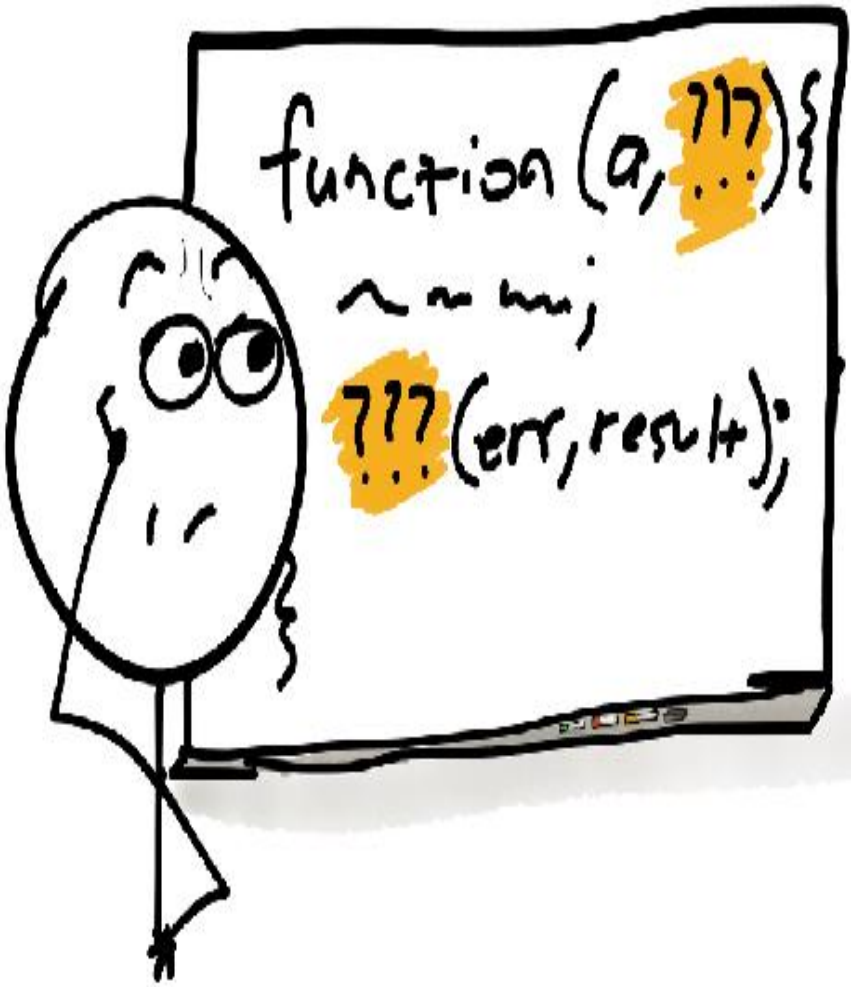
1. Similar to an instruction booklet, whereby the instruments and procedures used in the research are described.

2. It should be clearly written so that other researchers who are interested in conducting research in the same area can exactly follow the procedures you took in conducting the research. .

Main Elements of Research Methodology

- *Purpose or objectives of the research.*
- *Short description of the issue or problem to be investigated.*
- *Data collection methods.*
- *Data analysis methods.*

Ask your self, What the scientific meaning for these pictures?



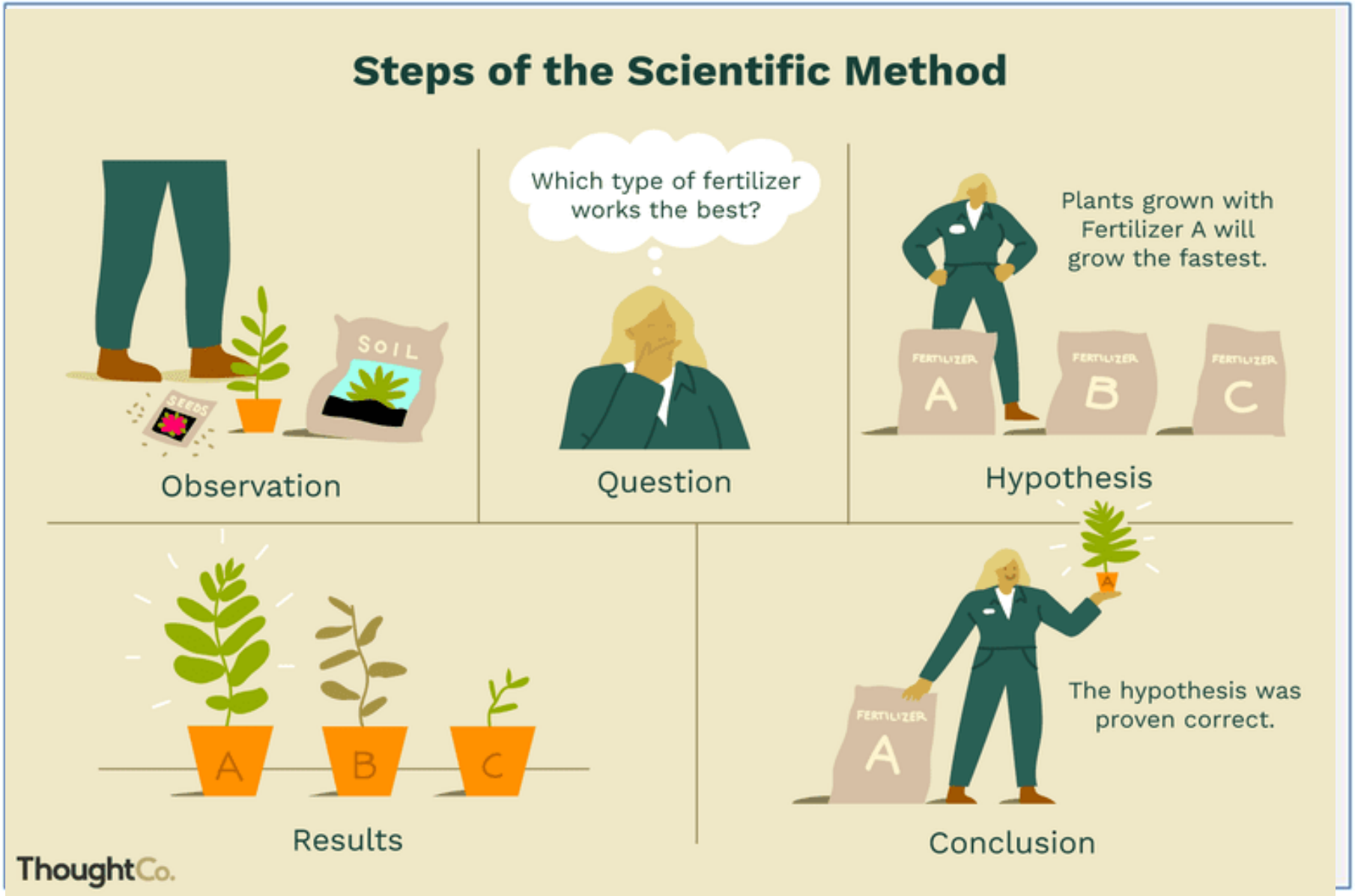
OBSERVATION

QUESTION

RESEARCH AND HYPOTHESIS

EXPERIMENT

ANALYSIS AND CONCLUSION


Steps of the Scientific Method
SOIL
SEEDS
Observation
Which type of fertilizer works the best?
Question
Plants grown with Fertilizer A will grow the fastest.
FERTILIZER A
FERTILIZER B
FERTILIZER C
Hypothesis
A
B
C
Results
FERTILIZER A
The hypothesis was proven correct.
Conclusion
ThoughtCo.

Research Methodology Sections

1. Introduction.
2. Description of Samples/Subjects.
3. Research Procedure.
4. Data Analysis and Conclusion.
5. Description of Instruments Used.

Students Exercise

Applied Surface Science 394 (2017) 498–508

Contents lists available at ScienceDirect

Applied Surface Science

journal homepage: www.elsevier.com/locate/apsusc

Full Length Article

Morphological driven photocatalytic activity of ZnO nanostructures

Khaldoon N. Abbas[a,b,c], Noriah Bidin[b,*]

[a] University Technology Malaysia, Department of Physics, Faculty of Science, Johor Bahru, Johor 81310, Malaysia
[b] University Technology Malaysia, Laser Center, Ibnu Sina Institute for Scientific and Industrial Research, Johor Bahru, Johor, 81310, Malaysia
[c] Al-Mustansiriya University, Faculty of Science, Physics Department, Baghdad, 00964, Iraq

ARTICLE INFO

Article history:
Received 7 August 2016
Received in revised form 10 October 2016
Accepted 15 October 2016
Available online 17 October 2016

Keywords:
Flower-, rod- and nanoparticle-like ZnO
Growth mechanism
Photoluminescence
Photocatalysis

ABSTRACT

Using a simple combination of pulse laser ablation in liquid and hydrothermal (PLAL-H) approaches, we control the morphology of ZnO nanostructures (ZNSs) to determine the feasibility of their photocatalytic efficacy. These ZNSs are deposited on Si (100) substrates and two different morphologies are achieved. In this synergistic approach, PLAL synthesized NSs are used as a nutrient solution with different pH for further hydrothermal treatment at 110 °C under varying growth time (5, 30 and 60 min). Surface morphology, structure, composition, and optical characteristics of the prepared ZNSs are determined using FESEM, XRD, FTIR and Photoluminescence (PL) and UV–vis absorption measurements. The morphology revealed remarkable transformation from nanorods (NRs)/nanoflowers (NFs) (at pH 7.6) to nanoparticles (NPs)-like (at pH 10.5) structure. XRD patterns showed better polycrystallinity for NPs with enlarged band gap than NR/NF-like structures. Both PL and UV–vis spectral analysis of ZNPs exhibited higher surface area and deep level defects density dependent morphology, where the nutrient pH and growth time variation are found to play a significant role towards structural evolution. Furthermore, the photocatalytic activities of such ZNSs are evaluated via sunlight driven photo-degradation of methylene blue (MB) dye

1. Introduction
2. Description of Samples/Subjects
3. Research Procedure
4. Data Analysis
5. Conclusion
6. Description of Instruments Used

2. Experimental

2.1. Samples preparation

Different types of ZNSs-based films are synthesized under moderate growth conditions by combining PLAL method with hydrothermal method which is indigenously developed [40]. The growth process is comprised of two steps, where the colloidal ZnO nanomaterial is first prepared via PLAL method which is then used as nutrients for further hydrothermal treatment [40,41]. An analytical grade metallic Zn plate of 1 mm thick (purity 99.9% from Sigma Aldrich) is used as target material, which is cleaned in an ultrasonic ethanol bath for 30 min followed by thorough rinsing with deionized water to eliminate the pollutants. Subsequently, this Zn target is fixed at the bottom of a glass vessel filled with 40 mL of distilled water before being ablated using a pulsed Nd:YAG laser source (ablation wavelength of 532 nm, ablation time of 6 min, laser fluence of 12 mJ/cm^2, pulse duration of 8 ns and repetition rate of 10 Hz). The solution is continuously stirred during the ablation process to reduce the aggregation of ZNPs, which acts as an obstacle to the pulse irradiation path. At the end of laser ablation, a colloidal solution-based ZnO nanomaterial is obtained. Next, such PLAL generated nanomaterial is subjected to hydrothermal treatment for achieving ZNSs with diverse morphologies. The hydrothermal treatment is performed at 110 °C with varying nutrient pH in the range of 7.6–10.5 and growth time of 5, 30 and 60 min. Two types of ZNSs-based films including NRs/NFs and NPs-like morphologies are successfully grown on Si (100) substrates. The pH value of the nutrient solution (colloidal solution-based ZnO nanomaterial) is adjusted by adding the aqueous NH_3. The hydrothermal treatment is carried out to enhance the coverage and the growth rate of ZNSs-based films deposited on the Si substrates. Eventually, the prepared samples are cooled down to room temperature, followed by rinsing with deionized water and drying at 80 °C for 60 min.

2.2. Characterization

The surface morphology and the structural properties of as-

adjusted by adding the aqueous NH_3. The hydrothermal treatment is carried out to enhance the coverage and the growth rate of ZNSs-based films deposited on the Si substrates. Eventually, the prepared samples are cooled down to room temperature, followed by rinsing with deionized water and drying at 80 °C for 60 min.

2.2. Characterization

The surface morphology and the structural properties of as-grown ZNSs are determined using FESEM (Hitachi 4100 – SU8020) and XRD (Rigaku, 2100) measurements. The FTIR spectra in the wavenumber range of 400–4000 cm^{-1} are recorded using a PerkinElmer spectrum GX spectrophotometer. PL spectrum is captured using Perkin-Elmer, Luminescence LS55 spectrophotometer equipped with a Xenon lamp as excitation source (wavelength of 320 nm). The UV–vis absorption spectra in the wavelength range of 200–800 nm are measured using a PerkinElmer Lambda-2 spectrometer. All the characterizations are performed at room temperature (RT).

2.3. Photocatalytic activity evaluation

The photocatalytic activities of synthesized ZNSs (NPs, and NRs/NFs) under solar irradiation are evaluated via the photo-degradation of MB dye in an aqueous solution possess pH value (7.4). An irradiated area of 4.5 cm^2 is selected for both types of as

11

Thanks

Questions ?

12

How To Do a Research

How to write your thesis

CHAPTER 1

1. What is the Introduction?
2. Problem Statement?
3. Purpose of the Study?
4. Objectives of the Study?
5. Research Questions?
6. Significance of the Study?
7. Scope of the Study ?