



Lecture on Research Idea Generation

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Agenda

- ☐ What is Research
- ☐ Generation of research ideas
- ☐ Types of journal
- ☐ Benefits of open-access journals
- ☐ Peer-reviewing system
- ☐ Indexing of a journal
- ☐ Impact factor
- ☐ Some well known publishers

What is research

Re-search

Research is derived from
the Middle
French "*recherche*",
"to go about seeking"
Creative and systematic work to
increase the stock of knowledge



Purpose of research

Research questions

- Contribution to Science
- Contribution to Society

What? Why? How?

Generation of research ideas

1. Academic sources: Journal

Search Engines

- **Google Scholar:** Broad and easy to use. Use its "Cited by" and "Related articles" features to follow a trail of research.
- **PubMed / MEDLINE:** For life sciences and biomedicine.
- **IEEE Xplore:** For engineering, computer science, and electronics.
- **Scopus & Web of Science:** Multidisciplinary and powerful for tracking citations and identifying influential papers.
- **arXiv, bioRxiv, SSRN:** Preprint servers for cutting-edge, unpublished work. This is where you see what's happening *right now*.

Review Articles

- **What They Are:** Papers that summarize the current state of knowledge on a specific topic.
- **Why They're Great:** They provide a high-level overview and explicitly identify gaps in the literature. Look for sentences like "more research is needed to understand..."

Systematic Reviews and Meta-Analyses:

What They Are: Rigorous syntheses of all available evidence on a specific research question.

Why They're Great: They conclude with a definitive statement on what is known and, more importantly, what is *not* known, providing a clear roadmap for future primary research.

Dissertations and Theses

The final chapter almost always contains a detailed section on "Suggestions for Future Research." These are often efficient and well-justified ideas.

Journal Clubs and Research Group Meetings

Presenting and critiquing papers with peers is one of the best ways to spark new ideas. Different perspectives will highlight flaws, alternative interpretations, and extensions you hadn't considered.

Conferences, Seminars, and Workshops

Attending talks, especially on the periphery of your main interest, can lead to novel cross-disciplinary ideas. Pay attention to the Q&A session after a talk—the questions are often mini-research proposals.

Social Media & Academic Networking Sites

- **X (Twitter):** Follow leading researchers, institutions, and journals. They often share new findings and pose questions.
- **ResearchGate:** A platform to ask questions directly to authors and see what others are working on.
- **LinkedIn:** Follow industry labs and research centers to see applied problems.



Interdisciplinary Collaboration

Talk to researchers in other fields. A technique common in their field might be a revolution in yours. For example, a machine learning method from computer science could be applied to a biological dataset.



2. Real-World & Problem-Based Sources

1. News & Popular Science Media:

1. **Sources:** *The Economist, Wired, Science Daily, Nature News, Quanta Magazine.*
2. **Why:** They report on big, emerging challenges (e.g., climate change, AI ethics, public health crises) that require research solutions.

2. Policy & Government Reports:

1. **Sources:** Reports from organizations like the WHO, IPCC, UN, NIH, NSF, and national government departments.
2. **Why:** These bodies identify grand challenges and research priorities that are socially relevant and often well-funded.



3. Industry & Non-Profit Challenges:

- 1. Sources:** Kaggle (for data science), Innocentive, and challenges posted by companies or non-profits.
 - 2. Why:** They present concrete, real-world problems that need solving. Adapting an academic solution to a practical problem can be a significant research project.
- 

Types of journal- access basis

☐ Traditional or subscription based



☐ Open access



Why open-access?

- ❑ Increased citation and usage
- ❑ Greater public engagement
- ❑ Faster impact
- ❑ Broader collaboration
- ❑ Increased interdisciplinary interaction



Peer-Reviewing System

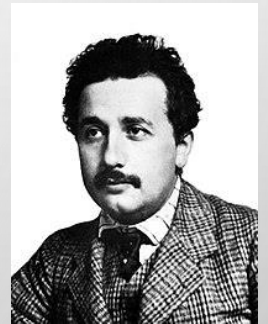
Henry Oldenburg, 1665

Philosophical Transaction of Royal Society



End of nineteenth century peer reviewed by Editor-in-Chief

Annus Mirabilis Published in *Annalen der Physik* in 1905 Reviewed by Max Planck and Wilhelm Wein.



Albert Einstein

Nature started

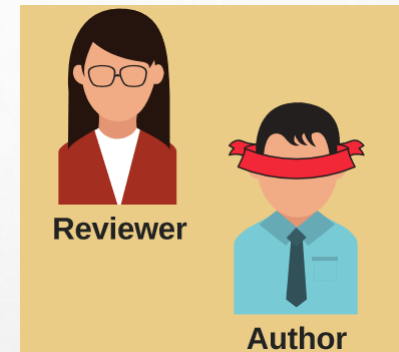
in 1967
External peer reviewing became popular in twentieth century

Peer- Reviewing System

Types of peer review

1. Single blind peer review

Reviewers know the authors but authors are unaware about the reviewers..



2. Double blind peer review

Both the authors and reviewers are unaware of each other.

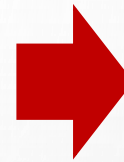


Peer- Reviewing System

Types of peer review

3. Open peer review

Both the authors and reviewers know each other.



4. Post publication peer review

Commenting about the published manuscript.

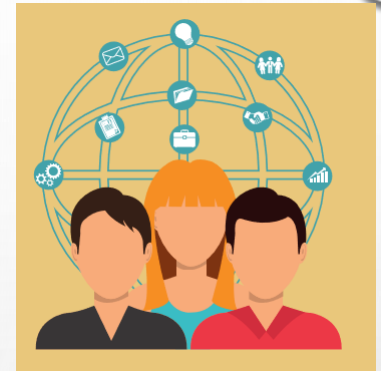
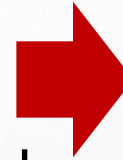


Peer- Reviewing System

Types of peer review

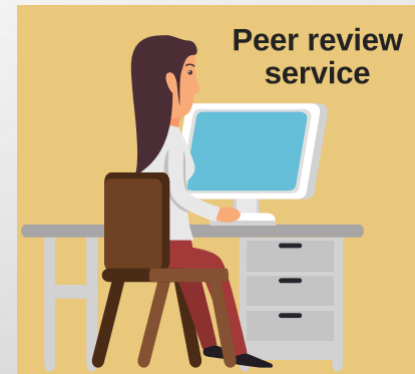
5. Collaborative peer review

Journal provided platform, authors and reviewers can discuss and improve the paper.



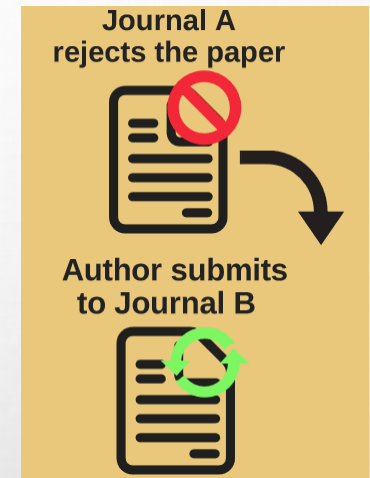
6. Third party peer review

Independent peer reviewing service. No connection with any journal, no guarantee of acceptance also.



7. Cascading peer review

Rejected manuscript suggested to other journal.



Indexing of a journal

Indexing means journal is indexed
in various database

Journal Citation Reports (JCR)
Web of Science

1900-present

Science , Social Science, Arts, Humanities

Owner: Clarivate Analytics

No. of records: 90 million+

WEB OF SCIENCE™

Indexing of a journal

Science Citation Index (SCI)

Science, Medicine and Technology

2000-present

Producer: Clarivate Analytics

No. of records: 8500 journals, 150 disciplines



Scopus Index

Scopus®

Life Sciences, Social Sciences, Physical Sciences, Health Sciences

2004-present

Provider: Elsevier

No. of records: 69 million

Impact Factor (IF)

- Measure of average number of citation

First calculated in 1975 for
Journal Citation Reports



Eugene Eli Garfield

$$IF_y = \frac{Citation_{y-1} + Citation_{y-2}}{Publications_{y-1} + Publications_{y-2}}$$

For example, IF of *Nature* in 2014 is 41.456

$$IF_{2014} = \frac{Citation_{2013} + Citation_{2012}}{Publications_{2013} + Publications_{2012}} = \frac{29753 + 41924}{860 + 869} = 41.456$$

Controversy with IF

Generally higher IF indicates high rank of a journal

Radiation Physics and Chemistry → 1.369

Coloration Technology → 1.168

Textile Research Journal → 1.540

Journal of Industrial Textiles → 1.369

IF is the collective journal metric not individual

Authorship in a Scientific Manuscript

American Chemical Society (ACS)

"share responsibility and accountability for the results"

Order of author in list

Mathematics → alphabetically

Engineering → alphabetically

Biology → Group leader name last

Computer Science → Group leader first

Some well-known publishers

- ☐ American Association for the Advancement of **Science**
- ☐ Nature
- ☐ American Chemical Society (ACS)
- ☐ Royal Society of Chemistry (RSC)

Some well-known publishers

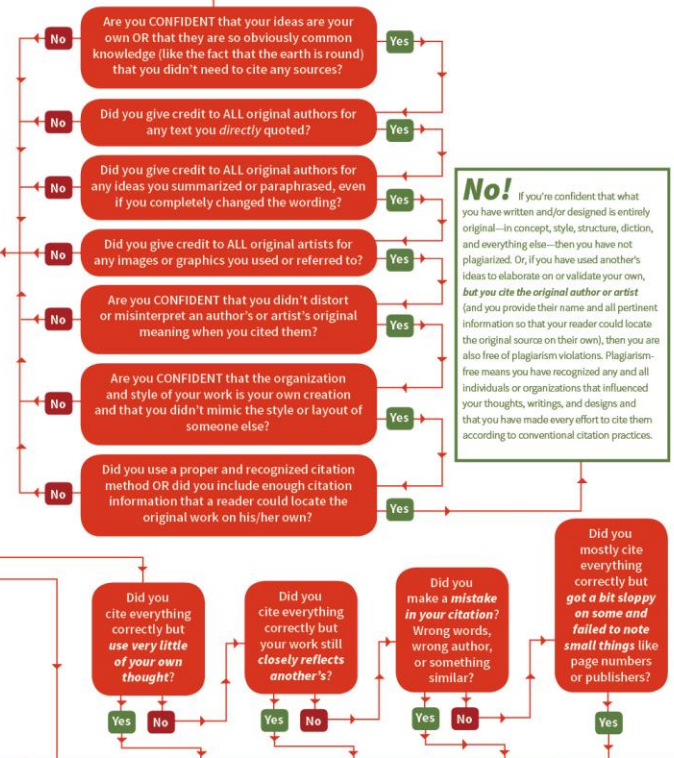
- ☐ John Wiley and Sons
- ☐ Elsevier
- ☐ Springer
- ☐ Taylor and Francis
- ☐ SAGE



Did I Plagiarize?

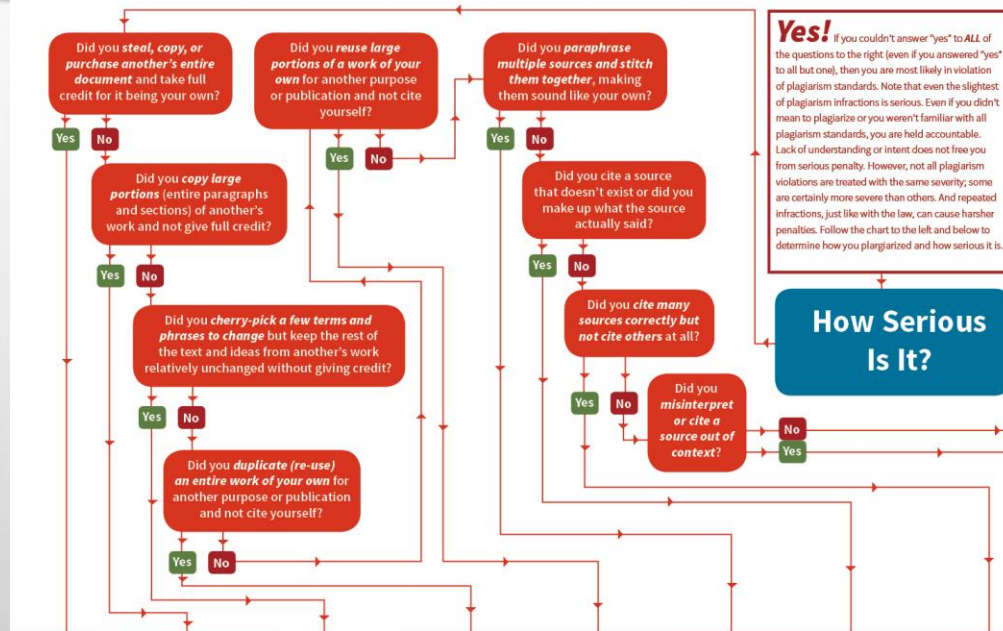
The Types and Severity of Plagiarism Violations

Did I Plagiarize?



Yes! If you couldn't answer "yes" to **ALL** of the questions to the right (even if you answered "yes" to all but one), then you are most likely in violation of plagiarism standards. Note that even the slightest of plagiarism infractions is serious. Even if you didn't mean to plagiarize or you weren't familiar with all plagiarism standards, you are held accountable. Lack of understanding or intent does not free you from serious penalty. However, not all plagiarism violations are treated with the same severity; some are certainly more severe than others. And repeated infractions, just like with the law, can cause harsher penalties. Follow the chart to the left and below to determine how you plagiarized and how serious it is.

How Serious Is It?



Plagiarism Severity Meter: How Serious Is the Violation?

TheVisualCommunicationGuy.com | 2014

References: <http://www.plagiarism.org/plagiarism-101/types-of-plagiarism/>

<http://thevisualcommunicationguy.com>

Thesis or Research Writing

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Purpose of scientific writings

- ❑ Express information efficiently
- ❖ Responsibility of the writer to make the writing easy;
- ❖ Don't put forward the readers in doubt;
- ❖ No personal history-readers want the info.
- ❖ Organization and sequence of presentation flows like story-**not novel !**



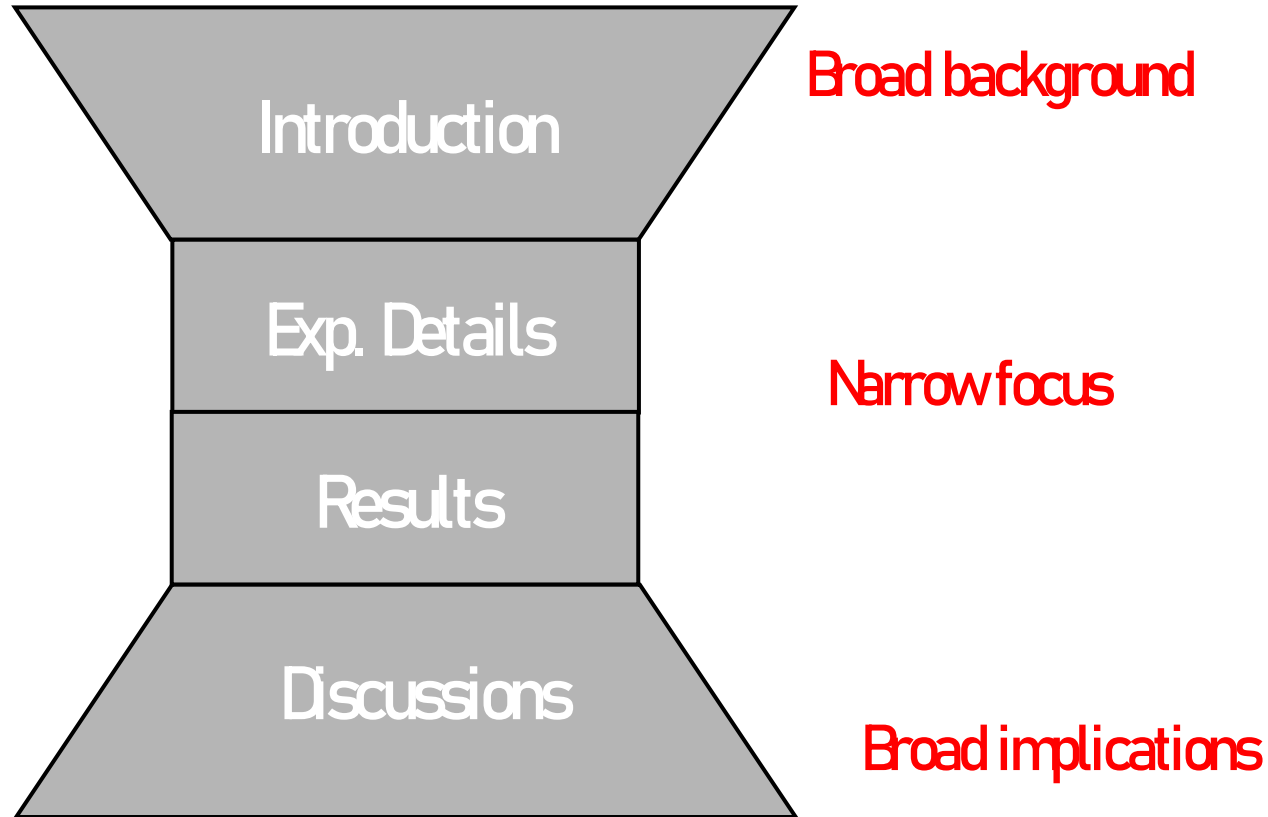
Target readers ?

1st Year undergraduate student

Structure of the thesis

Section	Contain/mean to
Abstract	Summarizes the work
Introduction	What are you talking about?
Experimental details	What did you do?
Results	What did you get?
Discussion	So what?
Conclusions	Key points, you want readers to remember

Trapezoidal organization



Introduction

Identify the knowledge gap



Explain why it needs to be filled



Summarize how this study attempt to fill that gap

Structure of Introduction



Different sections of Introduction

- ☐ General background
- ☐ Literature review
- ☐ Research gap
- ☐ Objectives /statement of purpose

Hardest part: Introduction and discussion!!

□ General background Information

- Give a strong statement that reflects your research subject area.
- State the problems explored in your study.
- Use keywords from your title.
- Don't state obvious or broad facts about your topic.
- Highly relevant information is always helpful.
- Cite all the sources of references.

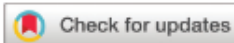
1. General background

□ Purpose

- Place paper in broad context
- Bring reader up to read

□ Style

- Should be understandable by every reader
- Defines topic
- Short (~3-5 sentence)
- Usually very general



Cite this: DOI: 10.1039/c8gc01814f

Environmentally friendly dyeing of cotton in an ethanol–water mixture with excellent exhaustion

Liangjun Xia,^a Aming Wang,^{†a,b} Chunhua Zhang,^a Yang Liu,^a Heng Guo,^c Cailing Ding,^d Yunli Wang^{*a,c,e} and Weilin Xu^{*a}

Conventional cotton dyeing methods rely on high salt concentrations and consume large amounts of water. To decrease the ecological impact of the textile industry, the development of a green and sustainable dyeing method for cotton fibres is essential. In the present work, ethanol was used to reduce the amounts of salt and water required for cotton dyeing. Cotton yarns were pretreated with alkali and then dyed with six reactive dyes in a 90 : 10 (v/v) ethanol–water mixture. Using various techniques, including transmission electron microscopy, the effects of ethanol on the particle size and zeta potential of the reactive dyes were examined in detail. Compared with conventionally dyed samples, the cotton yarns dyed in the ethanol–water system using the investigated reactive dyes exhibited enhanced exhaustion, total fixation, and colour strength in the absence of salt. Industrial-scale cotton bobbins produced using the developed method showed commercially acceptable levelness and reproducibility. This method affords a substantial reduction in eutrophication potential and wastewater effluent load, which would considerably improve the environmental cost of cotton dyeing processes. This eco-friendly dyeing process has considerable potential for application to a broad range of natural fibres.

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rsc.li/greenchem

1. Introduction

Among the varied fibres available in nature, cotton has gained much popularity owing to its desirable properties, such as high hygroscopicity and air permeability, as well as being comfortable to wear and easy to dye.^{1,2} Generally, reactive dyes with soluble sulphonate groups are used for the coloration of cotton fibres.^{3,4} However, owing to the dissociation of hydroxyl groups on cotton fibres, slightly negative surface charges are easily produced when cotton comes in contact with water, leading to electrostatic repulsion between the dye and the fibres.^{5,6} Accordingly, huge amounts of salts (30–100 g L^{−1}) such as sodium sulfate (Na₂SO₄) and sodium chloride (NaCl) are required in dyeing processes to suppress repulsion, thus improving the affinity of the reactive dye towards the fibres.^{7,8} It is common knowledge that discharging the dyeing effluent with a high salt content may cause pipeline blockages, dust

pollution, and soil saline-alkalization. Furthermore, as most commercial reactive dyes can only be dissolved in aqueous solution, conventional reactive dyeing of cotton fibres is carried out in water, resulting in high water consumption.^{9–11} Water is widely regarded as the most important natural resource.¹² Owing to the uneven distribution of fresh water, more than two billion people live in highly water-stressed regions and this number is increasing remarkably.¹³

According to the investigation of Arivithamani¹⁴ and Fernandez *et al.*,¹⁵ dyeing 1 kg of cotton fabrics consumes 120–200 L of water, 0.8–1.0 kg of salt, and 0.2–0.3 kg of alkali. Therefore, the dyeing process generates chemically complex effluents that are characterized by high salinity, high alkalinity, and a deep colour. Discharge of these effluents causes environmental pollution.¹⁶ Although treatment of effluents from dyeing processes can be achieved using various techniques, including membrane filtration,¹⁷ photocatalytic degradation,¹⁸ activated carbon adsorption,¹⁹ and biological treatment,²⁰ it is difficult to meet environmental discharge requirements using these methods.²¹

^aState Key Laboratory of New Textile Materials and Advanced Processing Technologies, Wuhan Textile University, Wuhan 430200, P. R. China.

□ General background Information

1. Introduction

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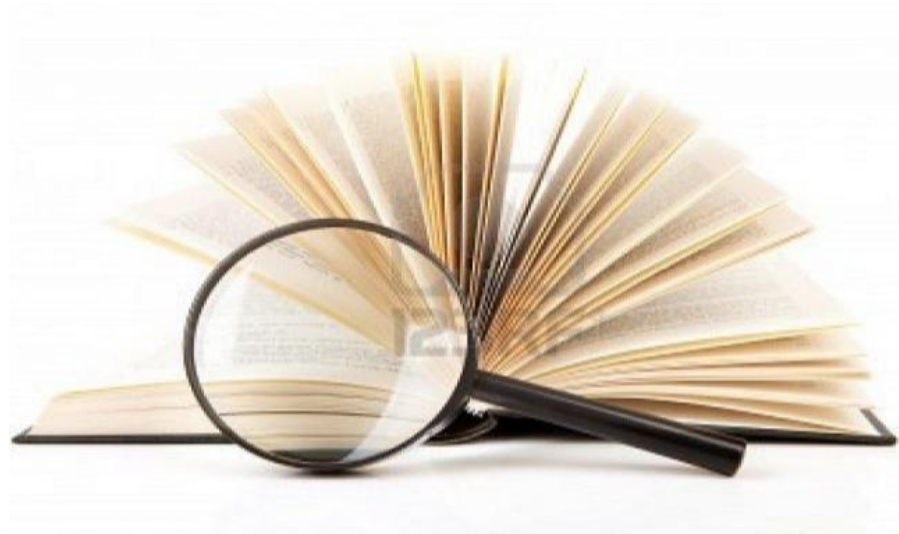
□ General background Information cont..

pollution, and soil saline-alkalization. Furthermore, as most commercial reactive dyes can only be dissolved in aqueous solution, conventional reactive dyeing of cotton fibres is carried out in water, resulting in high water consumption.^{9–11} Water is widely regarded as the most important natural resource.¹² Owing to the uneven distribution of fresh water, more than two billion people live in highly water-stressed regions and this number is increasing remarkably.¹³

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❖ Literature review

An objective, concise, critical summary of published research literature relevant to topic being researched



Literature Review

Literature Review Steps

Richard E. West, Brigham Young University

Problem Statement

2-3 page summary of the gap in the literature, your review question, and why you think it matters to the audience you have chosen.

1. Define the problem



2. Literature Searching

Methods Section

A detailed description of your review methods. Usually 1-2 pages.

3. Summarizing

Annotated Bibliography



Detailed annotations and critiques of 3 sources. You will have more, but will practice the skill with 3.

4. Defining the argument

Simple Outline

A simple outline is usually 1-2 pages, focusing on broad ideas that are just emerging and what your discovery and advocacy arguments will be.

Extended Outline

An extended outline of 5-7 pages showcases your logical reasoning and the overall flow of your paper

5. Detailed Argument



6. Drafting

Seek feedback from experts, semi-experts, and non-experts. For us this is:

- **Draft 1** to peers (15 pages)
- **Draft 2** to Rick (20 pages)
- **Draft 3** to peers (25 pages)
- **Final version** to Rick

Communicate through visuals, publishing your paper, and presentations with visual storytelling.

7. Communicate your findings!



❖ Literature review

□ Purpose

- Place paper in specific context
- Stating what was done previously (others people works)

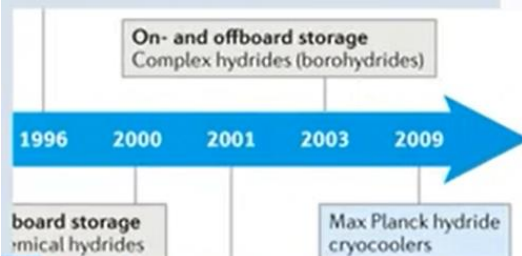
Organization–Citation order

- Approach (end with that closest to yours)
- Relevance (end with most relevant)
- Chronologically (end with the latest)

A good literature review-----



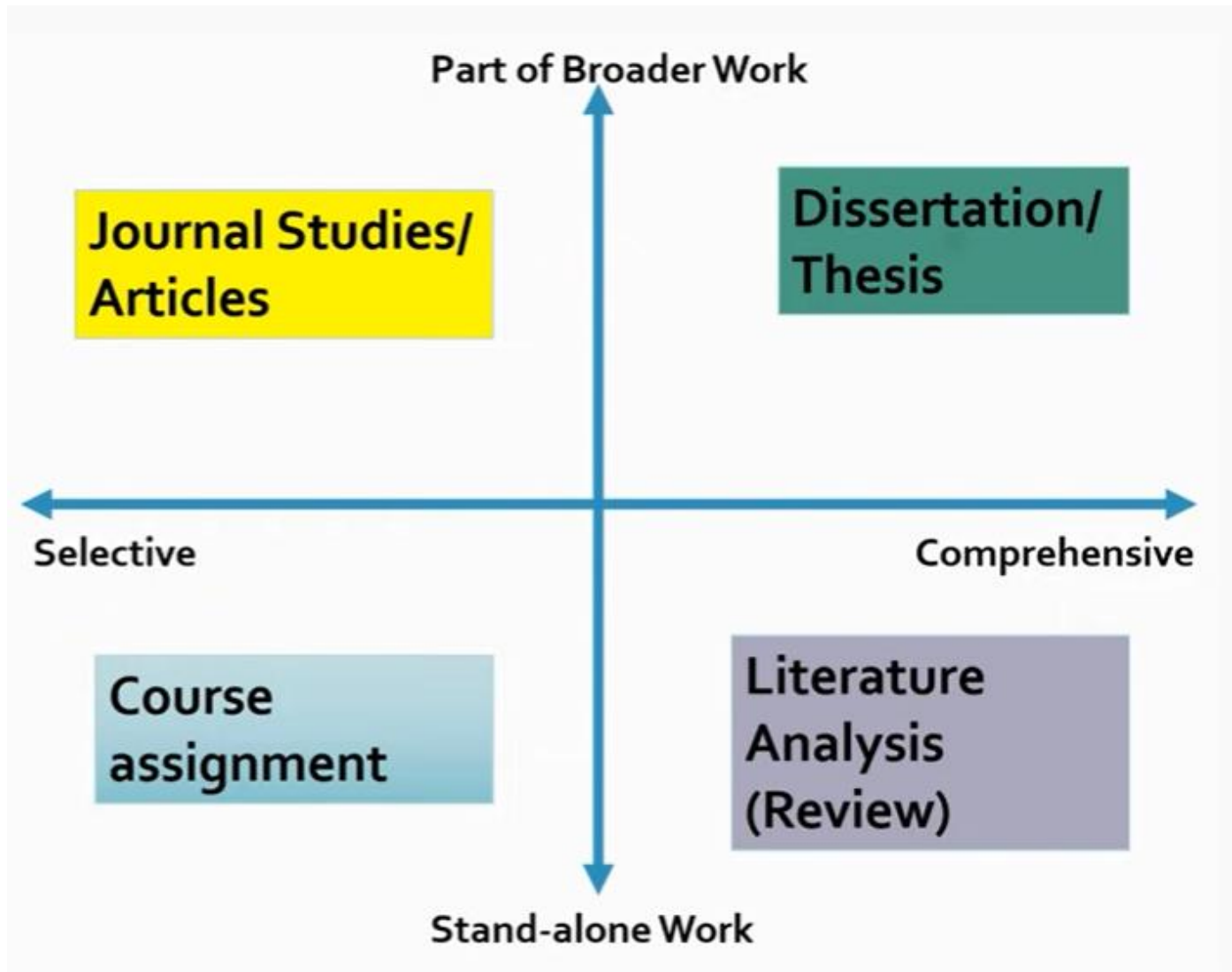
- Order articles and books to focus on unresolved **debates, inconsistencies, tensions, and questions** in a research field
- Summarize the **most relevant** important aspects of scientific literature related to your area of research
- Synthesize **past and current research** on the topic and show how your research fits in



What is included in a literature review-----

- ✓ Historical background for research
- ✓ Current research context—
questions, issues, debates, etc.
- ✓ Relevant theories and concepts
- ✓ Definition of relevant terminology
- ✓ Research your work expands on
and/or gaps that your work fills
- ✓ Supporting evidence for a practical
problem/issue

Types of literature review



Types of literature review

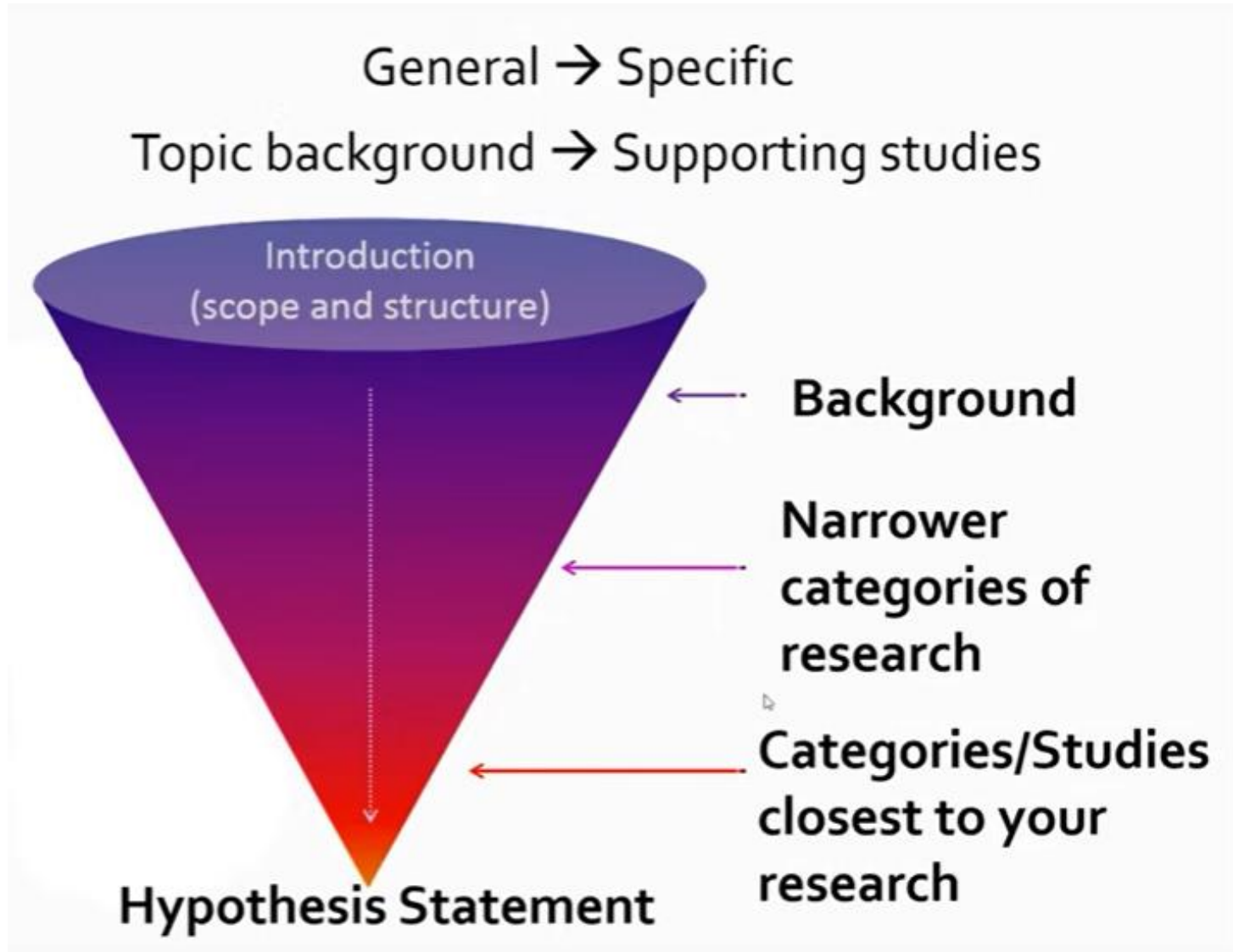
Journal Studies/ Articles

- Introduce research related to this specific study (Introduction section)
- Shorter than stand-alone reviews
- Narrower in scope
- Often used to set research precedent and support theory or methods

Literature Review (stand-alone article)

- Presents and analyzes many relevant texts to explain an approach or theory
- Broader in scope
- More extended analysis
- All sections refer to literature rather than to one current study

Structure of a literature review of an article



Steps in writing literature review----

Step 1:

Choose a TOPIC—
focus and explore
this topic

Topic you are
familiar with and
interested in

Topics that are
current, well-
established, and
have ample research
for review

Topic your readers
and other
researchers will be
interested in



Step 2:

RESEARCH—
collect scholarly
information and
sources

Scholarly articles



Books



Conference papers



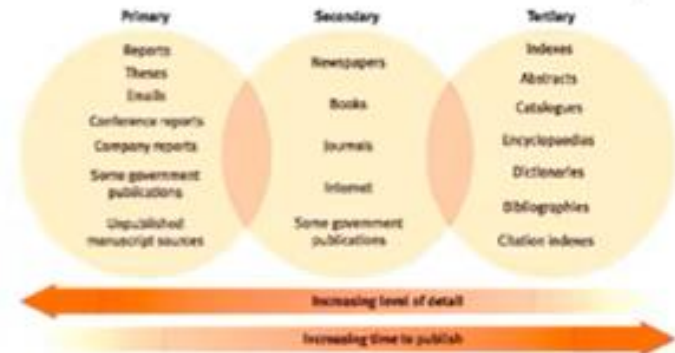
Dissertations/Theses



Step 3:

ANALYZE the
network of
information and
SELECT works

Use thought maps and charts to
identify intersections of the research
and outline important categories



**Select the material most
useful to your review**



Step 4:

DESCRIBE and
SUMMARIZE
each selected
article

Determine 2-3 important concepts or findings discussed in each text; take notes of important aspects



Example: A Study of Heart Disease

- A. Atherosclerosis
- B. Hypertension
- C. Obesity

→ “Yang’s (1995) longitudinal study of obese patients attempts to measure the effects of chronic hypertension on atherosclerosis...”

Step 5 :

DEMONSTRATE
how concepts in the
literature relate to
results of study;
ESTABLISH how the
literature is
connected

For intro to a journal article:

- Identify the missing parts in previous studies that your study addresses.
- Highlight concepts that support your hypothesis, methods, results, or conclusions.

For a stand-alone literature review:

- Highlight the concepts in each article and show how they strengthen a hypothesis or show a pattern.
- Identify unaddressed issues in previous studies.
- Identify what is accurate and what is out of scope within these works.

How long should a literature review be?

- Determined by the number of sources reviewed and concepts explored
- Stand-alone review: 2-3 pages – entire book
Introducing a study: 2-4 paragraphs

How many sources should I review?

- Determined by the scope of the topic, the depth of analysis, and the extent of consensus or disagreement in this area
- Stand-alone review: 5-15 – 30+ (book)
Introducing a study: < 5

Tips for writing literature review



Clearly define your topic and audience first



Read many literature reviews and articles



Focus on more current sources



Take notes while reading literature

❑ Statement of purpose

Research gap indicates what wasn't done previously,
shows that your work is new!

Gap sentence should ideally be

-1 sentence long

-Must be always negative

- State your purpose and give a clear hypothesis of objective of the study.
- Hypothesis is very short. Usually extends with 1-2 sentences
- Tell here what useful knowledge will be gained

□ Research gap

Amato *et al.*⁴⁸ found that the adsorption isotherms of a direct dye on cotton fibres in ethanol–water mixtures were affected by the concentration of ethanol. The dyeing properties of cotton with pigments from an ethanol–water system were determined by Jiang *et al.*,⁴⁹ showing that the dyeing depth of cotton fabrics was initially enhanced and then decreased with increasing ethanol content. In another study, Yakubu *et al.*⁵⁰ indicated that the pretreatment of cotton fibres with ethanol had a positive influence on dye uptake. Dyeing of cotton yarns with reactive dyes using ethanol as an auxiliary agent at low content was studied, and an enhancement in the uptake of reactive dyes was observed.⁵¹ This phenomenon was more strongly suggested by the work of Islam,⁵² who explored the relationship between low concentrations of ethanol and the uptake of reactive dyes. However, the influence of high contents of ethanol on the dyeing properties of cotton fibres with reactive dyes has not been examined.

Statement of purpose/ objectives

- ☐ Immediately follows the gap sentence
- ☐ State objectives of the research which is basically to fill the research gap
- ☐ Should be concise, precise, explicit and focused

Objective provides the background information so that readers can understand or appreciate the work.

□ Statement of purpose

Therefore, in the present work, a 'green' ethanol-water mixture was proposed for reactive dyeing of cotton fibres to minimize the consumption of salt and water simultaneously. Swelling of cotton fibres with an alkali aqueous solution has been shown to be an effective approach to address the low solubility of alkalis, such as sodium hydroxide and sodium carbonate, in organic solvents.^{34,37,53,54} Thus, our new approach incorporates the preswelling of cotton fibres with an alkali aqueous solution. Accordingly, cotton fibres were first pretreated with alkali and then dyed in an ethanol-water dye liquor containing a relatively high concentration of ethanol. This study was undertaken with the aim of determining an environmentally friendly method for promoting the exhaustion of reactive dyes on cotton fibres without the addition of salt.

Experimental details

Sufficiently details so that the work can be duplicated elsewhere

- ❑ Starting with apparatus—standard or nonstandard

- ❑ Description should in past tense

- ❑ Voice

Human agent: Passive preferred: *Fastness was measured (by experimenter)*

Instrument agent: Active preferred: *The generator produced series of voltage*

Results

Contains the basic answer of the questions

What did I get or What did I observe?

Typically most results given in table or figures
and text revolves around them

Three types of sentences in text–

Location sentences: indicates which tables or figures contain particular results.

Location sentence can be in present tense

Presentation sentences: present the most important results.

Simple past tense

Comment sentences: Comment on results –present tense

Results (contd.)

Type of sentences	Examples
Location	The correlation parameters as a function of distance is shown in fig. 3.
Presentation	It may be seen that the correlation decreased steeply with distance and becomes negligible after 5 cm
Comment	This results differ significantly from those observed with conventional jets.

Discussions

1. Reference to the main purpose
2. Review of the most important findings
3. Limitations and justifications
4. Comparisons

General statements

5. Implications and generalizations
6. Recommendation for future work or Practical applications

Abstract

A abstract is the summary of the entire research

A short and concise summary of a longer work such as dissertation or research paper

An abstract explain in brief the longer reports

An abstract is very important for research paper because researcher first come to the abstract

It hold the attention whether the readers will read the whole research

Abstract (contd.)

The abstract should be informative not indicative

Indicative: The voltage as a function of temperature was measured.

Informative: It was found that the voltage decreased as a function of the temperature reaching a saturation value 30mV

If you got many results: Pick important one

All are equally important: Pick any one of them

The abstract should stand alone no references

Abbreviation– not preferred

Abstract

- Write draft before writing body of the thesis
- Rewrite when you finished

Summarize in 1-2 sentences of the following

1. Background
2. Objective
3. Methodology
4. Most important results
5. Conclusions

Features of an abstract

❑ Abstract reflects all the major section of the report

It will redirect the

- Introduction
- Materials and methods
- Results and discussion
- Conclusions

❑ Abstract is concise or to the point

- No unnecessary or extra things mentioned in the abstract
- The word limit of an abstract is 150-250 word in general

❑ Abstract is self contained

- No supporting or supplement is needed
- The abstract is complete with itself

❑ Abstract is written last

- Once you finish your entire work you know the key points of the topic

Component of an abstract

□ Introduction

- Motivation or background behind the project
- Why is this research is important
- How this will create an impact to science or society

Explain all in 1-2 lines at the best

□ Problem statement

- Mention the research gap which was not covered by the previous researches
- The purpose or objectives of your research

Explain all in 1-2 lines at the best

□ Procedure/ method

- Overview of the whole process not details
- Don't describe step by step

Explain all in 1-2 lines at the best

□ Results and discussion

- Key results and discussion in brief
- No supporting or additional information required

Explain all in 1-2 lines at the best



Cite this: DOI: 10.1039/c8gc01814f

Environmentally friendly dyeing of cotton in an ethanol–water mixture with excellent exhaustion

Liangjun Xia,^{†a,b} Aming Wang,^{†a} Chunhua Zhang,^a Yang Liu,^a Heng Guo,^c Cailing Ding,^d Yunli Wang^{*,a,c,e} and Weilin Xu^{*a}

Conventional cotton dyeing methods rely on high salt concentrations and consume large amounts of water. To decrease the ecological impact of the textile industry, the development of a green and sustainable dyeing method for cotton fibres is essential. In the present work, ethanol was used to reduce the amounts of salt and water required for cotton dyeing. Cotton yarns were pretreated with alkali and then dyed with six reactive dyes in a 90 : 10 (v/v) ethanol–water mixture. Using various techniques, including transmission electron microscopy, the effects of ethanol on the particle size and zeta potential of the reactive dyes were examined in detail. Compared with conventionally dyed samples, the cotton yarns dyed in the ethanol–water system using the investigated reactive dyes exhibited enhanced exhaustion, total fixation, and colour strength in the absence of salt. Industrial-scale cotton bobbins produced using the developed method showed commercially acceptable levelness and reproducibility. This method affords a substantial reduction in eutrophication potential and wastewater effluent load, which would considerably improve the environmental cost of cotton dyeing processes. This eco-friendly dyeing process has considerable potential for application to a broad range of natural fibres.

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1. Introduction

- Motivation or background behind the project
- Why is this research is important
- How this will create an impact to science or society

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- Mention the research gap which was not covered by the previous researches
- The purpose or objectives of your research

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3. Methodology

- Overview of the whole process not details
- Don't describe step by step

Using various techniques, including transmission electron microscopy, the effects of ethanol on the particle size and zeta potential of the reactive dyes were examined in detail. Compared with conventionally dyed samples, the cotton yarns

4. Results and discussion

- Key results and discussion in brief
- No supporting or additional information required

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5. Conclusion

- Broader impact of the study
- How it added value to research field
- Never exaggerate the advantages—it will reduce the importance

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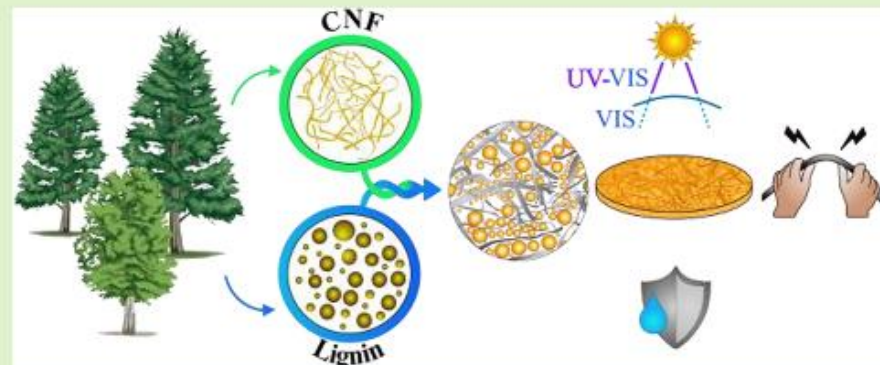
Strong, Ductile, and Waterproof Cellulose Nanofibril Composite Films with Colloidal Lignin Particles

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Supporting Information

ABSTRACT: Brittleness has hindered commercialization of cellulose nanofibril (CNF) films. The use of synthetic polymers and plasticizers is a known detour that impairs biodegradability and carbon footprint of the product. Herein, we utilize a variety of softwood Kraft lignin morphologies to obtain strong and ductile CNF nanocomposite films. An optimum 10 wt % content of colloidal lignin particles (CLPs) produced films with nearly double the toughness compared to a CNF film without lignin. CLPs rendered the films waterproof, provided antioxidant activity and UV-shielding with better visible light transmittance than obtained with irregular lignin aggregates. We conclude based on electron microscopy, dynamic water sorption analysis, and tp-DSC that homogeneously distributed CLPs act as ball bearing lubricating and stress transferring agents in the CNF matrix. Overall, our results open new avenues for the utilization of lignin nanoparticles in biopolymer composites equipped with versatile functionalities for applications in food packaging, water purification, and biomedicine.



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Conclusions

Concluding paragraph of the discussion

- Short 1-2 paragraph in a paper 1-2 pages in thesis
- Don't repeat the objective or methodology
- No new information

Summarize the most important results and their implications

Must include the answer of the research questions

□ Conclusion

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Explain all in 1-2 lines at the best

Component of conclusions

- Describe broader context
- Summarize the main finding
- Interpret results with broader context
- Point out limitations or alternate interpretation of your research
- Describe implications of other systems
- List practical applications
- Suggest further research areas

4. Conclusions

In summary, a green and sustainable reactive dyeing technology was developed using ethanol. Cotton fibres treated with alkali were dyed successfully with the investigated reactive dyes in an ethanol–water mixture. The dyeing efficiency of the investigated dyes was enhanced significantly by increasing the ethanol content, with an optimal ethanol to water ratio of 90/10 (v/v). Furthermore, the mean particle size of the investigated dyes increased and the maximum absorption wavelength of the dye solutions changed owing to the addition of ethanol, which was attributed to the aggregation behaviour of the reactive dyes in the ethanol–water mixture. This phenomenon was further confirmed by TEM analysis. The developed salt-free approach realized excellent exhaustion and a high total fixation of the investigated reactive dyes. Images of the dyeing effluents revealed that this enhanced dye utilization reduces the effluent load. Moreover, the samples dyed in the ethanol–water mixture had the same tone and chromaticity as the conventionally dyed samples, as well as exhibited excellent washing fastness. Cross-sections of the cotton yarns confirmed that the reactive dyes penetrated the cotton fibres. Dyeing of cotton bobbins on the industrial scale revealed that satisfactory commercial dyeing with a uniform and bright colour could be achieved in the ethanol–water mixture. Therefore, this dyeing system is a highly viable and green alternative to conventional reactive dyeing methods for cotton fibres. Future studies will address the reuse of the ethanol–water mixture in reactive dyeing by methods, including azeotropic distillation, adsorption separation, and direct reuse.

Title

- Construct the title beginning of the research
- Reevaluate whether the title represent the work after you have done

Title should be-----

- ☐ Short < 2 lines, 1 is better
- ☐ Accurately express the new results presented
- ☐ No abbreviation

