

SEMESTER LESSON PLAN



LESSON PLAN DEVELOPER(S):

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**AQUACULTURE MASTER'S PROGRAM
FACULTY OF FISHERIES AND MARINE SCIENCE
UNIVERSITAS BRAWIJAYA
2021**

SEMESTER LESSON PLAN

1. Course Identity

Study Program	: Aquaculture Master's Program
Course	: Bioindicator and Toxicology in Water
Course Code	: PIB 8203
Course Group	: Aquatic Environment
Credit	: 3
Degree	: Master's Degree
Semester	: 2
Pre-requisite	: <i>(if any, write down the course code)</i>
Status	: Compulsory
Lecturers' names and codes:	Prof. Ir. Yenni Risjani, DEA, Ph.D. Dr. Asus Maizar Suryanto, S.pi., MP. Dr. Yuni Kilawati, S.Pi, M.Si. Dr. Ir. Umi Zakiyah, M.Si. Dr. Ir. Dwi Setijawati, M.Kes. Dr. Uun Yanuhar, S.Pi., M.Si. Dr. Ir. Muhammad Musa, MS. Dr. Ir. Mohammad Mahmudi, MS. Dr. Ir. Titik Dwi Sulistiyati, MP.

2. Course Description

This course systematically discusses the organism mechanism in order to evaluate changes in aquatic environment quality. The presence of these organisms specifically reflects the ecosystem condition and environment quality. This course also describes changes in the quality of the aquatic environment due to toxic substances that pollute the waters and the impacts that include problems in growth, development, reproduction, pharmacokinetic responses, pathology, biochemistry, physiology and behavior of organisms.

3. Program Learning Outcomes (PLO)

1. Being able to develop the existing concept and create new knowledge in the field of aquaculture (CPL 2).

4. Course Learning Outcomes

After completing this course, students will be able to:

1. understand and explain bioindicators and aquatic toxicology in general and comprehend the levels of aquatic ecotoxicology.
2. comprehend toxicological agents and their effects in waters, understand the metallothionein biomarkers, fish hematology, physical and chemical pollution in waters , xenobiotic and microplastic materials in waters, and understand fish and invertebrates as bioindicators.
3. understand the functions of mentoring bioindicators and biomolecules and identify the internal and external responses of bioindicator organisms, as well as the mechanism of molecular toxicity.

5. Lesson Plan

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
1	1.1 Accuracy in explaining the functions of aquatic bioindicators 1.2 Accuracy in explaining bioindicators and aquatic toxicology as a discipline in aquatic resource management.	- introduction to bioindicators and aquatic toxicology, - the roles and benefits of bioindicators and aquatic toxicology.	• Lecture (S)	2	Note taking (A) Working on assignments (A)	Criteria: Scoring Guideline Non-test: Summarizing the lecture materials (A)	1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i> . American Fisheries Society. 2) Boyd, 1982. <i>Water Quality Management for pond Fish Culture</i> . Amsterdam. 3) Boyd, 1990. <i>Water Quality in Pond for Aquaculture</i> . Amsterdam 4) Boyd, 2011. <i>Interpretation of pH, acidity and alkalinity in Aquaculture and</i>

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
							<p>fisheries. North American.</p> <p>5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms.</p>
2	1.3 Accuracy in explaining the definition of ecotoxicology and describing ecotoxicological levels	- Definition of ecotoxicology, ecotoxicology at the cellular, molecular, tissue and individual levels of organisms.	<ul style="list-style-type: none"> • Lecture (S) • Assignment (A) & Presentation (S) 	2	<p>Note taking (A)</p> <p>Working on assignments (A)</p>	<p>Criteria: Scoring Guideline</p> <p>Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)</p>	<ol style="list-style-type: none"> 1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i>. American Fisheries Society. 2) Boyd, 1982. <i>Water Quality Management for pond Fish Culture</i>. Amsterdam. 3) Boyd, 1990. <i>Water Quality in Pond for Aquaculture</i>. Amsterdam 4) Boyd, 2011. <i>Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries</i>. North American. 5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
							selected aquatic organisms.
3	2.1 Accuracy in describing different toxicological causative agents and their effects on the waters and aquatic organisms.	- Definition, different toxicological causative agents, impacts of toxicology on the waters and aquatic organisms in it.	<ul style="list-style-type: none"> • Lecture (S) • Assignment (A) & Presentation (S) 	2	Note taking (A) Working on assignments (A)	Criteria: Scoring Guidelines Non-test: - Summarizing the materials (A) - group or independent presentation (S)	1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i> . American Fisheries Society. 2) Boyd, 1982. <i>Water Quality Management for pond Fish Culture</i> . Amsterdam. 3) Boyd, 1990. <i>Water Quality in Pond for Aquaculture</i> . Amsterdam 4) Boyd, 2011. <i>Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries</i> . North American. 5) Kienle, 2009. <i>Toxicity of environmental chemicals and their mixtures to selected aquatic organisms</i> .
4	2.2 Accuracy in explaining the sources of pollutants in the waters.	- Determination and explanation on the sources and polluting mechanisms in the waters	<ul style="list-style-type: none"> • quiz 1 (S) • Lecture (S) • Assignment (A) & 	2	Note taking (A) Working on assignments (A)	Criteria: Scoring Guidelines Non-test:	1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i> . American

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
			Presentation (S)			<ul style="list-style-type: none"> - Summarizing the lecture materials (A) - group or independent presentation (S) 	<ul style="list-style-type: none"> 1) Fisheries Society. 2) Boyd, 1982. Water Quality Management for pond Fish Culture. Amsterdam. 3) Boyd, 1990. Water Quality in Pond for Aquaculture. Amsterdam 4) Boyd, 2011. Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries. North American. 5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms.
5	2.3 Accuracy in describing aquatic organisms as aquatic bioindicators	- Fish, bivalves and invertebrates as aquatic bioindicators	<ul style="list-style-type: none"> • Lecture (S) • Assignment (A) & Presentation (S) 	2	Note taking (A) Working on assignments (A)	<p>Criteria: Scoring Guidelines</p> <p>Non-test:</p> <ul style="list-style-type: none"> - Summarizing the lecture materials (A) - group or independent presentation (S) 	<ul style="list-style-type: none"> 1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i>. American Fisheries Society. 2) Boyd, 1982. Water Quality Management for pond Fish Culture. Amsterdam. 3) Boyd, 1990. Water

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
							<p>Quality in Pond for Aquaculture. Amsterdam</p> <p>4) Boyd, 2011. Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries. North American.</p> <p>5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms.</p>
6	2.4 Accuracy in explaining aquatic toxicological biomarkers	- Toxicological biomarkers in waters	<ul style="list-style-type: none"> • Lecture (S) • Lecture (S) • Assignment (A) & Presentation (S) 	2	<p>Note taking (A)</p> <p>Working on assignments (A)</p>	<p>Criteria: Scoring Guidelines</p> <p>Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)</p>	<p>1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i>. American Fisheries Society.</p> <p>2) Boyd, 1982. Water Quality Management for pond Fish Culture. Amsterdam.</p> <p>3) Boyd, 1990. Water Quality in Pond for Aquaculture. Amsterdam</p> <p>4) Boyd, 2011. Interpretation of pH, acidity and alkalinity in</p>

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
							<p>Aquaculture and fisheries. North American.</p> <p>5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms.</p>
7	2.5 Accuracy in describing algae as aquatic bioindicators	- The mechanism of algae as bioindicators in waters	<ul style="list-style-type: none"> • Lecture (S) • Assignment (A) & Presentation (S) 	2	<p>Note taking (A)</p> <p>Working on assignments (A)</p>	<p>Criteria: Scoring Guidelines</p> <p>Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)</p>	<ol style="list-style-type: none"> 1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i>. American Fisheries Society. 2) Boyd, 1982. <i>Water Quality Management for pond Fish Culture</i>. Amsterdam. 3) Boyd, 1990. <i>Water Quality in Pond for Aquaculture</i>. Amsterdam 4) Boyd, 2011. <i>Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries</i>. North American. 5) Kienle, 2009. <i>Toxicity of environmental chemicals and their</i>

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
							mixtures to selected aquatic organisms.
8	MIDTERM EXAM						
9	2.6 Accuracy in explaining fish as bioindicators and biomarkers	- The impacts of toxic substances on fish and the mechanism toxicological biomarkers in waters.	<ul style="list-style-type: none"> Lecture (S) Assignment (A) & Presentation (S) 	2	Note taking (A) Working on assignments (A)	Criteria: Scoring Guidelines Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)	1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i> . American Fisheries Society. 2) Boyd, 1982. <i>Water Quality Management for pond Fish Culture</i> . Amsterdam. 3) Boyd, 1990. <i>Water Quality in Pond for Aquaculture</i> . Amsterdam 4) Boyd, 2011. <i>Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries</i> . North American. 5) Kienle, 2009. <i>Toxicity of environmental chemicals and their mixtures to selected aquatic organisms</i> .
10	3.1 Accuracy in explaining the function and relationship between	- The functions of bioindicators and biomolecular, the	<ul style="list-style-type: none"> Lecture (S) Assignment (A) & 	2	Note taking (A) Working on	Criteria: Scoring Guidelines	1) Adam, 2002. <i>Biological indicators of</i>

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
	bioindicators and biomolecules	relationship between bioindicators and biomolecular	Presentation (S)		assignments (A)	Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)	<p><i>aquatic ecosystem stress</i>. American Fisheries Society.</p> <p>2) Boyd, 1982. Water Quality Management for pond Fish Culture. Amsterdam.</p> <p>3) Boyd, 1990. Water Quality in Pond for Aquaculture. Amsterdam</p> <p>4) Boyd, 2011. Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries. North American.</p> <p>5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms.</p>
11	3.2 Accuracy of explaining xenobiotic and microplastic materials in aquatic environment	- Sources and types of xenobiotics and microplastics that pollute waters	<ul style="list-style-type: none"> Lecture (S) Assignment (A) & Presentation (S) 	2	Note taking (A) Working on assignments (A)	<p>Criteria: Scoring Guidelines</p> <p>Non-test: - Summarizing the lecture materials (A)</p>	<p>1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i>. American Fisheries Society.</p> <p>2) Boyd, 1982. Water Quality Management for pond Fish Culture.</p>

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
						- group or independent presentation (S)	<p>Amsterdam.</p> <p>3) Boyd, 1990. Water Quality in Pond for Aquaculture. Amsterdam</p> <p>4) Boyd, 2011. Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries. North American.</p> <p>5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms.</p>
12	3.3 Accuracy in describing the internal and external responses of organisms as bioindicators and biomarkers	- Internal and external response of organisms as bioindicators and biomarkers	<ul style="list-style-type: none"> Lecture (S) Assignment (A) & Presentation (S) 	2	Note taking (A) Working on assignments (A)	<p>Criteria: Scoring Guidelines</p> <p>Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)</p>	<p>1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i>. American Fisheries Society.</p> <p>2) Boyd, 1982. Water Quality Management for pond Fish Culture. Amsterdam.</p> <p>3) Boyd, 1990. Water Quality in Pond for Aquaculture. Amsterdam</p> <p>4) Boyd, 2011. Interpretation of</p>

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
							<p>pH,acidity and alkalinity in Aquaculture and fisheries. North American.</p> <p>5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms.</p>
13	3.4 Accuracy in explaining the occurrence of toxicity in waters molecularly.	- Molecular mechanism of water toxicity	<ul style="list-style-type: none"> Lecture (S) Assignment (A) & Presentation (S) 	2	<p>Note taking (A)</p> <p>Working on assignments (A)</p>	<p>Criteria: Scoring Guidelines</p> <p>Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)</p>	<ol style="list-style-type: none"> Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i>. American Fisheries Society. Boyd, 1982. <i>Water Quality Management for pond Fish Culture</i>. Amsterdam. Boyd, 1990. <i>Water Quality in Pond for Aquaculture</i>. Amsterdam Boyd, 2011. <i>Interpretation of pH,acidity and alkalinity in Aquaculture and fisheries</i>. North American. Kienle, 2009. <i>Toxicity of</i>

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
							environmental chemicals and their mixtures to selected aquatic organisms.
14	3.5 Accuracy in describing the treatments to water that contains chemical and biological pollutants using organic solids and gases	- Biochemical treatment using organic solids and gases in polluted waters.	<ul style="list-style-type: none"> • Lecture (S) • Assignment (A) & Presentation (S) 	2	Note taking (A) Working on assignments (A)	<p>Criteria: Scoring Guidelines</p> <p>Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)</p>	<ol style="list-style-type: none"> 1) Adam, 2002. <i>Biological indicators of aquatic ecosystem stress</i>. American Fisheries Society. 2) Boyd, 1982. <i>Water Quality Management for pond Fish Culture</i>. Amsterdam. 3) Boyd, 1990. <i>Water Quality in Pond for Aquaculture</i>. Amsterdam 4) Boyd, 2011. <i>Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries</i>. North American. 5) Kienle, 2009. <i>Toxicity of environmental chemicals and their mixtures to selected aquatic organisms</i>.
15	3.6 Accuracy in explaining the metabolism of	- Xenobiotic in waters and its metabolism	<ul style="list-style-type: none"> • Lecture (S) 	2	Note taking (A)	Criteria: Scoring	<ol style="list-style-type: none"> 1) Adam, 2002. <i>Biological</i>

Week	PLO Indicator	Topics	Teaching Strategies	Time (hour)	Learning Activities	Assessment	Learning Sources
	Xenobiotic components		<ul style="list-style-type: none"> Assignment (A) & Presentation (S) 		Working on assignments (A)	Guidelines Non-test: - Summarizing the lecture materials (A) - group or independent presentation (S)	<i>indicators of aquatic ecosystem stress</i> . American Fisheries Society. 2) Boyd, 1982. Water Quality Management for pond Fish Culture. Amsterdam. 3) Boyd, 1990. Water Quality in Pond for Aquaculture. Amsterdam 4) Boyd, 2011. Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries. North American. 5) Kienle, 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms.
16	FINAL EXAM						

Notes: S = Synchronous, A = Asynchronous, all soft skills achievement will be scored based on the analysis referring to the Learning Management System

6. References

- Adams, S. M. (2002). *Biological indicators of aquatic ecosystem stress*. American Fisheries Society.
- Boyd, 1982. *Water Quality Management for pond Fish Culture*. Elsevier scientific publishing company. Amsterdam. 279 hal.
- , 1990. *Water Quality in Pond for Aquaculture*. Elsevier scientific publishing company. Amsterdam. 279 hal. 482 hal.
- , 2011. Interpretation of pH, acidity and alkalinity in Aquaculture and fisheries. *Nort American Journal of Aquaculture*, 73: 403-408 p.
- Kienle, C. 2009. Toxicity of environmental chemicals and their mixtures to selected aquatic organisms. Behaviour, development and biochemistry; Toxizitaet von Umweltchemikalien und deren Mischungen auf ausgewaehlte aquatische Organismen. Verhalten, Entwicklung und Biochemie.

7. Appendices

Appendix 1. *Learning Materials*

- PPT 1 : Introduction
 - PPT 2 : Eco-toxicological levels
 - PPT 3 : Toxicity agents and triggers
 - PPT 4 : Sources of pollutants in the water
 - PPT 5 : Fish, bivalves and invertebrates as bioindicators
 - PPT 6 : Aquatic toxicological biomarkers
 - PPT 7 : Algae as an aquatic bioindicator
 - PPT 8 : Midterm exam
 - PPT 9 : Mechanism of biomarkers in waters
 - PPT 10 : Functions and relationships between bioindicators and biomolecules
 - PPT 11 : Xenobiotics and microplastics in the water
 - PPT 12 : Response of organisms as bioindicators and biomarkers
 - PPT 13 : Molecular mechanism of toxicity in waters
 - PPT 14 : Xenobiotic component metabolism
- Online learning resources: (URL/link)
and other learning resources: (URL/link)

Lampiran 2. *Media*

Zoom Meeting: (URL/link)

Google Meet: (URL/link)

Lampiran 3. *Assessment Instrument*

Scoring Rubric

Oral Presentation

Close to the Expectation (score 1-2)	Meeting the Expectation (score 3-4)	Exceeding the Expectation (score 5)
1) Presentation is not organized and not well developed 2) Material is not well-explained well 3) Theories and concepts are not thoroughly discussed 4) Presentation is not clear and not fluent 5) Lack of confidence in delivery, mostly note reading 6) Voice is unclear 7) Presentation does not attract audiences' attention 8) Inadequate responses to questions, inadequate comprehension of the material 9) Unsynchronized presentations 10) Exceeding the time limit, failing to complete the presentation	1) Presentation is rather well -organized and developed 2) Fair comprehension of the material being delivered 3) Theories and concepts are fairly discussed thoroughly 4) Presentation is fairly clear and fluent 5) Showing fairly strong confidence and speakers read notes wisely 6) Voice is quite clear 7) Able to engage audience's attention 8) Fairly good in responding to questions, showing excellent comprehension of the material being presented 9) Good synchronization of presentation flow 10) Exceeding the time limit yet presenters managed to complete the presentation	1) Presentation is very well organized and creatively developed 2) Very strong knowledge regarding the material being presented 3) Theories and concepts are very thoroughly-discussed 4) Presentation is very clear and smooth 5) Excellent confidence in delivery, reading notes very wisely 6) Voice is very clear 7) Adequately attracts audiences' attention well 8) Responding to questions very well, very strong comprehension of the material being delivered 9) Very clear synchronization in presentation flow 10) Not exceeding the time limit, presentation is completed

Written Assignments

Essay

Under the average (score 1 – 4)	Within the Average (score 5 – 8)	Above the Average (score 9 – 12)	Perfect (score 13 – 15)
1) Not using the right analytical method 2) Incorrect data analysis 3) Making wrong conclusions 4) No critical analysis of the data available	1) Using acceptable analytical methods 2) Data are well analyzed 3) Making relevant conclusions 4) There is a fairly critical analysis of the data 5) There are only one or two	1) Using a relatively precise analysis method 2) Proper data analysis 3) Making the right conclusion 4) Critical analysis of the data is found	1) Using the correct analytical method 2) Effective data analysis 3) Making strongly effective conclusions 4) There is a strong critical analysis of the data

<ul style="list-style-type: none"> 5) No references 6) Unmatched literature review (theory, research) and questions 7) Using non-standardized language and poor cohesion 8) No explanation about the implications of the topics being discussed 9) Essay is not systematically-structured 	<ul style="list-style-type: none"> references yet irrelevant 6) Matching literature review (theory, research) and question 7) Using standard language with good cohesion between sentences 8) The implications of the topics being discussed are explained yet less thoroughly 9) Essay is not systematically-structured 	<ul style="list-style-type: none"> 5) There are many references yet irrelevant at this point 6) Matching literature review (theory, research) and questions 7) Using standard language and sentences are cohesive 8) There is a unique and critical explanation of the implications of the topics being discussed 9) Essay is systematically-arranged 	<ul style="list-style-type: none"> 5) There are many references with strong relevancy 6) Strongly matching literature review (theory, research) and questions 7) Using standard language with strong cohesion between sentences 8) There is a unique and very critical explanation of the implications of the topics being discussed 9) Essay is systematically and neatly arranged
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Report

Under the average (score 1 – 4)	Within the Average (score 5 – 8)	Above the Average (score 9 – 12)	Perfect (score 13 – 15)
<ul style="list-style-type: none"> 1) Not using the right analytical method 2) Incorrect data analysis 3) Making wrong conclusions 4) No critical analysis of the data available 5) No references 6) Unmatched literature review (theory, research) and questions 7) Using non-standardized language and poor cohesion 8) No explanation about the implications of the topics being discussed 9) Report is not systematically-structured 	<ul style="list-style-type: none"> 1) Using acceptable analytical methods 2) Data are well analyzed 3) Making relevant conclusions 4) There is a fairly critical analysis of the data 5) There are only one or two references yet irrelevant 6) Matching literature review (theory, research) and question 7) Using standard language with good cohesion between sentences 8) The implications of the topics being discussed are explained yet less thoroughly 9) Report is relatively not 	<ul style="list-style-type: none"> 1) Using a relatively precise analysis method 2) Proper data analysis 3) Making the right conclusion 4) Critical analysis of the data is found 5) There are many references yet irrelevant at this point 6) Matching literature review (theory, research) and questions 7) Using standard language and sentences are cohesive 8) There is a unique and critical explanation of the implications of the topics being discussed 	<ul style="list-style-type: none"> 1) Using the correct analytical method 2) Effective data analysis 3) Making strongly effective conclusions 4) There is a strong critical analysis of the data 5) There are many references with strong relevancy 6) Strongly matching literature review (theory, research) and questions 7) Using standard language with strong cohesion between sentences 8) There is a unique and very critical explanation of the implications of the topics being discussed

	systematically-structured	9) Report is systematically-arranged	9) Report is systematically and neatly arranged
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