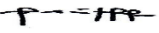


Module designation	Biometry/KB0620413
Semester(s) in which the module is taught	7 th
Person responsible for the module	1. Dr. Dewi Lengkana, M.Sc. 2. Rini Rita T. Marpaung, S.Pd., M.Pd.
Language	Bahasa
Relation to curriculum	elective
Teaching methods	Lecture
Workload (incl. contact hours, self-study hours)	Contact hours: 14 weeks x 100 minutes Structured learning: 14 weeks x 120 minutes Independent study: 14 weeks x 120 minutes
Teaching Methods	Lectures (100 minutes)
Workload	Contact hours: 14 weeks x 100 minutes
Credit points	2 sks = $(1.28 \times 2) = 2.56$ ECTS
Required and recommended prerequisites for joining the module	existing competences in basic mathematics
Module objectives/intended learning outcomes	This course aims to develop students' abilities to learn about the principles, methods and procedures that need to be used in the context of collecting, analyzing, disclosing and discovering data in information processing or research. The scope of his material includes the relationship between statistics and educational research, descriptive statistics, hypotheses and normal distribution, inferential statistics, correlation and also regression. Assessment is carried out on the mastery of lecture material by students.
Content	This course aims to provide knowledge about the basic concepts of statistics which include: 1. Definition of statistics and its relationship in biological research. 2. Descriptive statistics for single data.

	3. Descriptive statistics for group data. 4. Normal distribution 5. Inferential statistics 6. Test the sample mean 7. Mcnemar's test, sign test, Wilcoxon's rank test 8. Median test and man whitney test 9. Analysis of correlation and linear regression.
Examination forms	Essay examination
Study and examination requirements	Participants are evaluated based on their performance in class Performance in theory (100%): • Mid Exam (29%) • Final Exam (20%) • Assignments (25%) • Presentation (25%) • Class Participations (10%)
Reading list	1. Sheskin Sheskin J. 2011. Fifth Edition Handbook of Parametric and Nonparametric Statistical Procedures. Chapman & hall/crc is an imprint of taylor & francis group, a n in form a business no claim to o rig in a l U.S. Government works. 2. Jurnal statistik aplikasi dalam ilmu hayati, diterbitkan oleh German & Austro-Swiss regions of the International Biometric Society. Impact factor: 1.8 (2024) 3. Sugiyono. 2003. Statistika untuk Penelitian, Bandung. Alfabeta 4. Susetyo, Budi. 2010. Statistika Untuk Analisis Data Penelitian. Bandung. PT. Refika Aditama

Semester Learning Plan (SLP)

	UNIVERSITY OF LAMPUNG FACULTY OF TEACHER TRAINING AND EDUCATION DEPARTMENT OF MATHEMATICS AND NATURAL SCIENCES BIOLOGY EDUCATION PROGRAM			
	SEMESTER TEACHING PLAN (RPS)			
Course Name	Course Code	Credit Hours (sks)	Semester	Date of Preparation
Conservation of Natural Resources and the Environment	KB0620413	2 (2-0)	1	July 2025
Authorisation	Name of Development Coordinator	Field Coordinator	Head of Study Programme	
	RPS	Expertise (if applicable)		
			 Rini Rita T. Marpaung, S.Pd., M.Pd	

		Dr. Dewi Lengkana, M.SC.	Rini Rita T. Marpaung, S.Pd., M.Pd	
Learning Outcomes (LO)	CPL-PROGRAM (Programme Learning Outcomes) Assigned to Courses			
	1.Demonstrating scientific, educational, and religious attitudes and behaviours that contribute to improving the quality of life in society, nation, and state based on culture, norms, and academic ethics. 2.Applying logical, critical, systematic, and innovative thinking in the context of the development/implementation of science and technology that considers and applies humanities values appropriate to their field of expertise. 3. Mastering concepts, principles, theories, laws, and biological processes to solve problems in biology education.			
	CPMK (Course Learning Outcomes)			
	1. Master the concepts, fundamentals, principles, objectives, uses, and types of statistics in educational research. 2. Master data analysis techniques in educational research and be able to select the appropriate statistical tests, whether using parametric or non-parametric statistics. 3. Be able to prepare a draft design of a statistical test model to be used in educational research, suitable for thesis research.			
Brief Description of the Course	This course aims to develop students' ability to learn about the principles, methods, and procedures required for the collection, analysis, presentation, and interpretation of data in information processing or research. The scope of the material includes the relationship between statistics and educational research, descriptive statistics, hypotheses and the normal distribution, inferential statistics, correlation, and regression. Assessment is carried out based on students' mastery of the course material.			
Study Materials / Learning Materials	1. Introduction 2. Descriptive Statistics for Single Data 3. Descriptive Statistics for Grouped Data 4. Normal Distribution 5. One-Sample Inferential Statistics I			

	6. One-Sample Inferential Statistics II 7. Two-Sample Mean Test (Independent and Dependent) 8. MID Test 9. Two-Sample Proportion Test, Two-Sample Variance Test 10. McNemar's Test, Sign Test, Wilcoxon Signed-Rank Test 11. Median Test, Mann–Whitney Test 12. Inferential Statistics for Samples (One-Way ANOVA) 13. Inferential Statistics for Samples (Two-Way ANOVA) 14. Correlation Analysis and Linear Regression 15. Kruskal–Wallis Test 16. Final Test	
Main References:	Primary:	
	1. Sheskin Sheskin J. 2011. Fifth Edition Handbook of Parametric and Nonparametric Statistical Procedures. Chapman & hall/crc is an imprint of Taylor & Francis group, an international business no claim to originality in a U.S. Government works. 2. Jurnal statistik aplikasi dalam ilmu hayati, diterbitkan oleh German & Austro-Swiss regions of the International Biometric Society. Impact factor: 1.8 (2024) 3. Sugiyono. 2003. Statistika untuk Penelitian, Bandung. Alfabeta 4. Susetyo, Budi. 2010. Statistika Untuk Analisis Data Penelitian. Bandung. PT. Refika Aditama	
	Supporters:	

	-
Lecturer's Name Lecturer	Dr. Dewi Lengkana,M. Sc. Rini Rita T. Marpaung, S.Pd., M.Pd
Prerequisite Courses (if any)	-

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
1	Introduction: Definition of statistics and its relationship in biological research.	Course contract statistics and its relationship in biological research	Sharing of lecture agreements and lecture contracts		Face-to-face 2 x 50 minutes	Discussion about agreements and expressing opinions	Activities and Q&A	Ability to express opinions in academic agreements	0

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
2	Able to explain the basic concepts of descriptive statistics, particularly for single data	Descriptive Statistics for Single Data	Lectures and Discussions Source Learning: Sheskin Sheskin J. 2011. Fifth Edition Handbook of Parametric and Nonparametric Statistical Procedures. Chapman & hall/crc is an imprint of Taylor & Francis 4. Normal distribution	Media: Learning Resources: e-books	Face-to-face 2 x 50 minutes	a. Discussion concepts Biometry b. Presentation of discussion results with strong arguments c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with the group that	Activities and Question and Answer	Ability to explain the Basic Concepts biometry	2

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assessment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						gave the presentation			
3	Able to explain the basic concepts of Descriptive Statistics for Grouped Data	Descriptive Statistics for Grouped Data	Lectures and Discussions SPSS – statistical analysis software for descriptive statistics and hypothesis testing. Source Learning: Sheskin Sheskin J. 2011. Fifth Edition Handbook of Parametric and Nonparametric Statistical Procedures. Chapman & hall/crc is an imprint of Taylor & Francis group, an imprint of a U.S. Government works	Media: Video Learning Resources: e-books	Face-to-face 2 x 50'	a. Discussion on scientific concepts, working Descriptive Statistics for Grouped Data b. Presentation of discussion results with strong arguments c. Question and answer session and confirmation of the accuracy of the discussion	Activities and Question and Answer	Ability to analyse	2

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						results by comparing the discussion results with the group that gave the presentation			
4	Able to calculate parameter estimates (mean, proportion) in a single sample	One-Sample Inferential Statistics : t-test and z-test	Lectures and Discussions SPSS – statistical analysis software for descriptive statistics and hypothesis testing. Source Learning: Sheskin Sheskin J. 2011. Fifth Edition Handbook of Parametric and Nonparametric Statistical Procedures. Chapman & hall/crc is an imprint of Taylor & Francis group, an imprint of a U.S. Government works.	Media: Videos 4 and 5 Learning Resources: e-book 3	Face-to-face (TM) 2 x 50 minutes	a. Discussion on scientific concepts, working scientifically by calculate parameter estimates (mean, proportion) in a single sample) b. Presentation of discussion results with	Activities and Question and Answer	Ability to analyse	2

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						strong arguments c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with the group that gave the presentation			
5	Identify the characteristics of the normal distribution, including the shape of the	Normal curve parameters (mean and standard deviation)	Power Point presentations with visual explanations of the normal curve.			a. Discussion on scientific concepts, working scientifically by calculate			

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
	curve, parameters (mean and standard deviation), and the property of symmetry within the context of real-world problems		SPSS – statistical analysis software for descriptive statistics and hypothesis testing.			parameter estimates (mean, proportion) in a single sample) b. Presentation of discussion results with strong arguments c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with			

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						the presenting group			
6	Interpret the results of the analysis in the context of real-world problems to support decision-making	Results of the analysis in the context of real-world problems	Lectures and Discussions Learning Resources: e-book 1 and online learning resources	Media: Videos 4 and 5 Learning Resources: e-book	Face-to-Face (TM) 2 x 50'	a. Discussion on scientific concepts, works scientifically by analysing Non-Living Natural Resources b. Presentation of discussion results with strong arguments c. Question and answer session and	Activities and Question-Answer	Able to analyse	3

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						confirmation of the accuracy of the discussion results by comparing the discussion results with the presenting group			
7	Interpret the results of one-sample inferential statistical analysis in the context of real-world problems to support decision-making	One-sample inferential statistical	Lectures and Discussions Media: Video Learning Resources: e-book 4 and online learning resources	Media: Videos 4 and 5 Learning Resources: e-book 4	Face-to-face (TM) 2 x 50 minutes	a. Discussion on scientific concepts, working scientifically with b. Presentation of discussion results with strong arguments about analysis	Activities and Question and Answer	Analysing Conservation Strategies and Techniques	3

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						of conservation strategies and techniques c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with the presenting group			
8	Midterm Exam	-		-	Face-to-face 2 x 50 minutes	-	-	-	3

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
9	Interpret the results of one-sample inferential statistical analysis in the context of real-world problems to support decision-making	one-sample inferential statistical analysis	Lectures and Discussions		Face-to-face 2 x 50 minutes	a. Discussion on scientific concepts, working scientifically with b. Presentation of discussion results with strong arguments about analysis c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion	Essay Test		20

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assessment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						results with the presenting group			
10	Determine and interpret the confidence interval for the population mean or proportion based on a single sample	The population mean or proportion based on a single sample	Lectures and Discussions Source Learning: e-books and online learning resources	Media: Videos 4 and 5 Learning Resources: e-books 6 & 7,	Face-to-face 2 x 50 minutes	a. Discussion on scientific concepts, working scientifically by explaining Conservation Education	Activities and Q&A	Able to explain Conservation Education and Socialisation	5

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assessment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						tion and Socialisation Presentation of discussion results withing strong arguments a. Question and answer session and confirmation			

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						n of the accuracy of the discussion results by comparing the discussion results with the presenting group			
11-12	Explain the basic concepts of inferential	Inferential Statistics for Samples	Lectures, Discussions	Media: Video	Face-to-face 2 x	a. Discussion on scientific concepts,	Non-test:	Ability to analyse Environmen	10

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
	statistics, particularly two-way analysis of variance (Two-Way ANOVA)	(Two-Way ANOVA)	Learning resources: e-books	Learning resource s:	50 minutes	working scientifically by analysing and Ecotourism b. Question i and answer n session and u confirmation t of the e accuracy of s the discussion results by comparing the l discussion results with the group that gave the presentation c. Question and answer session and	Participati on, Q&A,	tal Economics and Ecotourism	

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						confirmation of the accuracy of the discussion results			
13-14	Explain the basic concepts of Correlation Analysis and Linear Regression	Correlation Analysis and Linear Regression	Lectures, Discussions Media: Learning Resources: e-book	Media: Google Docs for discussions Video No. Learning resource s:	Face-to-face 2 x 50 minutes 0. x 5 0 '	a. Discussion on scientific concepts, working scientifically by analysing b. Presenting the results of the work to obtain feedback from other groups c. Question and answer session and confirmation	Non-test: Active participation, Q&A,	Ability to analyse Global Issues and Conservation Innovations	10

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						of the accuracy of the discussion results			
15	Explain the basic concepts of Kruskal–Wallis Test	Kruskal–Wallis Test	Lectures, Discussions Media: Video: Learning resources: e-book	Media: Google Docs for discussions Learning resources:	Face-to-face 2 x 50 minutes	a. Discussion on scientific concepts, working scientifically by analysing environmental damage and	Non-test: Participation, Question and answer,	Analysing Environmental Damage and Degradation of Natural Resources	10

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assessment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						natural resource degradation Question and answer session and confirmation of the accuracy of the discussion results by comparing the results of the discussion with the group that presented			

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
15	Kruskal–Wallis Test	Kruskal–Wallis Test	Lectures, Discussions	Media: Google Docs for discussion Videos No. 8 and 9 Learning Resources: 1-3, and a-c	Face-to-Face (F2F) x 50 minutes	Discussion on scientific concepts, working scientifically by analysing the nature of waste and its impact on the environment and human health. Creating a prototype of a creative and environmentally friendly problem-solving tool Presenting the results of the work to obtain	Non-test: Active participation, Q&A, LKM, and prototype products	Actively participating in discussions and generating solutions and simple environmentally friendly prototypes as part of efforts to manage soil pollution	10

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						feedback from other groups Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with the presenting group			
15			Lectures, Discussions and Designing prototypes	Media: Google Docs for discussion	Face-to-face (TM) 2 x 50 minutes	Discussion of scientific concepts, working scientifically by analysing the nature of	Non-test: Active participation, Q&A, LKM, and	Actively participating in discussions and generating solutions	10

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
				Learning Resources: 1-3, and a-c		waste and its impact on the environment and human health. Creating prototypes of creative and environmentally friendly problem-solving tools. Presenting the results of the work to obtain feedback from other groups Question and answer session and confirmation	prototype products	and simple environmentally friendly prototypes as part of efforts to manage air pollution	

Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assesment		
							Criteria & Forms	Indicators	Percentage (%)
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
						of the accuracy of the discussion results by comparing the discussion results with the group that gave the presentation			
16	Final exam								

Note:

1. Programme-Specific Learning Outcomes (PSLO) are the competencies possessed by each graduate of the programme, which are the internalisation of attitudes, knowledge mastery, and skills appropriate to the programme level, acquired through the learning process.
2. The CPL assigned to a course are several learning outcomes of the study programme (CPL-PRODI) used for the formation/development of a course consisting of aspects of attitude, general skills, specific skills and knowledge.
3. Course CP (CPMK) is the ability that is specifically described from the CPL assigned to the course, and is specific to the subject matter or learning material of the course.

4. Sub-CP Course (Sub-CPMK) is a capability that is specifically described from CPMK that can be measured or observed and is the final capability planned at each stage of learning, and is specific to the learning material of the course.
5. Assessment Criteria are benchmarks used as a measure or yardstick for learning achievement in assessment based on predetermined indicators. Assessment criteria are guidelines for assessment to ensure that assessment is consistent and unbiased. Criteria can be quantitative or qualitative.
6. Assessment indicators of student learning abilities in the learning process and outcomes are specific and measurable statements that identify student learning abilities or performance accompanied by evidence.

MID-SEMESTER EXAM QUESTIONS

ASSESSMENT OUTLINE

Learning Outcomes (CP)	CPL-PRODI (Program Study Graduate Learning Outcomes) Assigned to Courses
	1. Demonstrate scientific, educational, and religious attitudes and behaviours that contribute to improving the quality of life in society, nation, and state based on culture, norms, and academic ethics.
	2. Integrating skills and innovation in the mastery of technology and information, career development, and life skills to become life long learners.
	3. Applying logical, critical, systematic, and innovative thinking in the context of the development/implementation of science and technology, while considering and applying humanistic values appropriate to their field of expertise
	CPMK (Course Learning Outcomes)
	1. Able to analyze the requirements for the implementation of a biometric system in a real case
	2. Able to prepare scientific reports or presentations related to the analysis of biometric systems using appropriate academic language
Assessment Format	Written test in essay form
Aspects measured	COGNITIVE
Time Allocation	100 minutes

No	Materials	Competency Achievement Indicators						Question Type	Cognitive Level (C1–C6)
		Calculating the mean, median, mode, variance, and standard deviation of single data	Description/Calculation	C2, C3	Given the test scores of 10 students: 70, 65, 80, 90, 75, 85, 60, 95, 70, 85. Calculate the mean, median, mode, and standard deviation!	1	Descriptive statistics of single data	Calculating the mean, median, mode, variance, and standard deviation of single data	Description/Calculation
2	Descriptive statistics for grouped data	Create a frequency distribution table, calculate the mean, median, mode, and standard deviation of grouped data	Description/Calculation	C3, C4	Given the frequency distribution of students' math scores. Calculate the mean, median, mode, and standard deviation of the grouped data!	2	Descriptive statistics for grouped data	Create a frequency distribution table, calculate the mean, median, mode, and standard deviation of grouped data	Description/Calculation
3	Normal distribution	Explain the characteristics of a normal distribution; calculate probabilities using the standard normal	Description/Calculation	C2, C3, C4	The average height of students is 170 cm with a standard deviation of 5 cm. Calculate the probability	3	Normal distribution	Explain the characteristics of a normal distribution; calculate probabilities using the standard normal	Description/Calculation

		distribution (Z-table)			that a student is between 165–175 cm tall!			distribution (Z-table)	
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ASSESSMENT INSTRUMENT

RUBRIC

Assessment Section (Essay/Calculation Questions)

Assessment Aspects	Score 0	Score 1	Score 2	Score 3	Score 4
Conceptual Understanding	No understanding of the concept at all	Understands the concept very minimally	Understands the concept partially but still incorrectly	Understands the concept correctly but incompletely	Understands the concept completely and correctly
Steps to Solve	No correct steps	There are steps, but they are not relevant	Some steps are correct but there are many errors	Most steps are correct with a few errors	All steps are correct and systematic
Calculations	There are no calculations or they are all wrong	Calculations are mostly incorrect	Calculations are partially correct ($\leq 50\%$)	Calculations are mostly correct ($\geq 75\%$)	All calculations are correct
Interpretation of Results	No interpretation	Very incorrect interpretation	Less accurate interpretation	Interpretation is fairly accurate but incomplete	The interpretation of the results is correct, clear, and contextually appropriate

FINAL EXAM

ASSESSMENT GUIDELINES

No	Topic	Competency Achievement Indicators	Question Type	Cognitive Level (C1–C6)	Sample Questions
1	Two-sample proportion test	Formulate a hypothesis, calculate the two-sample proportion test, and draw conclusions	Description/Calculation	C3, C4, C5	Of 100 male respondents, 60 like product A; of 120 female respondents, 72 like product A. Test whether there is a difference in proportions at the 5% level!
2	Two-sample variance test (F-Test)	Formulate hypotheses, calculate the F-test for variance, and draw conclusions	Description/Calculation	C3, C4, C5	Class A ($n=20$, $s^2=25$), Class B ($n=25$, $s^2=16$). Test whether the two variances are equal at $\alpha=0.05$!
3	McNemar test	Determine the hypothesis, perform the McNemar test on paired data (nominal)	Description/Calculation	C3, C4, C5	Before training: 30 agreed, 20 disagreed; after training: 40 agreed, 10 disagreed. Use the McNemar test to see if there is a significant change!
4	Sign Test	Formulate a hypothesis, calculate the sign test on paired data, and draw conclusions	Description/Calculation	C3, C4, C5	Of the 15 patients tested before and after therapy, there were 12 improvements, 2 declines, and 1 remained unchanged. Use the sign test at $\alpha=0.05$!
5	Wilcoxon Test	Performing the Wilcoxon Signed Rank Test on paired data	Description/Calculation	C3, C4, C5	The pretest and posttest scores of 10 students are provided. Use the Wilcoxon test to determine if there is a significant improvement!
6	Median Test	Testing the equality of the medians of two independent groups	Description/Calculation	C3, C4	Two groups of students were given different learning methods. Use the median test to see if the median scores are significantly different!
7	Mann-Whitney test	Using the Mann-Whitney test for 2 independent samples	Description/Calculation	C3, C4, C5	The test scores for Group A ($n=8$) and Group B ($n=7$) are provided. Use the Mann-Whitney test at $\alpha=0.05$ to determine the difference in medians!

No	Topic	Competency Achievement Indicators	Question Type	Cognitive Level (C1–C6)	Sample Questions
8	One-Way ANOVA	Formulate hypotheses, calculate the ANOVA test, and draw conclusions	Description/Calculation	C3, C4, C5	Three learning methods were applied to 3 classes. The test results data is provided. Test with one-way ANOVA whether there is a difference in the means!
9	Two-Way ANOVA	Formulate hypotheses, calculate two-way ANOVA, and interpret main effects and interactions	Description/Calculation	C3, C4, C5	Factor A = type of method, Factor B = gender. Test scores are provided. Perform a two-way ANOVA!
10	Correlation and Linear Regression Analysis	Calculate the correlation coefficient, construct a regression model, test for significance, and interpret the results	Description/Calculation	C3, C4, C5	The height (X) and weight (Y) data of 10 students are given. Calculate the Pearson correlation coefficient, create a regression equation, and test its significance!
11	Kruskal-Wallis test	Perform the Kruskal–Wallis test for k independent samples	Description/Calculation	C3, C4, C5	Three groups of students were given different learning methods. Test scores were provided. Use the Kruskal–Wallis test at $\alpha=0.05$ to test for differences!

MID-SEMESTER EXAM ANSWER

Name : Ade Amelia Chanra

MPM : 1963024002

'Midterm Exam'

(20)

Answer :

1). Given data : 70, 65, 80, 90, 75, 85, 60, 95, 70, 85

Mean = $\frac{775}{10} = 77,5$

Median =

Data : 60, 65, 70, 75, 80, 85, 85, 90, 95

Median = $\frac{75 + 80}{2} = 77,5$

Mode : 70 and 85

Standard deviation

$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}} = \sqrt{112,25} = 10,59$

2). Given data :

class interval = 40-49 50-59 60-69 70-79 80-89 90-99

Frequency = 4 6 12 15 8 5 = 50

Mean = $\bar{x} = \frac{\sum f_i x_i}{N} = \frac{4(44,5) + 6(54,5) + 12(64,5) + 15(74,5) + 8(84,5) + 5(94,5)}{50} = 70,90$

Median = $L + \frac{(N/2 - F_m) \times h}{f_m}$
 $= 69,5 + \frac{25 - 22}{15} \times 10 = 69,5 + \frac{3}{15} \times 10 = 69,5 + 2,0 = 71,5$

Standard deviation = $\sigma = \sqrt{\frac{\sum f_i (x_i - \bar{x})^2}{N}} = 13,68$

3). Data

Mean (μ) = 170 cm

Standard deviation (σ) = 15 cm

Find $p(165 \leq x \leq 175)$

$z = \frac{x - \mu}{\sigma}$

For $x = 165$: $z = -1$

For $x = 175$: $z = 1$

$\Rightarrow p(165 \leq x \leq 175) = p(-1 \leq z \leq 1)$

from z-table :

$p(z \leq 1) = 0,8413$

$p(z \leq -1) = 0,2420$

$p(-1 \leq z \leq 1) = 0,8413 - 0,2420 = 0,5993$

$\Rightarrow$ the probability that a student's height is between 165 cm and 175 cm is approximately 59,93%

4). Data :

$$\mu_0 = 500 \text{ populasi} \quad s = 15 \quad \alpha = 0,05$$

$$\bar{x} = 510 \quad n = 25$$

Hypotheses

$$H_0 : \mu = 500$$

$$H_1 : \mu \neq 500$$

$$\Rightarrow t = \frac{510 - 500}{15 / \sqrt{25}} = 3,33, df = 24$$

critical value $t_{0,05, 24} = 2,064$ since $3,33 > 2,064$, we reject H_0
 $\Rightarrow$ conclusion at $\alpha = 0,05$ the sample mean (510) is significantly different from 500.

5). Data :

$$\mu_A = 30$$

$$H_0 : \mu_A = \mu_B \text{ vs } H_1 : \mu_A \neq \mu_B \quad \alpha = 0,05$$

$$\bar{x}_A = 75$$

$$s_A = 8$$

Test statistic

$$n_A = 30$$

$$\bar{x}_B = 70$$

$$s_B = 10$$

$$t = \frac{75 - 70}{\sqrt{8^2/30 + 10^2/30}} = \frac{5}{\sqrt{64/30 + 100/30}} = \frac{5}{2,338} = 2,14$$

$\Rightarrow$ degree of freedom $df = 58$

Critical Value $\alpha = 0,05 : t_{0,05, 58} = 2,004$

Decision $t = 2,14 > 2,004 \rightarrow$ reject H_0 .

Approximate two tailed p -value = 0,034 ($< 0,05$)

$\Rightarrow$ Conclusion

At the 5% level, there is a statistically significant difference between the two teaching methods, class A (mean 75) performed significantly than class B (mean 70).

6) Data :

$$n = 20$$

$$\sum d_i = 105$$

$$\bar{d} = \frac{\sum d_i}{n} = \frac{105}{20} = 5,25$$

$$s_d = \sqrt{\frac{\sum (d_i - \bar{d})^2}{n-1}} \approx 1,16416 \Rightarrow \text{deviation standard}$$

$$\bullet \text{ Test Statistic } \Rightarrow t = \frac{\bar{d}}{s_d / \sqrt{n}} = \frac{5,25}{1,16416 / \sqrt{20}} = 20,17$$

• Degrees of freedom
 $\Rightarrow df = 19$

► Critical Value (one sided, $\alpha = 0,05$)

$$t_{0,05,19} \approx 1.729$$

► Decision

Since $t = 20,17 > 1.729$, We reject H_0 .

► p-value (approximation)

The one-sided p-value is extremely small ($p < 0,05$), confirming significance.

► Conclusion

At the 5% significance level, there is a statically significant improvement after the treatment; posttest score are significantly higher than pretest scores, with an average increase of about 5,25 points.

FINAL EXAM ANSWER

Name : Ade Annalia Ctansa

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'final Semester Exam'

Answer :

(80)

1). Problem :

- Out of 100 male respondents 60 like product A.
- Out of 120 female respondents 72 like product A.

Test whether there is a difference in proportions at the 5% significance level.

a. Hypotheses

- $H_0 : p_1 = p_2$ (no difference in proportions)
- $H_1 : p_1 \neq p_2$ (there is a difference in proportions)

b. Sample Proportions

- Male : $p_1 = 60/100 = 0,60$
- Female : $p_2 = 72/120 = 0,60$
- pooled proportion :

$$p = \frac{60 + 72}{100 + 120} = \frac{132}{220} = 0,60$$

c. Standard error

$$SE = \sqrt{p(1-p) \left(\frac{1}{n_1} + \frac{1}{n_2} \right)} = \sqrt{0,60 \times 0,40 \times (0,01 + 0,00833)} \\ = 0,0663$$

d. Test statistic

$$Z = \frac{p_1 - p_2}{SE} = \frac{0,60 - 0,60}{0,0663} = 0$$

e. Decision

at $\alpha = 0,05$, the critical value are $\pm 1,96$

Since $Z = 0$ lies within the acceptance region, we fail to reject H_0 .

⇒ Conclusion :

There is no significant difference in the proportions of males and females who like product A at the 5% significance level.

2). Data

Class A: $n_1 = 20, s_1^2 = 25 \rightarrow df_1 = n_1 - 1 = 19$

Class B: $n_2 = 25, s_2^2 = 16 \rightarrow df_2 = n_2 - 1 = 24$

Hypotheses

$$H_0: \sigma_1^2 = \sigma_2^2 \quad H_1: \sigma_1^2 \neq \sigma_2^2$$

Test statistic

$$F = \frac{s_1^2}{s_2^2} = \frac{25}{16} = 1.5625$$

Critical value $\alpha = 0.05$

$$F_{0.975; 19, 24} = 2.3452 \quad F_{0.025} = \frac{1}{F_{0.975; 24, 19}} = 0.4078$$

Reject H_0 if $F > 2.3452$ or $F < 0.4078$

Decision

$F = 1.5625$ lies between 0.4078 and 2.3452

Therefore we fail to reject H_0 .

→ Conclusion

At the 5% significance level there is no evidence that the population variances of class A and class B differ.

3) McNemar Table (Before x After)

Before/After	Agree	Disagree	Total
Agree	a	b	30
Disagree	c	d	20
Total	40	10	50

Test statistic

$$\chi^2 = \frac{(b-c)^2}{b+c} = \frac{(10)^2}{10} = 100$$

If $a = 20 \Rightarrow b = 10, c = 20, b+c = 30$

$\chi^2 = 100/30 = 3.333, p = 0.066 \rightarrow$ fail to reject $\alpha = 0.05$

If $a = 30 \Rightarrow b = 0, c = 10, b+c = 10$

$\chi^2 = 100/10 = 10, p = 0.0016 \rightarrow$ reject H_0 at $\alpha = 0.05$

4). Data:

Patients $n = 15$

define: 2

refraction $n = 12 + 2 = 14$

Improvement: 12

no change: 1

$H_0: X \sim \text{binomial}(14, 0.5)$, where X = number of improvement

$P(X \geq 12) = P(X = 12) + P(X = 13) + P(X = 14)$

$$= \binom{14}{12} 2^{-14} + \binom{14}{13} 2^{-14} + \binom{14}{14} 2^{-14}$$

$$= 0,00555 + 0,000351 + 0,000061 = 0,0064$$

$$\text{Two sided } p \text{ value} = 2 \times 0,0064 = 0,0129$$

Decision at $\alpha = 0,05 \Rightarrow p = 0,0129 < 0,05 \rightarrow \text{reject } H_0$.

$\Rightarrow$ Conclusion

there is a statistically significant change significantly more patients improved after therapy.

5). Given data $\Rightarrow$ Pretest : 60 65 72 80 58 90 76 69 85 73
Posttest : 70 68 75 85 62 88 82 94 87 80

$$d_i = \text{Posttest} - \text{Pretest}$$

$\triangleright$ Calculate test Statistic

$$\bullet \text{ Sum of positive ranks } T^+ = 1.5 + 2.5 + 3.5 + 5 + 6.5 + 6.5 + 8 + 10 = 53.5$$

$$\bullet \text{ Sum of negative ranks } T^- = 1.5$$

$$\text{Test Statistic } T = \min(T^+, T^-) = 1.5$$

$\triangleright$ Decision rule

for $n = 10$ (pairs $\neq 0$), the critical value of Wilcoxon Signed-Rank test at $\alpha = 0,05$ (two-tailed) ≈ 8 .

$\bullet$ Since $T = 1.5 < 8$, we reject H_0 .

6). Median test

$\bullet$ the combined data ($n = 22$) gave an overall median ≈ 59.5

$\bullet$ Group A : 7 above median, 5 below

$\bullet$ Group B : 4 above median, 6 below

$\bullet$ Test statistic : $\chi^2 = 0.3$ $df = 1$, $p = 0.39$

$\bullet$ Since $p > 0,05$, we fail to reject H_0

$\Rightarrow$ Conclusion

there is no significant difference in the median scores between the two group at the 5% significance level.

7). Given data $\Rightarrow$ Group A : $n_A = 8$

$\bullet$ Group A : $n_A = 8$

Group B : $n_B = 7$

Sum total ranks = 120.

$$\text{Ranks} = 3.5 + 7 + 9 + 11 + 12 + 13 + 14 + 15 = 84.5$$

$$\text{Group B ranks} = 120 - 84.5 = 35.5$$

$\triangleright$ Compute U Statistic

$$U_A = n_A n_B + \frac{n_A (n_A + 1)}{2} - R_A$$

$$U_A = 8 \times 7 + \frac{8 \times 9}{2} - 84.5 = 56 + 36 - 84.5 = 7.5$$

$$u_B = n_A n_B - u_A = 56 - 7.5 = 48.5$$

$$\text{So, } U = \min(u_A, u_B) = 7.5$$

Decision

from Mann-Whitney U critical values table for $n_A = 8, n_B = 7$, at $\alpha = 0.05$

(two-tailed), critical value = 13.

Since $U = 7.5 < 13$, we Reject H_0 .

Conclusion: At the 5% significance level, there is a significant difference in medians between group A and Group B.

8) Given data:

Class I: $n_1 = 5$

Class II: $n_2 = 5$

Class III: $n_3 = 5$

Calculate Means

$$\bar{x}_1 = \frac{75 + 78 + 80 + 74 + 77}{5} = \frac{384}{5} = 76.8$$

$$\bar{x}_2 = \frac{82 + 85 + 89 + 81 + 83}{5} = \frac{420}{5} = 84.0$$

$$\bar{x}_3 = \frac{90 + 88 + 85 + 89 + 87}{5} = \frac{439}{5} = 87.8$$

Grand Mean

$$\bar{x} = \frac{384 + 420 + 439}{15} = \frac{1243}{15} = 82.87$$

Calculate Sum of Squares Between Groups (SSB)

$$SSB = \sum_{i=1}^k n_i (\bar{x}_i - \bar{x})^2$$

$$SSB = 5(76.8 - 82.87)^2 + 5(84.0 - 82.87)^2 + 5(87.8 - 82.87)^2$$

$$\text{Class I} = 5(-6.07)^2 = 184.15$$

$$\text{II} = 5(1.13)^2 = 6.35$$

$$\text{III} = 5(4.93)^2 = 122.85$$

$$\Rightarrow 313.35$$

SSW (Square Within Groups)

$$SSW = \sum_{i=1}^k \sum_{j=1}^{n_i} (x_{ij} - \bar{x}_i)^2$$

$$SSW = 22.80 + 10 + 14.80 = 47.60$$

Degrees of Freedom

$$df_{\text{between}} = k - 1 = 3 - 1 = 2 \quad df_{\text{within}} = N - k = 15 - 3 = 12$$

Mean Squares

$$MSB = \frac{SSB}{df_{\text{between}}} = \frac{313.35}{2} = 156.68 \quad MSW = \frac{SSW}{df_{\text{within}}} = \frac{47.60}{12} = 3.97$$

$$F_{\text{Statistic}} \Rightarrow F = \frac{MSB}{MSW} = \frac{156.68}{3.97} = 39.47$$

Decision $\Rightarrow$ At $\alpha = 0.05$ with $df_1 = 2, df_2 = 12$, the critical $F = 3.89$.

Since $39.47 > 3.89$, we Reject H_0 . $\Rightarrow$ there is a significant difference.

9) Given data

Method/Gender	Male	Female
Method 1	78, 82, 80	85, 88, 90
Method 2	75, 77, 79	80, 83, 85
Method 3	82, 84, 86	88, 90, 92

- we have :
- Factor A = type of Method (3 levels)
 - Factor B = Gender (2 levels)
 - $n = 3$ per cell (each method/gender combination)

- Cell means :
- Method 1 Male : $(78+82+80)/3 = 80.0$
 - Method 1 Female : $(85+88+90)/3 = 87.67$
 - Method 2 Male : $(75+77+79)/3 = 77.0$
 - Method 2 Female : $(80+83+85)/3 = 82.67$
 - Method 3 Male : $(82+84+86)/3 = 84.0$
 - Method 3 Female : $(88+90+92)/3 = 90.0$

- Factor Means :
- $M_1 = (80.0 + 87.67)/2 = 83.83$
 - $M_2 = (77.0 + 82.67)/2 = 79.83$
 - $M_3 = (84.0 + 90.0)/2 = 87.0$
 - Male = $(80.0 + 77.0 + 84.0)/3 = 80.33$
 - Female = $(87.67 + 82.67 + 90.0)/3 = 86.11$

$\Rightarrow$ Grand Mean $\Rightarrow \bar{X} = \frac{\text{Sum of all scores}}{N} \Rightarrow \bar{X} = \frac{1518}{18} = 84.33$

$\Rightarrow$ Total SS $\Rightarrow SS_{\text{Total}} = \sum (x_{ijk} - \bar{X})^2$

$\Rightarrow$ SSA $= nB \cdot n \cdot \sum_i (\bar{X}_{i.} - \bar{X})^2$

$= 6[-0.50]^2 + (-4.50)^2 + (2.67)^2$

$\Rightarrow$ SSA $= 6[0.25 + 20.25 + 7.11] = 6[27.6] = 165.66$

$\Rightarrow$ SSB $= nA \cdot n \cdot \sum_j (\bar{X}_{.j} - \bar{X})^2$

$SSB = 9[(80.33 - 84.33)^2 + (86.11 - 84.33)^2] = 9[16 + 3.17] = 9(19.17) = 172.53$

$SS_{B \times A \times B} = n \cdot \sum_i \sum_j (\bar{X}_{ij} - \bar{X}_{i.} - \bar{X}_{.j} + \bar{X})^2 = 4.0$

$SS_{\text{within}} = 300 - 165.66 - 172.53 - 4.0 = 4.0$

$\Rightarrow$ Degree of freedom

$df_A = a - 1 = 2$

$df_B = b - 1 = 1$

$df_{A \times B} = (a-1)(b-1) = 2 \times 1 = 2$

$df_{\text{within}} = N - ab = 18 - 6 = 12$

▷ Mean Squares

$$MS_A = SS_A / df_A, MS_B = SS_B / df_B, MS_{A \times B} = SS_{A \times B} / df_{A \times B}, MS_{within} = SS_{within} / df_{within}$$

$$MS_A = 165.66 / 2 = 82.83; MS_B = 172.53 / 3.52 = 49.00; MS_{A \times B} = 2 / 3.52 = 0.57; MS_{within} = 12.19 / 12 = 1.02$$

▷ F-Statistic

$$F_A = \frac{MS_A}{MS_{within}} = \frac{82.83}{1.02} = 81.19 \quad \left| F_B = \frac{MS_B}{MS_{within}} = \frac{49.00}{1.02} = 48.04 \right| F_{A \times B} = \frac{MS_{A \times B}}{MS_{within}} = \frac{0.57}{1.02} = 0.57$$

▷ Decision: At $\alpha = 0.05$:

- Critical F for $df_A = 2, df_{within} = 12 \approx 3.89$.
- Critical F for $df_B = 1, df_{within} = 12 \approx 4.75$.
- Critical F for $df_{A \times B} = 2, df_{within} = 12 \approx 3.89$.

Comparing: $F_A = 81.19 > 3.89 \rightarrow$ reject H_0 for Method factor.

• $F_B = 48.04 > 4.75 \rightarrow$ reject H_0 for Gender factor

• $F_{A \times B} = 0.57 < 3.89 \rightarrow$ fail to reject H_0 for interaction

Conclusion: At the 5% significance level:

- There is a significant difference in test scores between different learning methods (factor A).
- There is a significant difference in test scores between genders (factor B).
- There is no significant interaction between method and gender.

10. Given data:

$\Rightarrow$ Compute Means $\Rightarrow \bar{X} = 167$

$$\bar{Y} = 61.7$$

$\Rightarrow$ Compute Sum $\Rightarrow \sum x_i, \sum x_i^2, \sum y_i^2$

$$\sum x_i = 1670, \sum y_i = 617, \sum x_i y_i = 104,072; \sum x_i^2 = 285,536; \sum y_i^2 = 36,009$$

▷ Pearson Correlation Coefficient

$$r = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{\sqrt{[n \sum x_i^2 - (\sum x_i)^2][n \sum y_i^2 - (\sum y_i)^2]}}$$

$$r = \frac{10(104,072) - (1670)(617)}{\sqrt{[10(285,536) - (1670)^2][10(36,009) - (617)^2]}}$$

$$= -0.999$$

▷ $r = -0.999$

▷ Regression equation $\Rightarrow$

$$b = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{n \sum x_i^2 - (\sum x_i)^2} \Rightarrow b = 0.8, a = -71.9$$

$$Y = -71.9 + 0.8X$$

$$a = \bar{Y} - b\bar{X}$$

► Significance tests of r

$$t = r \sqrt{\frac{n-2}{1-r^2}}$$

$$r = 0,95, n = 10$$

$$t = 0,95 \sqrt{\frac{8}{1-0,9025}} = 0,95 \sqrt{\frac{8}{0,0975}} = 8,58$$

Degree of freedom: $n-2=8$

Critical t-value for $\alpha=0,05$ is 2,306.

Since $t = 8,58 > 2,306$, we reject H_0 — the correlation is significant.

► final Answer

- Pearson correlation coefficient: $r \approx 0,95$
- Regression equation: $Y = -11,9 + 0,8X$
- Significance: Correlation is significant at $\alpha=0,05$.

11. Given data:

AM score: 75, 76, 78, 80, 82, 82, 85, 86, 88, 88, 90, 90, 92, 94

$$H = \frac{12}{N(N+1)} \sum_{j=1}^k \frac{R_j^2}{n_j} - 3(N+1)$$

Where:

- $N = 15$ (total scores)
- $k = 7$ groups
- $n_j = 5$ (per group)
- R_j = rank sums

$$H = \frac{12}{15(16)} \left(\frac{39,5^2}{5} + \frac{19,5^2}{5} + \frac{6^2}{5} \right) - 3(16)$$

Calculate:

$$\bullet 15 \times 16 = 240, \text{ so } 12/240 = 0,05$$

$$\bullet \frac{39,5^2}{5} = \frac{1560,25}{5} = 312,05$$

$$\bullet \frac{19,5^2}{5} = \frac{380,25}{5} = 76,05$$

$$\bullet \frac{6^2}{5} = \frac{36}{5} = 7,2$$

$$\text{Sum} = 312,05 + 76,05 + 7,2 = 495,3$$

$$H = 0,05 \times 495,3 - 48 = 56,615 - 48 = 8,615$$

► Decision

→ Degree of freedom: $df = k-1 = 2$.

Critical value from F^2 table at $\alpha=0,05$

$$\rightarrow F_{0,05,2}^2 = 5,991.$$

Since $H = 8,615 > 5,991$, we reject H_0 .

Conclusion: There is a significant difference between the groups medians.