Experimental design, data analysis and presentation

Educational subject description sheet

Basic information

Field of study Environmental Protection and Management **Speciality** - **Department** Faculty of Biology **Study level** second cycle **Study form** full-time degree programme **Education profile** General academic **Mandatory** obligatory	**Education cycle** 2021/22 **Subject code** UJ.WBIEPMS.230.5cac67baddc61.21 **Lecture languages** English **Disciplines** Biological sciences **ISCED classification** 0511 Biology **USOS code**

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Lecturer	Paweł Koteja, Joanna Rutkowska

Period Semester 1	**Examination** - **Activities and hours** wykład z elementami konwersatorium: 50, classes: 30	**Number of ECTS points** 0.0

Period Semester 2	**Examination** exam **Activities and hours** conversatory classes: 15	**Number of ECTS points** 9.0

Goals

C1	The objective of the teaching is to achieve the effects of learning described in the respective points

Subject's learning outcomes

Code	Outcomes in terms of	Effects	Examination methods
Knowledge – Student knows and understands:			
W1	• The student understands basics of scientific methodology (concepts of research program, paradigm, hypothesis, falsification, and the scheme of empirical hypothesis testing) and limitations of scientific methodology (hypothetical status of scientific theories, limitations to generality of inferences and to inferences concerning causal mechanisms); • understands at a base level theoretical background of statistical methods typically applied in biological sciences, especially the methods based on the General Linear Model and the Least Squares estimation (methods of regression analysis and correlation, analysis of variance and covariance); distinguishes types of factors in experimental/quasi-experimental designs (manipulative vs. classification, fixed vs. random) and types of experimental structures (factorial vs. hierarchical).	EPM_K2_W06, EPM_K2_W07, EPM_K2_W08	written exam, project, credit
Skills – Student can:			
U1	The student can: • prepare a description of complete research project in a form suitable for a grant proposal in a main research-funding agency (e.g., the Polish National Science Centre, the US National Science Foundation, etc.); • design a proper multi-factor experiment or a quasi-experimental scheme of field observations that will allow legitimate tests of hypotheses in a given research problem; • describe statistical models (in the form of the Linear Model) and indicate proper ways of testing hypotheses concerning effects included in the models for a given complex experimental or quasi-experimental design, including both factorial and hierarchical structures and both fixed and random factors; • effectively use a spreadsheet program (e.g. Excel) to prepare well-organized databases; • effectively use statistical software packages (such as Statistica, SAS, R or other comparable programs) to perform statistical analyses for the above mentioned models, and critically interpret results of the analyses; • effectively present results of empirical research in the form of a written report and an oral presentation assisted by multimedia tools.	EPM_K2_U02, EPM_K2_U04, EPM_K2_U05, EPM_K2_U07, EPM_K2_U11	written exam, project, credit
Social competences – Student is ready to:			
K1	• The student effectively collaborates with other students in designing experiments, analyzing results, and preparing written reports and oral presentations; • complies with methodological requirements in designing research plans and interpreting results of empirical studies; • accepts the importance of research results presentation in scientific activity.	EPM_K2_K01, EPM_K2_K04, EPM_K2_K06	written exam, project

Calculation of ECTS points

Semester 1

Activity form	Activity hours*	
preparation for a test	20	
preparation for exercises	15	
problem tasks solving	15	
analysis of literature given by the teacher	15	
report preparation	15	
konsultacje	5	
wykład z elementami konwersatorium	50	
classes	30	
Student workload	**Hours** 165	**ECTS** 0.0
Workload involving teacher	**Hours** 80	**ECTS** 3.0
Practical workload	**Hours** 50	**ECTS** 2.0

* hour means 45 minutes

Semester 2

Activity form	Activity hours*	
conversatory classes	15	
preparation of a project	15	
preparation of a multimedia presentation	10	
konsultacje	5	
preparation for the exam	15	
participation in an exam	4	
Student workload	**Hours** 64	**ECTS** 9.0
Workload involving teacher	**Hours** 15	**ECTS** 0.6

* hour means 45 minutes

Study content

No.	Course content	Subject's learning outcomes
1.	Lectures/conversations: • elements of the methodology of science: research program, paradigm, hypothesis, falsification, the scheme of empirical hypothesis testing, limitations of scientific methodology; • elements of the sociology of science and mechanisms of financing: the exchange of scientific information, evaluation of the achievements of scholars and research projects, the main mechanisms of financing scientific research in Poland, a scheme of a typical grant application (such as submitted to the National Science Centre), a scheme of report from empirical research published in a scientific journal; • repetition of the basics of statistical methods; • advanced methods of statistical analysis of experimental data: theoretical basis of the least-squares estimation, analysis of regression and correlation, analysis of variance and covariance, and the General Linear Model; fixed, random, and mixed models of ANOVA and ANCOVA; factorial, hierarchical, repeated measures, and combined designs; multiple comparisons (a priori and a posteriori tests).	W1, K1
2.	Practical classes and individual work: • applications of Excel and statistical software packages (such as Statistica, SAS, R); • work on projects defined by instructor: - analysis of methodological errors in case studies; - defining proper statistical models for complex experimental designs, identifying types of the factors and model structures, and proper error terms for hypothesis testing; - planning the scheme of an experiment or field data collection for a given research problem and logistical limitations; • work on students' own projects (these can be real projects planned for MSc theses or hypothetical "dummy" projects created for the purpose of the course): - individual presentation of preliminary proposal and analysis of its scientific value and methodological correctness; - team preparation and presentation of a complete research proposal and grant application; - critical review of the research proposal; - complete statistical analysis of hypothetical results "obtained" in the project (results are generated by the instructor); - research report: preparation of a written report from the hypothetical project, in such a form as required by scientific journals for manuscript submissions; - research report: oral presentation of results from the hypothetical project in a form suitable for a typical conference (support with computer-based slides); - critical review of the written and oral presentations of research report.	W1, U1, K1

Course advanced

Semester 1

Teaching methods:

conversation lecture, lecture with multimedia presentation, case study, solving tasks, practicals

Activities	Examination methods	Credit conditions
wykład z elementami konwersatorium		• Active participation in discussions; • Accepted individual and group work (research project, report, and presentation);

Activities	Examination methods	Credit conditions
classes		- accepted reports from individual homework; - >40% points in quizzes performed during practical classes. The final score for practical classes is pass/fail.

Semester 2

Teaching methods:

project method, seminar, case study

Activities	Examination methods	Credit conditions
conversatory classes	written exam, project, credit	• Active participation in discussions; • Accepted individual and group work (research project, report, and presentation); • Final exam consisting of two parts: - theoretical (paper-based): a test checking theoretical knowledge and designing a plan of an experiment or a scheme of field-data collection that solves a given research problem within given logistical limitations, and proposing an adequate statistical model for the design; - practical (computer-based): performing complete data analysis for a given problem and a set of empirical results; - conditions of passing the final exam: >40% points from each of the two parts of the exam; • Condition of getting the credit for the entire course: > 50% points for the weighted mean score from the quizzes performed on practical classes and the exam.

Entry requirements

• knowledge of basic statistical methods, such as required in level I biology curriculum; • ability to effectively use a computer with Windows OS and basic office software (Word, Excel, PowerPoint)
Participation in lectures is obligatory

Literature

Obligatory

1. J. Fowler, L. Cohen & P. Jarvis: Practical Statistics for Field Biology. Wiley, 2nd edition, 1998 (or newer)
2. Karen Kinsley: A student handbook for writing in biology. Sinauer, 2013 (or newer).
3. P. Dalgaard: Introductory Statistics with R. Springer, 2008

Optional

1. G. Quinn and M. Keough: Experimental design and data analysis for biologists. Cambridge U. Press 2002 (or newer).
2. Internet sources, especially manuals and handbooks of respective statistical software packages (primarily R).

Effects

Code	Content
EPM_K2_W06	The graduate knows and understands the rules of planning research and verifying research hypotheses, as well as research techniques and tools used in the analysis and evaluation of the quality of natural environment
EPM_K2_W07	The graduate knows and understands the rules of acquiring and settling academic and implementation projects in environment protection and natural resources management
EPM_K2_W08	The graduate knows and understands the rules of analyzing empirical data, research results and their interpretation, as well as the rules of predicting the course of biological phenomena and processes while using relevant mathematical, statistical and computational methods
EPM_K2_U02	The graduate is able to use appropriate statistical tools and software to collect and interpret data
EPM_K2_U04	The graduate is able to prepare public presentations related to environment and nature protection using various techniques of verbal and multimedia communication
EPM_K2_U05	The graduate is able to write a text on environment protection issues presenting his/her own research and describe the results of his/her professional evaluations and environmental analyses
EPM_K2_U07	The graduate is able to plan and evaluate the condition of the environment and natural resources under the guidance of the academic supervisor and to evaluate the risks of planned actions and investments for the environment.
EPM_K2_U11	The graduate is able to continuously acquire knowledge and raise his/her qualifications, inspire and help others, set and achieve career objectives
EPM_K2_K01	The graduate is able to critically appraise acquired information, use reliable and well-established sources of scientific information and draw appropriate conclusions when settling practical problems
EPM_K2_K04	The graduate is able to think and act independently to protect natural environment and to manage common resources in a sustainable way
EPM_K2_K06	The graduate is able to pursue team work while assuming different roles and also is able to plan the work in terms of sharing responsibilities and managing time