

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	ZNANSTVENI PRISTOPI V NARAVOSLOVJU
Course title:	SCIENTIFIC APPROACHES IN NATURAL SCIENCES

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Vede o Zemlji in okolju, magistrski študij 2. stopnje	vsí	1	1
Earth and Environmental Sciences, Master study 2nd level	all	1	1

Vrsta predmeta / Course type Obvezni/Mandatory

Univerzitetna koda predmeta / University course code: MT001

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
35		35			80	6

Nosilec predmeta / Lecturer: Simona Kralj-Fišer (Asistent: Janko Šet)

Jeziki / Languages:	Predavanja / Lectures:	angleščina, angleščina / Slovenian, English
	Vaje / Tutorial:	angleščina, angleščina / Slovenian, English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Končan študijski program 1. stopnje ali dodiplomski študijski program za pridobitev univerzitetne izobrazbe, sprejet pred 11. 6. 2004 s področja naravoslovja.

Prerequisites:

First-cycle Bologna degree or a university degree in the natural sciences.

Vsebina:

SPLOŠNI DEL:

- Hipotetični deduktivizem vs. Induktivizem
- Osnove teorije znanosti
- Empiričen vs. teoretičen pristop
- Osnove znanstvene metode (karakterizacija problema, hipoteze, predikcije, opazovanje/meritve, eksperimenti)
- Koraki v znanstveni metodi (identifikacija znanstvenega vprašanja, pregled in pregled literature (Web of Science, Google Scholar, Endnote, idr.), postavitve hipotez,

Content (Syllabus outline):

GENERAL PART:

- Deductive vs. inductive reasoning
- Principles of scientific theory
- Empirical vs. theoretical approach
- Essentials of the scientific method (characterizations, hypotheses, predictions, observation/measurement, experiments)
- Steps in the scientific method (defining research problem, literature searches and management (Web of Science, Google

opazovanja in meritve, laboratorijske analize, empirični poskusi / testi (tipi, osnove načrtovanja eksperimentov, dejavniki, ki vplivajo na rezultate), modeliranje (vzpostavljanje in validacija modelov), oblikovanje teorij in odkrivanje naravnih zakonov, analiza podatkov, interpretacija in posploševanje rezultatov)

- Osnovne statistične metode (osnovni pojmi, tipi podatkov, opisna statistika, porazdelitev podatkov, grafični prikazi, analiza časovnih vrst, testiranje hipotez, parametrični in neparametrični testi: korelacija, regresija, (M)AN(C)OVA, faktorska analiza)
- Veljavnost in zanesljivost rezultatov; ponovljivost raziskav, verifikacija modelov
- Struktura znanstvenega pisanja (kako napisati seminar, članek, abstrakt, magistrsko nalogo);
- raziskovalna etika (plagiatorstvo idr).

SPECIFIČNI DEL:

- Osnovni raziskovalni pristopi v raziskavah biodiverzitete, ekologije in evolucije (osnovni pojmi in principi, predstavitev metod iz študijskih primerov: npr. Ekosistemska pestrost Slovenije, Mikro- in makroevolucijski vzorci zlatih mrežarjev, Povezava med okoljskimi faktorji in rastlinsko vrstno pestrostjo mokrotnih travnikov, spoznavanje orodij in dela v molekularnem laboratoriju in na terenu)
- Osnovni raziskovalni pristopi v krasoslovju (multidisciplinarnost metodologije, primeri geološko-geomorfoloških, hidrogeoloških, meteoroloških, fizikalnih, laboratorijsko-kemičnih in prostorsko-geografskih metod v krasoslovju)
- osnovni raziskovalni pristopi v paleontologiji in sedimentarni geologiji (metode vzorčevanja v paleontologiji in sedimentologiji, neodvstnost vzorčevanja, ponovljivost rezultatov, terenski in laboratorijski pristop k raziskovanju).

Scholar, Endnote, etc.), defining hypothesis, observation/measurement, laboratory analyses, empirical tests (types, basics of experimental design, confounding factors), modeling (setting and validating models), formulating theories and discovering natural laws, data analyses, results interpretation and generalization)

- The basics of statistical methods (basic terms, types of data, descriptive statistics, sampling distribution, graphical representations, time series analysis, statistical hypothesis testing, parametric and nonparametric tests: correlation, regression, (M)AN(C)OVA, factor analysis)
- Validity and reliability of the results; repeatability and reproducibility of research
- Structure of scientific writing (how to write seminar, abstract, research paper, thesis);
- Ethics in research (plagiarism, etc.).

SPECIFIC PART:

- The basics of research in biodiversity, ecology and evolution (research: terms and principles, case studies method presentation: e.g. Ecosystem diversity of Slovenia, Micro- and macroevolutionary patterns in nephilids, plant species richness in wet grassland and relation to environmental factors, familiarization with molecular laboratory and the field survey tools and methods).
- Basic research approaches in karstology (multidisciplinary methodology, examples of geological-geomorphological, hydrogeological, meteorological, physical, laboratory-chemical and spatial-geographical methods in karstology)
- Basic research approaches in paleontology and sedimentary geology (sampling methods in paleontology and sedimentology (sampling independence, repeatability of results), field and laboratory approach).

Temeljni literatura in viri / Readings:

- Quinn, G. P., & Keough, M. J. (2002). *Experimental design and data analysis for biologists*. Cambridge University Press. Chapters: 1-8, 12-13, 17.
- Snieder, R., Larner, K. (2010). *The Art of Being a Scientist : a guide for graduate students and their mentors*. Cambridge University Press. Chapter 2: »What is Science«, Chapter 8: »Ethics of Research«.
- Gomarasca, M. A. (2009). *Basics of Geomatics*. Springer.
- Kastens, K.A. & Manduca, C.A. (Eds.) (2012). *Earth and Mind II: A Synthesis of Research on Thinking and Learning in the Geosciences*. Geological Society of America Special Paper Vol. 486.
- Silobrčić, V. 2008: *Kako sastaviti, objaviti i ocijeniti znanstveno djelo*. Medicinska naklada Zagreb, 298 pp.
- Izbrani članci iz znanstvenih revij. / Selected articles from scientific journals.
- Hammer, Ø., Harper, D. 2006: *Paleontological data analysis*. Blackwell Publ. 78-316.
- Frodeman R. 1995: *Geological reasoning: Geology as an interpretive and historical science*. GSA Bulletin 107/8, 960–968.
- Cochran, W., Fenner, P., Hill, M. 1979: *Geowriting. A guide to writing, editing, and printing in Earth science (3rd edition)*. American Geological Institute. 1-69.

Cilji in kompetence:

Prvi cilj tega predmeta je seznaniti študente s temelji znanstvene metodologije v naravoslovju. Znanstveni napredek je rezultat stalnega, postopnega procesa, ki vključuje generiranje hipotez, zbiranje dokazov, analize podatkov, testiranje hipotez in sklepanje na podlagi dokazov. Študenti bodo spoznali različne veljavne načine za reševanje znanstvenih vprašanj z različnimi vrstami podatkov. Preko tega se bodo naučili, da moramo znanstvene pristope prilagajati posebnostim izbranih znanstvenih disciplin. Študenti bodo spoznali metodološke pristope v znanosti, kot so opazovanje, merjenje, vzorčenje in eksperimentalne raziskave. V prvem delu predavanj bodo študenti seznanjeni s splošnimi komponentami znanstvenega raziskovanja, kot so logično sklepanje v hipotetičnem deduktivizmu in načrtovanje raziskav. Naučili se bodo osnovnih znanj statistike in uporabe pogostih statističnih testov. Slednje bodo izvajali tudi praktično v programih R in SPSS. Poučili se bodo o ponovljivosti raziskav. Predstavljen bo pristop objavljanja, kjer raziskovalci objavljajo svoje znanstvene članke skupaj z prostodostopnimi podatki in analizami, ki so jih uporabili. Poseben poudarek bo na poznavanju znanstvene etike.

Objectives and competences:

The first objective of this course is to help students understand the basic scientific methodology in natural sciences. Scientific progress involves a continuous, incremental process that involves generating hypotheses, collecting evidence, testing hypotheses, data analyses, and reaching evidence-based conclusions. There are different valid ways to address scientific questions and there are various types of data. Approaches thus need to flexibly adapt to particulars of a scientific discipline. Students will learn about methodological approaches in science, such as observation, measurement, sampling, and experimental research. The first part of the course will introduce students to the common components of scientific inquiry, from its logical foundation in hypothetical deductivism, to experimental design and the basics of statistical analyses. The latter will be taught during practical courses of R and SPSS statistical tools. The idea of scientific work is to undertake reproducible research. Students will get familiar with ways to verify research findings where data and analyses are freely shared. Special emphasis will be laid on scientific ethics. In order to disseminate results effectively, the course will teach scientific dissemination. For native and non-native

Za učinkovito komunikacijo rezultatov znanstveni in širši publiki se bodo študenti naučili znanstvenega pisanja. V sodobni znanosti je tako za domače kot tuje študente znanje znanstvene angleščine bistvenega pomena. Spretnost v le-tem bodo pri predmetu pridobili preko individualnih, vendar vodenih, seminarjev. Na ta način se bodo študenti urili v pisanju v angleščini, uporabi sodobnih iskalcev literature in orodjih za urejanje referenc. V drugem delu bodo spoznali osnovne pojme, pristope in metode s področij vseh treh študijskih usmeritev / modulov: raziskave biodiverzitete, ekologije in evolucije, krasoslovja ter paleobiologije in sedimentarne geologije. To znanje bodo poglobili preko študijev primerov in praktičnim udejstvovanjem. Študenti bodo osvojeno znanje iz obeh delov združili v pripravo končnega izdelka, strokovnega članka.

speakers alike, scientific English is of prime importance in modern science. The course will thus take a seminar-based approach to a scientific paper the student will write in English while using modern literature searches and reference management tools.

The second part of the course will focus on the basic principles and approaches to scientific endeavour specific to the disciplines covered in the study program Life on Earth: biodiversity, ecology and evolution studies, karst research and paleobiology and Sedimentary geology. The student's knowledge will be further deepened through presentation of case studies and participation in molecular lab work and a field survey. Students will merge both parts of the course into a final product, a professional paper.

Predvideni študijski rezultati:

- Študenti bodo pridobili znanje o znanstvenih metodah in pristopih ter o pravilnem načrtovanju in poteku znanstvenih raziskav; spoznali bodo metodologije različnih naravoslovnih področij, dobili bodo praktične izkušnje z iskanjem in kritičnim vrednotenjem znanstvene literature, pridobivanjem podatkov in postopki statističnih analiz ter se priučili znanstvenega pisanja.
- Študenti bodo poznali principe in osnovne znanstvene pristope v raziskavah biodiverzitete, ekologije in evolucije, krasoslovja ter paleobiologije in sedimentarne geologije.
- Študenti bodo sposobni samostojno izvajati osnovne statistične analize
- Študenti bodo sposobni samostojnega zbiranja vsebin s področij biodiverzitete, ekologije in evolucije, krasoslovja ter paleobiologije in sedimentarne geologije, njihovo smiselno povezovanje in artikulirano predstavljanje drugim v pisni in ustni obliki (seminar).

Intended learning outcomes:

- Students will be equipped with knowledge on the scientific approach and experimental design, will understand the differences in natural scientific fields, and will obtain hands-on experience with literature searches, data acquisition and analyses, as well as scientific writing.
- Students will learn principles and basic scientific methodology that is specific to biodiversity, ecology and evolution research, karst research and paleobiology and Sedimentary geology research.
- Students will be independent in basic statistical analyses
- Skills in reading and interpreting literature from the fields of biodiversity, ecology and evolution, karstology and paleobiology and sedimentary geology, as well as summarizing and presenting these in written and oral forms (seminar).
- Students will gain experience in research work in the fields of biodiversity, ecology and evolution, karstology and paleobiology and sedimentary geology, in the laboratory and in the field.

<ul style="list-style-type: none"> • Študentje bodo imeli izkušnje z raziskovalnim delom na področjih raziskavah biodiverzitete, ekologije in evolucije, krasoslovja ter paleobiologije in sedimentarne geologije, v laboratoriju in na terenu. 	
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Metode poučevanja in učenja:

<ul style="list-style-type: none"> • Predavanja • Računalniški laboratorij (R, SPSS) • Seminar • Delo na terenu • Vaje

Learning and teaching methods:

<ul style="list-style-type: none"> • Lectures • Computer laboratory (R, SPSS) • Seminar • Field work • Tutorial
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Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment
<ul style="list-style-type: none"> • Izpit (ustni) • Končni izdelek - strokovni prispevek napisan v angleškem jeziku - bo po principu znanstvene recenzije pregledal in ocenil predavatelj specifičen za področje študentskega študija. 	<p>50%</p> <p>50%</p>	<ul style="list-style-type: none"> • Exam (oral) • The final product, a professional paper written in English, will be evaluated through a simulated peer review by the lecturer specific to the student field of study.

Reference nosilca / Lecturer's references:

<ol style="list-style-type: none"> 1. Kralj-Fišer, S., Čandek, K., Lokovšek, T., Čelik, T., Cheng, R. C., Elgar, M. A., & Kuntner, M. (2016). Mate choice and sexual size dimorphism, not personality, explain female aggression and sexual cannibalism in raft spiders. <i>Animal Behaviour</i>, 111, 49-55. 2. Kralj-Fišer, S., Hebets, E. A., & Kuntner, M. (2017). Different patterns of behavioral variation across and within species of spiders with differing degrees of urbanization. <i>Behavioral Ecology and Sociobiology</i>, 71(8), 125. 3. Kralj-Fišer, S., & Gregorič, M. (2019). Spider Welfare. In <i>The Welfare of Invertebrate Animals</i> (pp. 105-122). Springer, Cham. 4. Kralj-Fišer, S., Laskowski, K. L., & Garcia-Gonzalez, F. (2019). Sex differences in the genetic architecture of aggressiveness in a sexually dimorphic spider. <i>Ecology and evolution</i>, 9(18), 10758-10766. 1. Kralj-Fišer, S., Premate, E., Copilaș-Ciocianu, D., Volk, T., Fišer, Ž., Balázs, G., ... & Fišer, C. (2020). The interplay between habitat use, morphology and locomotion in subterranean crustaceans of the genus <i>Niphargus</i>. <i>Zoology</i>, 139, 125742.
