Mag. Luka Praprotnik, dr. Gregor Torkar

Razumevanje pojma prehranjevalna veriga med bodočimi učitelji

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KLJUČNE BESEDE: prehranjevalna veriga, gozd, vrstna pestrost, znanje, študent

POVZETEK – V raziskavi se osredotočamo na pomen poznavanja vrstne pestrosti ekosistemov za ustrezno uporabo pojma prehranjevalna veriga. Zanimalo nas je, ali študenti predšolske vzgoje in razrednega pouka, ki bodo poučevali otroke o ekoloških pojmih, kot sta prehranjevalna veriga in prehranjevalni splet, znajo pravilno navesti konkretne primere prehranjevalnih verig v slovenskih gozdovih. V raziskavi je sodelovalo 170 študentov Pedagoške fakultete Univerze v Ljubljani. Študenti so morali navesti štiri primere prehranjevalnih verig za gozd in pojasniti, kaj predstavlja prehranjevalna veriga. Iz rezultatov je razvidno, da slaba četrtina vprašanih ni pravilno navedla niti enega primera verige. Izkazalo se je, da imajo študenti težave z razumevanjem vloge puščic v prehranjevalni verigi, ki pogosto izostanejo ali so nasprotno obrnjene. Ugotavljamo tudi, da večina študentov nima toliko težav z razumevanjem pojma prehranjevalna veriga, kot ga ima s poznavanjem vrstne pestrosti gozda in prehrane živali, kar jim otežuje ustrezno sestavo primerov prehranjevalnih verig.

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KEYWORDS: food chain, forest, species diversity, knowledge, student

ABSTRACT – This article focuses on the importance of familiarity with the species variety of ecosystems for proper use of the food chain concept. We were interested in whether university students in preschool and primary school education programmes, who will teach children about ecological concepts such as food chains and food webs, can correctly name specific examples of food chains in Slovenian forests. The study included 170 students from the University of Ljubljana's Faculty of Education. The students had to list four examples of food chains and explain what a food chain is. The results show that a quarter of the respondents did not offer a single correct example of a food chain. It turned out that students find it difficult to understand the role of arrows in a food chain. The arrows were often missing or facing the wrong direction. Most students do not have as much difficulty understanding the concept of a food chain, but they have limited familiarity with species diversity in the forest and animal nutrition, which makes it difficult for them to adequately structure food chain examples.

1 Uvod

V ekologiji ponazarjamo prehranjevalna zaporedja in procese z različnimi diagrami, kot sta prehranjevalna veriga in prehranjevalni splet. Prehranjevalna veriga predstavlja linearno zaporedje organizmov oziroma transfer energije, nakopičene v hrani od primarnega producenta prek zaporedja porabnikov, kjer je vsak plenilec v verigi za nekoga tudi hrana (Odum, 1971; Tome, 2006). Tarman (1992) opisuje, da je za delovanje ekosistema oziroma združbe pomembno izkoriščanje in prenos energije med sestavnimi deli ekosistema, vse to pa poteka s prehranjevanjem. Pojasnjuje, da se vrste iz prehranjevalne verige in spleta uredijo v prehranjevalne ravni ali trofične nivoje. Rastlinam in drugim primarnim proizvajalcem sledijo rastlinojedci, to so potrošniki prvega reda. Tem sledijo mesojedci, ki so potrošniki drugega reda. Mesojedcem prvega reda sledijo

mesojedci drugega reda, torej potrošniki tretjega reda, in tako naprej. Vrste so med sabo povezane kakor členi verige, zato jih imenujemo prehranjevalne ali trofične verige (Tome, 2006). Med členi verige se prenaša le približno 10–20 % energije na višji trofični nivo, posledično je število členov verige omejeno na štiri do pet (Odum, 1971, 1989). Povezave med členi verige ponazarjamo s puščicami, ki označujejo smer pretvorb energije in snovi. Prehranjevalne verige niso med seboj izolirane, ampak se povezujejo v prehranjevalne ali trofične splete. V takšnih sistemih odnosi med organizmi niso samo premočrtni, kot pri verigi, ampak se razvijejo v različne smeri (Tome, 2006).

Znanje o prehranjevalnih spletih in verigah je priljubljena ekološka tema v pedagoškem raziskovanju (Adeniyi, 1985; Allen, 2017; Hogan, 2000; Leach et al., 1996; Wyner in Blatt, 2018). Allen (2017) ugotavlja, da večina petletnikov lahko dojame ključne koncepte, povezane s prehranjevalno verigo, ki se jih učenci učijo v času osnovnošolskega izobraževanja. Po drugi strani pa Adeniyi (1985), Leach in sodelavci (1996), Hogan (2000) ter Wyner in Blatt (2018) poročajo, da imajo učenci in dijaki pogosto težave s pojmoma prehranjevalna veriga in splet. Zamenjujejo pojma prehranjevalni splet in prehranjevalna veriga (Adeniyi, 1985; Wyner in Blatt, 2018). Griffiths in Grant (1985) poročata, da dijaki razumejo prehranjevalni splet le kot zbir več prehranjevalnih verig. Težave imajo pri razumevanju prenosa energije v navedenih sistemih in posrednih vplivov med organizmi (Hogan 2000, Leach et al. 1996). Sebe pogosto tudi ne zaznavajo kot dela prehranjevalne verige ali spleta (Wyner in Blatt, 2018). Hogan (2000) poroča, da kljub enomesečnemu poučevanju, ki je vključevalo učna gradiva in praktično delo, kjer so v plastenkah izdelovali poenostavljene ekosisteme z živimi organizmi, polovica učencev ni napredovala v svojem razumevanju interakcij oziroma vplivov med organizmi v danem primeru prehranjevalnega spleta. Pri večini ostalih učencev pa je bil opažen le manjši napredek.

V članku prestavljamo izsledke preliminarne raziskave, kjer se osredotočamo na pomen poznavanja vrstne pestrosti ekosistemov za ustrezno uporabo pojma prehranjevalna veriga. Ob pregledu domače in tuje literature namreč nismo zasledili raziskave, ki bi se osredotočala na ta vidik opisane problematike. Zanimalo nas je, ali bodoči učitelji in vzgojitelji, ki bodo poučevali predšolske otroke in učence o ekoloških pojmih, kot sta prehranjevalna veriga in prehranjevalni splet, znajo pravilno navesti konkretne primere prehranjevalnih verig v slovenskih gozdovih. S tem smo želeli dobiti vpogled v njihovo poznavanje vrstne pestrosti v gozdu, ki je predpogoj za ustrezno sestavo primerov prehranjevalnih verig za gozd.

2 Raziskovalni vprašanji

- Kako dobro študenti razumejo pojem prehranjevalna veriga v gozdu?
- Kako dobro študenti poznajo vrstno pestrost gozdnih organizmov?

3 Metoda

Vzorec

V raziskavi je sodelovalo 170 študentov Pedagoške fakultete Univerze v Ljubljani. Od tega 105 študentov dodiplomskega študijskega programa Predšolska vzgoja, ki so obiskovali predmet Začetno naravoslovje, ter 55 študentov dodiplomskega študijskega programa Razredni pouk, ki so obiskovali predmet Naravoslovje – biološke vsebine. Dodatno smo 10 študentov dodiplomskega študijskega programa podrobneje izprašali o razumevanju podanega primera prehranjevalne verige za gozd.

Instrument in potek zbiranja podatkov

Študentom smo pisno zastavili vprašanje oziroma dali navodilo, ki se je glasilo: "Napišite štiri primere prehranjevalnih verig v slovenskih gozdovih. Vsak primer verige naj vsebuje najmanj tri člene (rastlina, rastlinojed, mesojed) in ti naj se ne ponavljajo med navedenimi primeri verig." Z vprašanjem oziroma navodilom smo želeli preveriti razumevanje pojma prehranjevalna veriga ter poznavanje vrstne pestrosti gozdnih organizmov. Naknadno smo izvedli še deset poglobljenih intervjujev s študenti študijskega programa Razredni pouk, ki niso sodelovali v preizkusu znanja. Podrobneje smo jih izprašali o razumevanju prikaza prehranjevalne verige (vsakemu študentu je bil prikazan primer prehranjevalne verige s tremi členi: *bor → gosenica borovega prelca → kukavica*). Zanimalo nas je, ali študenti vedo, da je prikazani diagram prehranjevalna veriga, zakaj je rastlina na prvem mestu prehranjevalne verige, kaj predstavlja vrstni red organizmov v verigi ter kaj ponazarjajo puščice v diagramu.

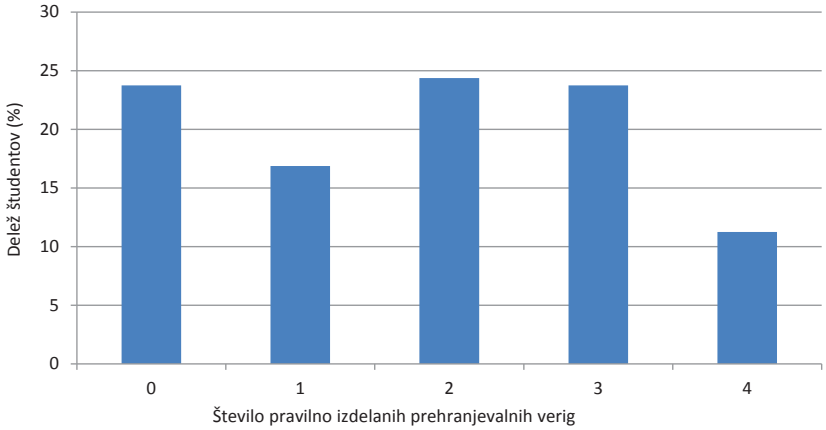
Obdelava zbranih podatkov

Zbrani podatki so bili kvantitativno obdelani. Uporabljeni postopki obdelave podatkov so zajemali postopke opisne statistike. Izračunani so bili odstotki (f%) in frekvence (f). Rezultati so prikazani grafično ali tabelarično. Podatki, pridobljeni s pomočjo intervjujev, so bili obdelani kvalitativno.

4 Rezultati

Iz rezultatov, prikazanih na sliki 1, je razvidno, da je le 11 % študentov ustrezno navedlo vse štiri primere prehranjevalnih verig v gozdu. Slaba četrtina vprašanih ni pravilno navedla niti enega primera verige.

Slika 1: Deleži študentov, ki so pravilno zapisali določeno število primerov prehranjevalnih verig v gozdu.



Najpogostejše napake študentov pri zapisu prehranjevalnih verig v gozdu smo vsebinsko kategorizirali in predstavili v tabeli 1. Iz tabele je razvidno, da so študenti najpogosteje napačno definirali taksone rastlin. Pri tem so navajali različne rastlinske organe, oblike rastlin ali zamenjevali rastline z glivami in drugimi heterotrofi. Študenti so imeli tudi težave s poznavanjem prehrane posameznih skupin živali in jih posledično napačno uvrščali v trofične nivoje. Opazno je tudi pomanjkljivo razumevanje pomena puščic in njihove smeri v zapisu prehranjevalne verige. Velikokrat puščice ni bilo ali je ta bila usmerjena v nasprotno smer proti primarnim producentom. Med napakami smo opazili tudi neustrezne primere organizmov, ki jih v gozdnih ekosistemih ne najdemo.

Tabela 1: Vrste napak, ki so jih študenti delali pri zapisu prehranjevalnih verig v gozdu

Vrsta napake	*f*	*f (%)*	*Primeri napak*	*Pojasnilo*
Rastlinski organi	163	38,63	žir, list, korenina	Ni navedena vrsta organizma, ampak le organ oziroma del rastline.
Manjka navedba proizvajalca	28	6,64	manjka rastlina, gliva namesto rastline, rastlina ni navedena na začetku prehranjevalne verige	Nerazumevanje funkcije proizvajalca v prehranjevalni verigi.
Oblike rastlin	28	6,64	grmičevje, podrast, drevo	Ni naveden vrsta rastline, ampak oblika rastline.
Nepoznavanje prehrane živali	47	11,14	trava – pikapolonica – pajek	Žival ni na ustreznem trofičnem nivoju v prehranjevalni verigi.
Neustrezne verige za gozd	36	8,53	solata – kokoš – lisica	Slabo poznavanje gozdnega ekosistema.
Neustrezna raba puščic	120	28,44	manjkajo, nasprotno obrnjene	Nerazumevanje pomena puščic v zapisu prehranjevalne verige.

Analiza pogostosti pojavljanja posameznih taksonomskih skupin rastlin (tabela 2) in živali (tabela 3) je pokazala, da med rastlinami močno prevladuje navajanje primerov semenk (94,1 %), med skupinami živali pa sesalcev (55,5 %). Študenti so navedli 24 različnih vrst rastlin oziroma njihovih skupin. Deset najpogostejših je navedenih v tabeli 4. Rastline, katerih skupni delež navedb presega 10 odstotkov, so trava, hrast in bukev. Študenti so navedli 44 različnih vrst živali oziroma skupin živali. Deset najpogostejših je navedenih v tabeli 5. V prehranjevalnih verigah so najpogosteje uporabili lisico, veverico, srno in zajca. V prehranjevalnih verigah so navajali tudi glive. Navedli so jih štiriindvajsetkrat. Večinoma so jih napačno uvrščali na začetek prehranjevalne verige, torej na mesto primarnih proizvajalcev. Le v petih primerih so jih pravilno uvrstili v prehranjevalno verigo. Navedli so štiri različne glive oziroma njihove skupine (npr. goba, gliva, jurček, lisička).

Tabela 2: Deleži posameznih skupin rastlin, ki so jih študenti navedli v prehranjevalnih verigah v gozdu

Taksonomska skupina	*f*	*f(%)*
Mahovi	4	0,69
Lišaji	1	0,17
Praprotnice	29	5,03
Semenke	542	94,10
Vsota	576	100

Tabela 3: Deleži posameznih skupin živali, ki so jih študenti navedli v prehranjevalnih verigah v gozdu

Taksonomska skupina	*f*	*f(%)*
Sesalci	703	55,53
Ptice	219	17,30
Plazilci	15	1,18
Dvoživke	31	2,45
Žuželke	207	16,35
Pajkovci	15	1,18
Kolobarniki	27	2,13
Mehkužci	32	2,53
Raki	1	0,08
Druge skupine živali	16	1,26
Vsota	1266	100

Tabela 4: Seznam najpogosteje omenjenih rastlin oziroma njihovih skupin

Vrsta rastline/skupina rastlin	*f*	*f(%)*
Trava	110	19,10
Hrast	71	12,33
Bukev	58	10,07
Leska	36	6,25
Smreka	34	5,90
Praprot	29	5,03
Detelja	22	3,82
Kostanj	13	2,26
Malina	11	1,91
Regrat	10	1,74

Tabela 5: Seznam najpogosteje omenjenih živali oziroma njihovih skupin

Živali/skupina živali	*f*	*f(%)*
Lisica	120	9,48
Veverica	110	8,69
Srna	84	6,64
Zajec	83	6,56
Volk	63	4,98
Medved	55	4,34
Ris	50	3,95
Listna uš	42	3,32
Pikapolonica	40	3,16
Miš	40	3,16

S pomočjo desetih poglobljenih intervjujev smo želeli pridobiti njihove interpretacije prehranjevalne verige ter s tem dopolniti odgovor na prvo raziskovalno vprašanje. Ugotovili smo, da večina prepozna prikazani diagram kot prehranjevalno verigo. Le eden od desetih študentov je prikazani diagram poimenoval ekosistem. Študenti raznoliko pojasnjujejo, zakaj je rastlina prvi člen prehranjevalne verige. Med odgovori so: "ker je hrana živalim", "ker je avtotrof", "ker živali ne morejo pretvarjati energije sonca" ter "ker je prehranjevanje rastline manj kompleksno od prehranjevanja živali". Tudi v odgovorih na vprašanji, kaj predstavlja vrstni red organizmov in kaj ponazarjajo puščice, je očitno, da študenti razumejo prehranjevalno verigo predvsem kot ponazoritev odnosov med plenom in plenilcem oziroma "kdo koga poje", kot se je izrazila ena od študentk. Samo dva od desetih intervjuvanih študentov eksplicitno pojasnita, da puščice prikazujejo prehajanje energije med posameznimi členi prehranjevalne verige. Drugi

na primer navajajo, da puščica ponazarja, "kdo je vir hrane komu" ali "tisti, v kogar je usmerjena puščica, ima korist od tistega, iz katerega gre puščica".

5 Razprava in zaključek

Kurikulum za vrtce predvideva, da predšolski otroci neposredno spoznavajo različne naravne ekosisteme in odnose med organizmi v ekosistemih. Med globalnimi cilji je navedeno, da je treba spodbujati "doživljanje in spoznavanje žive in nežive narave v njeni raznolikosti, povezanosti, stalnem spreminjanju in estetskih razsežnostih" (Kurikulum za vrtce, 1999, str. 38). Tudi učni načrti za osnovno šolo, predvsem predmetov naravoslovje in tehnika, naravoslovje ter biologija, predvidevajo obravnavo pojmov iz ekologije. Pojma prehranjevalna veriga in splet se obravnavata prvič v petem razredu osnovne šole pri predmetu naravoslovje in tehnika. Med učnimi cilji je navedeno, da morajo petošolci znati sestaviti preproste prehranjevalne verige in jih povezati v prehranjevalne splete (Učni načrt: program osnovnošolskega izobraževanja Naravoslovje in tehnika, 2011). V prvem raziskovalnem vprašanju nas je zato zanimalo, ali so študenti, bodoči vzgojitelji in učitelji razrednega pouka, ustrezno usposobljeni za razlago pojma prehranjevalna veriga. Iz rezultatov raziskave je razvidno, da skoraj četrtina vprašanih ni pravilno sestavila niti enega primera prehranjevalne verige v gozdu. Ostale tri četrtine vprašanih so pravilno navedle en, dva, tri ali štiri primere prehranjevalnih verig v gozdu.

Nepravilnosti v analiziranih prehranjevalnih verigah so redko odraz nerazumevanja trofičnih nivojev v prehranjevalni verigi oziroma položaja rastlin kot primarnih producentov. Opisane težave študentov zaznavajo tudi v predhodnih raziskavah (npr. Hogan, 2000; Wyner in Blatt, 2018). Več težav imajo študenti z razumevanjem vloge puščic v prehranjevalni verigi, ki pogosto izostanejo ali so nasprotno obrnjene. Iz rezultatov je moč sklepati, da je to posledica napačnega razumevanja, kaj puščice pravzaprav ponazarjajo. Študenti zelo pogosto razlagajo prehranjevalno verigo predvsem kot odnose med organizmi, kjer plenilec poje plen, in temu primerno puščice usmerijo proti primarnemu producentu.

Večina študentov torej nima toliko težav z razumevanjem pojma prehranjevalna veriga, ampak imajo večje težave s poznavanjem vrstne pestrosti gozda (drugo raziskovalno vprašanje) in z nepoznavanjem prehrane živali. Pomanjkanje znanja o vrstni pestrosti rastlin študenti nadomeščajo z uporabo splošnejših pojmov grmičevje, drevo in podrast. Navajajo tudi različne rastlinske organe (npr. list) ali pa med primarne producente uvrstijo glivo. Tudi število in vrstna sestava navedenih rastlin pričata o njihovem omejenem poznavanju drevesnih vrst in drugih gozdnih rastlin. Večinoma omenjajo semenke, čeprav lahko v slovenskih gozdovih opazujemo tudi veliko vrst praprotnic in mahov. Pomanjkanje znanja o rastlinah ter sposobnosti določanja rastlinskih vrst sta lahko odraz njihovega nezanimanja za rastline, kar imenujemo "rastlinska slepota" (Wandersee in Schussler, 2001). Študenti izkazujejo tudi omejeno znanje o živalskih vrstah v gozdu. Med navedenimi prevladujejo sesalci. Težave imajo tudi s poznavanjem prehrane posameznih skupin živali, zato so jih posledično napačno uvrščali v trofične nivoje.

Študenti torej razmeroma slabo poznajo vrstno pestrost gozdov, kar močno omejuje njihove sposobnosti sestavljanja primerov prehranjevalnih verig v gozdu. Slabo poznavanje vrstne pestrosti v gozdu neobhodno pomeni tudi slabše razumevanje nekaterih vlog in funkcij gozda oziroma ekosistemskih storitev, predvsem podpornih in regulatornih storitev. Biotska pestrost ima dokazano velik vpliv na večino ekosistemskih storitev (Balvanera et al., 2006). Slovenija je tretja najbolj gozdnata država v Evropi. Skoraj 63 % ozemlja Slovenije prekrivajo gozdovi (State of Europe's Forests, 2011), zato je pomembno, da zagotovimo v šolah in širši družbi ustrezno raven znanja o gozdovih, vrstni pestrosti in ekologiji nasploh. Samo tako lahko utemeljeno pričakujemo razumevanje in širšo družbeno podporo ohranjanju in trajnostni rabi gozdov ter drugih naravnih virov.

Luka Praprotnik, MA, Gregor Torkar, PhD

Understanding of the Concept of the Food Chain among Future Teachers

In ecology, consumption sequences are illustrated with various diagrams, such as food chains and food webs. A food chain represents a linear sequence of organisms or the transfer of energy accumulated in food from a primary producer through a sequence of consumers, whereby each predator in the chain is also food for another organism (Odum, 1971; Tome, 2006). The species are related to each other as members of the chains, which are thus called food chains or trophic chains (Tome, 2006). Tarman (1992) describes that for the functioning of the ecosystem, an important exploitation and transfer of energy is a component of the ecosystem, all of which is done by eating. He explains that species from the food chain and the food web are arranged in food levels or trophic levels. Plants and other primary producers are followed by herbivorous, so called consumers of the first degree. They are followed by carnivores who are second degree consumers. First degree carnivores are followed by second degree carnivores, namely third degree consumers, and so on. Only about 10 to 20% of the energy is transferred to the higher trophic level from one chain member to another. Consequently, the number of chain members is limited to four or five (Odum, 1971, 1989). The links between chain members are illustrated by arrows that indicate the direction of energy, conversions, and substance passing. Food chains are not isolated from each other, but are linked to food or trophic webs. In such systems, the relationships between organisms are not only linear, like in the chain, but developed in different directions (Tome, 2006).

Knowledge of food chains and food webs is a popular ecological topic in pedagogical research (Adeniyi, 1985; Allen, 2017; Hogan, 2000; Leach et al., 1996; Wyner & Blatt, 2018). Allen (2017) notes that most five-year-olds can perceive key concepts related to the food chains that children learn about in elementary school. On the other hand, Adeniyi (1985), Leach et al. (1996), Hogan (2000), and Wyner and Blatt (2018) report that both primary school and university students often have problems with the concepts of food chains and food webs, and they confuse the two concepts (Adeniyi,

1985; Wyner & Blatt, 2018). They often do not perceive themselves as part of a food chain or food web (Wyner & Blatt, 2018).

Griffiths and Grant (1985) reported that students understand the food web only as a set of more food chains. They have problems in understanding energy transfer in these systems and indirect influences between organisms (Hogan, 2000, Leach et al, 1996). They often do not perceive themselves as a part of the food chain or the web (Wyner & Blatt, 2018). Hogan (2000) reports that, despite one month's teaching, which included teaching materials and practical work where bottles were produced in simplified ecosystems with living organisms, half of the pupils did not progress in their understanding of interactions between organisms in a given food chain. Only minor progress was observed in most other students.

This article presents the findings of preliminary research, focusing on the importance of knowing the species variety of ecosystems for the proper use of the concept of a food chain. A review of literature and articles did not yield any studies focusing on this aspect of the problem described. Of interest was whether future teachers and educators that will teach children in preschool and primary school about eco-concepts such as food chains and food webs can correctly identify specific examples of food chains in Slovenian forests. The goal was to gain insight into their knowledge of species diversity in the forest, which is a prerequisite for the proper composition of a food chain.

The research questions were:

- *How well do students understand the concept of food chains in the Slovenian forest? and*
- *How well do students know the species variety of forest organisms in Slovenia?*

The study included 170 students from the University of Ljubljana's Faculty of Education. Of these, 105 were students in the undergraduate programme in preschool education enrolled in the course Primary Science, and fifty-five were students in the undergraduate programme in primary education enrolled in the course Science and Biology. In addition, ten students in the undergraduate programme were questioned about their understanding of an example of a food chain in the Slovenian forest.

The data were collected in the academic year 2016/17 and 2017/18. The knowledge test took place in February or June 2017. We gave the students a written task: "Describe four examples of food chains in the Slovenian forest. Each example of a food chain should consist of at least three links (plant, herbivore, and carnivore) and should not be repeated between the chains." With this question we wanted to check the understanding of the concept of the food chain and the knowledge of the species variety of forest organisms. We subsequently carried out ten more in-depth interviews with the students of the primary teacher study programme who did not participate in the knowledge test. We asked them in greater detail about the understanding of the presentation of the food chain (each student was shown an example of a food chain with three articles: pine → pine leaf caterpillar → cuckoo bird). We were interested in whether the students know that the diagram shown is the food chain, why the plant is in the first place of the food chain, what is the order of the organisms in the chain, and what the arrows in the diagram represented.

The collected data were quantitatively processed. The data processing procedures used included descriptive statistics procedures. The frequencies (f) and percentag-

es (f%) were calculated. The results are displayed graphically or tabularly. The data obtained through interviews were processed qualitatively.

Only 11% of the students correctly cited four examples of food chains in the forest. About a quarter of the respondents did not offer even one correct example of a chain.

The students most often incorrectly defined plant taxa. Various plant parts, plant forms, or plants replaced by fungi and other heterotrophics were cited. Students also lacked familiarity with the nutritional habits of individual groups of animals and, consequently, placed them in the wrong trophic levels. There was also a lack of understanding of the importance of arrows and their direction in the food chain. There was often no arrow or it pointed in the wrong direction, i.e. toward the primary producers. Among the errors, we also detected inadequate examples of organisms that cannot be found in forest ecosystems.

Among the plants, the use of Spermatophyte samples was predominant (94.1%), and mammals (55.5%) were among the groups of animals. The students listed twenty-four different types of plants. Plants with a total share of records exceeding 10% are grass, oak, and beech. The students listed forty-four different species of animals or groups of animals. Those most often cited in the food chains were foxes, squirrels, deer, and rabbits. Fungi were also mentioned in the food chains and were cited twenty-four times. Most of them were wrongly placed at the beginning of the food chain; that is, in the place of primary producers. Only in five cases were they properly placed in the food chain. Four different fungi or their groups were listed.

After this, we conducted ten further extensive interviews with the students in the primary education programme that did not participate in the written task. We asked them in greater detail about their understanding of the presentation of a food chain (each student was shown an example of a food chain with three links: pines, pine borers, and cuckoos). We asked whether the students knew that the diagram shown was a food chain, why the plant was in first place in the food chain, what was the order of the organisms in the chain, and what the arrows in the diagram indicated.

The curriculum for preschool education demands that pre-school children directly learn about different natural ecosystems and relationships between organisms in ecosystems. Among the global goals, it is stated that it is necessary to promote "experiencing and learning about the living and non-living nature in its diversity, connection, constant change and aesthetic dimensions" (Curriculum for preschool education, 1999, p. 38). Curriculum for primary school, especially science and technology, natural sciences and biology, also expects the consideration of ecology concepts. The concepts of the food chain and the web are discussed for the first time in the fifth grade of primary school, in the field of science and technology. Among the learning goals, it is stated that students need to be able to compose simple food chains and link them to eating websites (Curriculum: primary education programme Natural Sciences and Technology, 2011). In the first research question, we were therefore interested in whether students, future educators and primary teachers were properly trained in the interpretation of the concept of the food chain. From the results of the study, it can be seen that almost a quarter of respondents did not correctly compose a single example of a food chain in the forest. The other three quarters of the respondents correctly stated one, two, three or four examples of food chains in the forest.

Irregularities in the analyzed food chains are rarely a reflection of the lack of understanding of trophic levels in the food chain or the position of plants as primary producers. The problems of students are also described in previous studies (eg Hogan, 2000; Wyner & Blatt, 2018). Students have more difficulty understanding the role of arrows in the food chain, which are often missing or reversed. From the results, it can be concluded that this is the result of a misunderstanding of what arrows actually illustrate. Students often explain the food chain primarily as relationships between organisms, where the predator eats prey and accordingly shifts the arrows toward the primary producer.

Most students did not have much difficulty understanding the concept of a food chain, but they had more difficulty with the species variety of the forest (the second research question) and ignorance of animal nutrition. The students made up for their unfamiliarity with species variety by using more general concepts of shrubs, trees, and undergrowth. They also referred to various plant parts (e.g. leaves) or classified fungi as primary producers. The number of species recorded in food chains also testifies to their limited knowledge of tree species and other forest plants. They mostly mentioned spermatophytes, although many species of ferns and mosses can also be observed in Slovenian forests. Lack of knowledge of plants and the ability to determine plant species may reflect their lack of interest in plants, which is termed "plant blindness" (Wandersee & Schussler, 2001). Students also showed limited familiarity with animal species in the forest. Mammals predominated among these. They also lacked familiarity with the feeding habits of individual groups of animals, which is why they were wrongly classified in trophic levels.

Lack of knowledge of species diversity in the forest necessarily also corresponds to a poor understanding of some of the roles and functions of forests as an ecosystem, especially support and regulatory services. Biodiversity has a proven impact on most ecosystem services (Balvanera et al., 2006). Slovenia is the third most-forested country in Europe. Almost 63 % of Slovenia's territory is covered by forests (State of Europe's Forests 2011), and therefore it is important to ensure an adequate level of knowledge about forests, species diversity, and ecology in general in schools and in society in general. Only in this way can one reasonably expect understanding and wider social support for the conservation and sustainable use of forests and other natural resources.

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Mag. Luka Praprotnik (1972), asistent na Pedagoški fakulteti Univerze v Ljubljani.
Naslov: Rojčeva ulica 15, 1000 Ljubljana, Slovenija; Telefon: (+386) 01 589 22 66
E-mail: luka.praprotnik@pef.uni-lj.si

Dr. Gregor Torkar (1977), izredni profesor na Pedagoški fakulteti Univerze v Ljubljani.
Naslov: Tacenska cesta 135 A, 1000 Ljubljana, Slovenija; Telefon: (+386) 031 370 151
E-mail: gregor.torkar@pef.uni-lj.si