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Datum: 17 FEB 2020

UNIVERZITET CRNE GPRE

-Centar za doktorske studije-

-Senat-

U skladu sa članom 41 Pravila doktorskih stduija, u prilogu akta dostavljamo Predlog Odluke Vijeća o imenovanju komisije za ocjenu doktorske disertacije Branka Anđića pod nazivom „Kreiranje novih pristupa u botaničkom obrazovanju slijepih i slabovidih" radi davanja saglasnosti.

DEKAN

Prof. dr Predrag Miranović

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Na osnovu člana 69 statuta Univerziteta Crne Gore i člana 41 Pravila doktorskih studija, na XLII sjednici Vijeća održanoj 11.02.2020. godine donijeta je

O D L U K A

I

Predlažemo Centru za doktorske studije i Senatu Univerziteta da imenuje komisiju za ocjenu doktorske disertacije "Kreiranje novih pristupa u botaničkom obrazovanju slijepih i slabovidih" kandidata mr Branka Anđića, u sastavu:

1. Dr Stanko Cvjetićanin, redovni profesor Prirodno-matematičkog fakulteta Univerziteta u Novom Sadu (naučna oblast: Metodika nastave prirodnih nauka);

2. Dr Tatjana Novović, vanredni profesor Filozofskog fakulteta Univerziteta Crne Gore (naučna oblast: Pedagogija);

3. Dr Srđan Kadić, docent na Prirodno-matematičkom fakultetu Univerziteta Crne Gore (naučna oblast: Računarske nauke);

4. Dr Danka Caković, vanredni profesor Prirodno-matematičkog fakulteta Univerziteta Crne Gore (naučna oblast: Botanika);

5. Dr Danijela Stešević, vanredni profesor na Prirodno-matematičkom fakultetu Univerziteta Crne Gore (naučna oblast: Botanika):

Obrazloženje

Mr Branko Anđić je predao doktorsku disertaciju pod nazivom " Kreiranje novih pristupa u botaničkom obrazovanju slijepih i slabovidih". Vijeće Prirodno-matematičkog fakulteta je utvrdilo da su ispunjeni uslovi iz člana 38 Pravila doktorskih studija, da kandidat Branko Anđić ima, kao prvi autor, rad sa rezultatima iz teze objavljen u časopisu sa SCI/SCIE liste. Samim tim su se steklu uslovi da se imenuje komisija za ocjenu pomenute doktorske disertacije.

DOSTAVLJENO

- Senatu
- Centru za doktorske studije
- -a/a

DEKAN
Prof. dr Predrag Miranović

ISPUNJENOST USLOVA DOKTORANDA

OPŠTI PODACI O DOKTORANDU			
Titula, ime, ime roditelja, prezime	Mr Branko (Vučeta) Anđić		
Fakultet	Prirodno-matematički fakultet		
Studijski program	Biologija		
Broj indeksa	1/15		
NAZIV DOKTORSKE DISERTACIJE			
Na službenom jeziku	Kreiranje novih pristupa u botaničkom obrazovanju slijepih i slabovidih		
Na engleskom jeziku	Development of new approaches in botanical education of partially sighted and blind people		
Naučna oblast	Metodika nastave biologije		
MENTOR/MENTORI			
Prvi mentor	Prof. dr Danijela Stešević	Univerzitet Crne Gore, Crna Gora	Botanika
Drugi mentor	/	/	/
KOMISIJA ZA PREGLED I OCJENU DOKTORSKE DISERTACIJE			
Prof. dr Stanko Cvjetićanin		Univerzitet u Novom Sadu, Srbija	Metodika nastave prirodnik nauka
Prof. dr Tatjana Novović		Univerzitet Crne Gore, Crna Gora	Pedagogija
Doc. dr Srđan Kadić		Univerzitet Crne Gore, Crna Gora	Računarske nauke
Prof. dr Danka Caković		Univerzitet Crne Gore, Crna Gora	Botanika
Prof. dr Danijela Stešević		Univerzitet Crne Gore, Crna Gora	Botanika

Datum značajni za ocjenu doktorske disertacije	
Sjednica Senata na kojoj je data saglasnost na ocjenu teme i kandidata	08.05.2018.
Dostavljanja doktorske disertacije organizacionoj jedinici i saglasanost mentora	27.12. 2019.
Sjednica Vijeća organizacione jedinice na kojoj je dat prijedlog za imenovanje komisija za pregled i ocjenu doktorske disertacije	11. 02. 2020. g.

ISPUNJENOST USLOVA DOKTORANDA
U skladu sa članom 38 pravila doktorskih studija kandidat **je** cjelokupna ili dio sopstvenih istraživanja vezanih za doktorsku disertaciju publikovao u časopisu sa **(SCI/SCIE)/(SSCI/A&HCI)** liste kao prvi autor.
Spisak radova doktoranda iz oblasti doktorskih studija koje je publikovao u časopisima sa (upisati odgovarajuću listu)

Anđić, B., Cvjetićanin, S., Maričić, M., & Stešević, D. **(2019a)**: Sensory perception and descriptions of morphological characteristic of vegetative plant organs by the blind: implementation in teaching. *Journal of Biological Education*, 1–19. doi: 10.1080/00219266.2019.1687107. Časopis indeksiran u SCI/SCIE (Odštampani primjerak rada je priložen uz obrazac); **Andjić, B.**, Cvijetićanin, S., Hayhoe, S., Grujičić, R., & Stešević, D. **(2019b)**: Dichotomous Keys In The Botanical Learning Of Non-Visual (Blind) People. *Journal of Baltic Science Education*, *18*(5), 668–680. doi: 10.33225/jbse/19.18.668. Časopis indeksiran u SSCI (Odštampani primjerak rada je priložen uz obrazac).
Obrazloženje mentora o korišćenju doktorske disertacije u publikovanim radovima
U radu Anđić et al. (2019a) prikazani su rezultati koji se odnose na multisenzorsku percepciju morfoloških odlika biljka od strane slijepih i slabovidih. U radu Anđić et al. (2019b) predstavljen je uticaj dihotomih ključeva na kognitivni, afektivni i kognitivno-afektivni domen botaničkog obrazovanja slijepih.
Datum i ovjera (pečat i potpis odgovorne osobe)
U Podgorici, 27.12.2019. godine UNIVERZITET CRNE GORE Prirodno-matematički fakultet MP DEKAN

Prilog dokumenta sadrži:

1. Potvrdu o predaji doktorske disertacije organizacionoj jedinici
2. Odluku o imenovanju komisije za pregled i ocjenu doktorske disertacije
3. Kopiju rada publikovanog u časopisu sa odgovarajuće liste
4. Biografiju i bibliografiju kandidata
5. Biografiju i bibliografiju članova komisije za pregled i ocjenu doktorske disertacije sa potvrdom o izboru u odgovarajuće akademsko zvanje i potvrdom da barem jedan član komisije nije u radnom odnosu na Univerzitetu Crne Gore

Saglasnost

Nakon uvida u doktorsku disetraciju kandidata MSc Branka Anđića zaključujem da rad zadovoljava sve predviđene kriterijume i dajem saglasnost da se isti preda na ocjenu.

U Podgorici 27.12.2019.godine

Prof. dr Danijela Stešević

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Datum: 27. 12. 2019

Na osnovu službene evidencije i dokumentacije Prirodno-matematičkog fakulteta u Podgorici, izdaje se

POTVRDA

MSc Branko Anđić, student doktorskih studija na Prirodno-matematičkom fakultetu u Podgorici, dana 26.12.2019. godine dostavio je ovom fakultetu doktorsku disertaciju pod nazivom „Kreiranje novih pristupa u botaničkom obrazovanju slijepih i slobovidih" na dalji postupak.

SEKRETAR
Nina Rubežić, dipl.pravnik

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Sensory perception and descriptions of morphological characteristic of vegetative plant organs by the blind: implementation in teaching

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ABSTRACT

Although very rare, the existing research on the biological education of blind people indicates that teaching content is not fully in line with the sensory perception of that content by the blind. The aim of this study is to analyse the morphological details which the blind can register in multisensory plant research and to harmonise the sequencing of these descriptions by the blind with the sequencing of the morphological descriptions used in the botanical education of partially sighted people in Montenegro and Austria. The research uses a descriptive-analytical and comparative method. The research technique is observation. The study included 100 blind people from Montenegro and Austria, with an average age of 25. It is necessary to harmonise the sequence of general description and the description of each vegetative plant organ in the previous botanical education of the blind, as well as to implement new descriptions of those morphological characteristic that are perceived by the blind, which are absent in the current botanical education of the blind. The proposed changes would contribute to the improvement of the botanical education of the blind.

KEYWORDS

Blind; vegetative plant organs; perception; morphology

Introduction

According to the World Health Organisation recommendations, more joint efforts by all authorities globally are needed to increase the accessibility of education, health services and employment tovisually impaired people (WHO 2013). When it comes to the field of education, one of the main challenges in teaching biology to the blind is the organisation of teaching and adapting the teaching content to the needs of blind students, in order to enable them to independently perform tasks and learn through research activities (Brown 1995). Blind students rarely have the opportunity to participate in conducting biological experiments or in field biology teaching (Fraser and Maguvhe 2008). In this paper, a proposal is made as to how to adapt the content of the *Morphology of Vegetative Plant Organs* to the needs of the blind, based on their sensory perceptions and the description of morphological characteristics of vegetative plant organs. Within the subject Morphology of Vegetative Plant Organs, the students in primary and secondary schools in Montenegro and Austria study the following units: Leaf morphology, Tree morphology and Root morphology. Based on the sensory perception and the descriptions of plant morphological characteristics of 100 participants who participated in this study, it can be concluded that blind people can register the main morphological characteristics of vegetative plant organs. The perception and

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description of morphological characteristics of vegetative plant organs by the blind differs from their presentation and description in the literature, from which the participants mostly learn about plants in Austria and Montenegro. When teaching the content from the *Morphology of Vegetative Plant Organs*, it is necessary to align it with the specifics of how the blind perceive and describe them through their senses.

Literature review

Salisbury (2000) states that there is a discrepancy between the attitudes of blind people, botanists and teachers on how to adapt botanical content to blind people. Due to the dominantly visual perception, description and explanation of the majority of the teaching content in biology, many teachers believe that blind students cannot acquire quality knowledge in biology (Davis and Redden Martha 1978; Supalo 2010). This attitude of teachers is not justified, as many studies indicate that if teaching content is adapted to blind students, they can achieve the same or a similar level of knowledge in the field of science as students without visual impairment (Jones et al. 2006). Blind and visually impaired students require specific teaching strategies and customised content for scientific education, and these requirements should be met (Fraser and Maguvhe 2008). Most teaching content in science is still not sufficiently well adapted, either to blind students or to students with other disabilities.

Researchers, education authorities and higher education institutions around the world do very little to adapt their teaching content to blind people (Fraser and Maguvhe 2008). Investigations in which the scientific education of the blind is examined need to be intensified (Lewis and Bodner 2013; Sözbilir 2016; Wild and Allen 2009) in order to adapt the teaching process to the blind and visually impaired students more effectively.

For example, the research conducted by Fraser and Maguvhe (2008) suggests that biology should take into account the needs of the visually impaired through the adaptation of teaching curricula; the replacement of tasks based on visual perception with tasks of the same difficulty which do not require sight; by providing additional time for students to respond to tasks; through the application of technology and similar teaching tools in order to enable visually impaired students to gain a better knowledge of the topic and by adapting the way of presenting the content to the perception of visually impaired people.

Blind students enjoy the sensory research of biological and scientific objects, so one of the main duties of biology teaching is to enable this sensory research (Erwin et al. 2001; Maguvhe 2005). For example, the researchers Malone and De Lucchi (1979), recommend that blind and visually impaired pupils be enabled to use their senses while discovering plant and animal species from their surroundings whenever possible. Abruscato (1996) suggests that blind pupils under supervision could sensorially examine animals such as fish in aquariums. The results of the research by Jones et al. (2006) suggest that visually impaired students achieve a much better understanding of cells if they are allowed to study sensorially through the application of heptic technology than they do when learning the same content without sensory experience. In addition, when the teaching content from biology is adapted to the sensory perceptions of the blind, they can successfully perform biological experiments and acquire complex biological content. In the De Haaff (1977), blind students who grew seedlings to bloom understood the process and concept of growth and development better than those students who had been studying the same content without experiment or sensory experience. Brown (1995) successfully adapted the techniques of electrophoresis to the needs of blind and visually impaired students. The students who participated in the research felt that adapting the procedure for performing this experiment enabled them to perform it independently, increasing their desire to learn.

According to Floyd (1973) the first attempt to adapt botanical content to blind people was carried out in a botanical garden in Pennsylvania, where blind people were enabled to experience the scent of flowers and the different texture of leaves. In this garden, as well as similar botanical

gardens, the intention was to adapt certain parts of the garden to the blind and the visually impaired, so they could get to know plants in a more efficient way. A large number of botanical gardens installed information boards with the names and descriptions of plants in Braille. However, according to the Carroll and Bentzen (1999), a great number of blind and visually impaired people are not satisfied with this method of adapting botanical gardens. The blind found the descriptions boring, which is why it was suggested that the blind to be allowed to experience plants independently through touch, smell and hearing. Blind people should be encouraged to discover their environment independently, including plants (Salisbury 2000). According to Erwin et al. (2001), Maguvhe (2005) and Pauw et al. (1990) it is assumed that blind people are able to differentiate between different plants and different plant organs based on the shape of the plant organs or the smell of the individual plants.

Methodology

This section of the paper presents the problem and the context of this study, explains the research design and the aim of the research, provides a description of the participants, as well as the process of data collection, most notably describing the coding process in detail. In this research, the author applied a qualitative methodology, based on grounded theory (Strauss and Corbin 1990). This research approach is applied when there has been no research done in a particular field, or the available research is scarce (McCann and Clark 2003).

The research subject

Based on the analysis of the existing scientific research from the following databases: the Institute of Scientific Information (ISI), the Web of Science (WoS), Scopus, EBSCOhost and the Academia Social Science (ASOS) Index, it can be concluded that research in which sensory perceptions and descriptions of biological content by the blind feature is scarce. No studies have been found that examine the sequence of sensory perception of morphological characteristics and the description of vegetative plant organs by the blind. The key words under which the search was performed were: 'botany' and 'blind'; 'vegetative plant organs' and 'blind'; 'Plant' and 'blind'; 'Botany' and 'visually impaired'; 'Plant' and 'visually impaired'; 'vegetative plant organs' and 'visually impaired'.

In order to improve the botanical knowledge of the blind, teaching content has to be adapted to them. The content should be created based on their previous knowledge and their sensory perception of plants. The sequence of morphological characteristics, as well as the descriptions of the plant organs derived from the sensory perception of the blind, should be included in their botanical education. In this research, the following questions should be answered:

- Are descriptions of the morphological characteristics of vegetative plant organs in the relevant textbooks in Montenegro and Austria sequenced in a way that is similar to the way in which the participants perceive and sequence these plants by sensory research?
- What is the sequence of descriptions and which descriptions of vegetative plant organs should be implemented in the botanical education of the blind, in order to make the content more familiar to them?

Aim and objectives of the research

The aim of this research is to align the sequence of descriptions and the descriptions of vegetative plant organs used in the botanical education of the blind, with the sequence of the sensory perception of the morphological characteristics and the description of vegetative plant organs as understood by the blind. This would contribute to the better botanical education of the blind,

because the teaching of vegetative plant organs would be taught in accordance with their sensory perceptions of plants.

The research objectives are as follows

- The analysis of the morphological characteristics of vegetative plant organs, which the participants can register through their sensory perception;
- The analysis and determination of the differences in the sequencing of perception of the morphological characteristics of vegetative plant organs and the qualitative analysis of their descriptions based on the sensory perception of the participants, with the sequencing and presentation of morphological characteristics and descriptions in the textbooks from which they had been taught. The study participants stated that they used the following school biological books when learning about plant content (SBB): Gereben-Krenn et al. (2016), Koch and Cattoen (2017); Kugler (2004); Petričević, Karaman, and Todorović (2009); and Petrović, Ojdanić, and Malidžan (2015). In all of these textbooks, the subject topics of the Morphology of Plants curriculum have the same content, which includes: Leaf morphology, Tree morphology and Root morphology. These textbooks are also used by students without visual impairment, which leads to the conclusion that the content provided in Plant Morphology is most often sequenced in the order in which they can be perceived by the sense of sight. Most often, the first explanations are about the colour, size and shape of the vegetative plant organ. For example, when describing a stem in all the SBBs, the first morphological marker is the colour. The analysis and determination of the difference in the sequencing of the morphological characteristics of vegetative plant organs registered and described by the non-vizual participants in this research and presented through this content in SBB is important, since content selection, as well as the sequencing of teaching that content, significantly affects students' knowledge and understanding when learning biological content (Banet and Ayuso 2003). It is very important for non-visual students to learn in a constructivist way, and to construct this knowledge based on their own capabilities (Ramsey 1993; Hanuscin and Lee 2008). It is important to emphasise that the aim of this study is not an analysis of the quality of textbooks of biology from which they learned, but only a comparison of the sequence and description of morphological characteristics of vegetative plant organs from those textbooks with the sequence of the perception and description of the same characteristics by the blind;
- Determining the sequence of the sensory perception of morphological characteristics and the description of vegetative plant organs by the participants, which should then be implemented in the teaching biology to the blind.

Research methods, techniques and instruments

The descriptive-analytical and comparative methods were applied in this paper. The descriptive method was used to determine the sequence of descriptions of the morphological characteristics of each vegetative plant organ by the participants, as well as their general descriptions. The analytical method carried out a qualitative analysis of the description of the morphological characteristics of the vegetative plant organs which were generated by the participants on the basis of sensory perception. Comparative analysis has established their compliance in the presentation of morphological characteristics and their descriptions in the analysed SBB with the sequence of perception of morphological characteristics and the description provided by the participants obtained through this study. The research technique is one of systematic observation, and the research instruments are: Sony ICDPX370 Recording Devices – used as recording equipment, a record list, and field notes.

Research design

The research was conducted from January 2017 to May 2018 through the following seven phases:

(1) *Testing participant knowledge of Plant Morphology*: A pre-interview was used to determine the participants' previous knowledge of Plant Morphology, and how they had learned the material. Each participant was asked the following questions: *Describe the typical root-tree-leaf of a plant; Tell us everything you know about root – tree – leaf morphology*; and *Describe the ways you have previously learned about plants*. The participants' responses were recorded by the researcher. When checking the previous knowledge of Plant Morphology, the procedure used in previous studies with pupils with visual impairment and the processing of the contents of the cell structure was used (Jones et al. 2006).
(2) *Selection of the plant species*: This involved the selection of the species of plants whose morphological characteristics the participants should describe. The selected plant species are found in the environment of the participants in Austria and Montenegro. The 100 plant species selected belonged to the following groups of plants: *Bryophyta, Pteridophyta, Gymnosperms* and *Angiosperms*. The following groups of plants were represented: trees (33 species), shrubs (33 species) and herbs (34 species).
(3) *Morphological descriptions of the participants*: The participants described the morphological characteristics of the vegetative plant organs in their environment based on the sensations of touch, odour and hearing. City parks and promenades were selected as sites for this process. The descriptions were recorded on the recorder. This research phase was the longest – a total of nine months. During this time, it was ensured that the vegetative plant organs were described by the participants of the research, exactly in the corresponding seasonal period (in terms of their floristic aspect) to which the plant belongs (e.g. *Galantus nivalis* was described in early spring, because it belongs to the spring aspect of flora, while *Salvia officinalis* was described in May).
(4) *Analysis of the morphological descriptions of the participants*: The analysis was carried out by coding, elimination and categorisation, and sequencing using the question-answer principle.
(5) *Verification of the validity and reliability of the description*: The degree of agreement in the coding and the sorting of codes into subcategories, categories and themes between the members of the research team; graduates and experts in qualitative research; teachers and experts on the one hand and participants in the research team on the other.
(6) *Comparative analysis*: In this stage, a comparative analysis between the sequence of the perception of morphological characteristics and their descriptions – which were formed by the participants, with the sequence of representation and description of the same organs, analysed in the SBB, was performed.
(7) *Proposal for the implementation of morphological descriptions*: Changes were proposed to the sequence of the representing of the morphological characteristics and descriptions of vegetative plant organs, which could then be applied in the botanical education of the blind.

Sample

The study involved 100 blind participants from Montenegro and Austria, who had an average age of 25 (SD = 11); their ages ranged from 7 to 45 years old. The participants in the study were blind people with visual acuity of less than 3/60 and a narrowing of the 10° vision field in their better eye (WHO, 2012). None of the participants in the research had any other disability. Snowball sampling was applied in the study. Researchers contacted the National Associations of the Blind in Montenegro and Austria, which recommended them to their members and schools where the visually impaired were educated (from where the members were recruited). Participation in the research was voluntary. All participants, institution managers and administrative staff, as well as the parents of underage

participants, were familiar with the procedure and purpose of the research, prior to its implementation. All research participants were guaranteed confidentiality and anonymity. Prior to each recorded description, all participants were asked for consent, emphasising the guarantee of confidentiality and anonymity. This approach to research ethics was formed on the basis of the recommendations made in relevant research methodologies (Cohen, Manion, and Morrison 2008).

Data collection and treatment

The descriptions of the vegetative plant organs by the participants were obtained in the field. Each participant in the research was sensorially exploring (touching, smelling, listening to) the plant organs in the natural habitat of the plant. They were provided with the underground organs (roots, tubers, bulbs and so on) by the researchers, as well as with branches with leaves of the high woody plants. When selecting the plants, it was taken into consideration that the plant was not covered with dust and dirt, nor by moss or lichens, which could possibly inhibit the sensory perception of the plant organs. Underground organs were collected by researchers and cleared of soil and dirt. In the selection of plants, species with a wide (mainly cosmopolitan) distribution and individuals from very numerous populations were selected, so that the collecting plants for this research did not in any way endanger the plant populations. All 100 plant species (33 woody, 33 shrubs and 34 herbaceous) were examined using the senses and described by all participants. In the selection of plants, species with a wide (mainly cosmopolitan) distribution and individuals from very numerous populations were selected, so that the collection of plants for this research did not endanger the subsistence of the populations.

The sensory study of the plant species was not limited in time. When describing the plants, an individual form of work was applied, that is, the participant whose description was recorded was asked to distance himself/herself from other participants in the field so that they could not hear other descriptions of the plant organs. The aim of such individual work was to prevent the interaction of the description with the participants in the research. During the describing process the participants did not ask questions, in order to ensure the authenticity of the description and avoid bias in its creation, ensuring that we obtained unprompted descriptions.

Based on the interviews with the participants, those plant species which were most familiar to them were noted. They first described the morphological characteristics of the organs of these plants, and then gradually switched to the description of plant species which were less familiar. At the same time, it was taken into account that they first described large plant vegetative organs. Having explored the vegetative plant organs, each participant in the research described the plant on the basis of their own sensory perception. The descriptions were recorded on the recorder. During the sensory investigation of the plant by the participants the researcher recorded in their field notes the non-verbal movements and behaviour of the participants in the research. These data in combination with the data obtained in the description increased the reliability of the obtained results (Talmy 2010). The field notes were used as additional information during the analysis of the description of the morphological vegetative characteristics of the plants.

Data analysis

Pre-interview data and descriptions of morphological markers of vegetative plant organs were processed in the same way. All the descriptions of the vegetative plant organs by the participants were transcribed. The researchers read and re-read the text several times before coding, in order to gain a verifiable insight into the obtained data. The coding method uses a grounded theory approach (Glaser and Strauss 1967; Strauss and Corbin 1990) and is similar to the coding method used in other studies in teaching biology to visually impaired students (Fraser and Maguvhe 2008) as well as to students with no visual impairment (Pugh, Koskey, and Linnenbrink-Garcia 2013).

Open coding was used. Specific codes were constructed from the transcribed material. The code names are derived from the descriptions of the participants. On the basis of the applied coding, general descriptions of the plant organs were obtained based on the sensory experience of the participants. The data coding was done manually. The frequency of certain codes in the narrative of the respondents was one of the main characteristics of acceptance, or rejection. Code frequency was calculated and expressed as the frequency of occurrence of a specific description-code in the descriptions of the study participants. The maximum frequency of the codes was 100, which corresponds to the number of participants (being one participant for each description code). After the coding process, codes were sorted into subcategories, categories and themes. The designation of subcategories, categories and themes was carried out by researchers, but on the basis of transcripts or descriptions by the research participants in which they were clearly expressed. For example, Ana (19 years old), Podgorica, Montenegro described the bark of the pine (*Pinus* sp.) as follows:

I feel deep cracks, which extend in all directions, irregularly distributed, on the bark of this tree, leaving behind a very rugged sensation.

The same participant described the bark of the linden (Tilia sp.) as:

Deep cracks that are oriented vertically from the root to the canopy, giving the impression that the bark is correctly cracked vertically.

From the narrative of this respondent, the codes describing the tree of these plants were extracted, namely: *deep cracks, irregular cracks* and *vertical cracks*. From these codes, we formed the category of *Bark cracks*, which clearly stands out from the narratives of the respondents. It was then further categorised into the category of *Tree*, also extracted from the narratives of the respondents.

The constant comparative method (Strauss and Corbin 1990) obtained by the joint identification of the morphological characteristics of the plant by the participants in the research was used to create and design those subcategories, categories and themes. The reliability of the obtained data was ensured through the encoding and allocating of codes into subcategories, categories and themes by each member of the research team; the checking of the distributed codes by experienced teachers and experts in qualitative research. This way of verifying the validity and reliability of qualitative data is recommended by Krippendorff (2013) and Miles and Huberman (1994). The reliability of the coding process was verified by the degree of agreement in the use of the basic codes. The codes obtained in the encoding process were given to biology teachers with ten or more years experience in teaching, and also to the experts in qualitative research with research experience of more 10 years. Using the formula of Miles and Huberman (1994) the reliability of the obtained data was calculated.

In order to determine the degree of agreement, i.e. to determine the sequencing in the description of the morphological markers of the participants in the research, question-answer sequencing was used. Question-response patterns provide special insight and provide opportunities for the formation of patterns that students respond to based on an analysis of their responses (Dijkstra and Ongena. 2006). Question-response sequencing is based on directly comparable and similar responses from interviewees (Schaeffer and Maynard 1996; Sykes and Collins 1992). According to some researchers, interviewees can provide answers by applying rules from other fields of action, other interviews or formal conversations, and based on these data, the sequences in respondents' answers can be predicted to some degree (Schaeffer 2002; Suchman and Jordan 1990). However, given that this research has a pioneering character, and that the respondents had not previously participated in similar research, the sequences in the responses could not have been a prediction but were rather generated from the responses given by the interview participants. Based on this question-and-answer approach, sequencing in this study is expressed through the percentage of particular utterances used by the study participants to describe the morphological markers of vegetative plant organs. For example, participants usually began describing the leaf with: 'the leaf is very rough, the leaf is quite rough, the leaf is smooth', and all these particular utterances are classified in the sequence of the smoothness of the leaf surface.

Results and discussion

An analysis of the content from the pre-interview showed that the students had very little knowledge of Plant Morphology. The following scientifically correct codes were used by students: round leaf, heart leaf, spear leaf, soft tree; solid tree; a branch tree. Other codes had a frequency of less than 50 (out of 100) or were scientifically inaccurate. The research participants stated that they had previously learned about plant morphology and anatomy most often from textbooks, stories told by their family members, friends and the media, and very rarely through sensory plant research.

The correspondence in the coding of the data obtained through field work and the ordination of the codes in the subcategories and categories between the members of the research team was 97%; between the teachers and experts in qualitative research, the value was 94%; and between the teachers and experts in qualitative research, on the one hand and participants in the research team, on the other, it was 92%. Due to these facts, the obtained data could be considered reliable. The data are classified into 86 codes, 28 subcategories and 12 categories within the 3 themes: *underground plant parts, the stem, and the leaf.* In order to give a better overview, the results are presented separately for each theme.

The descriptions of the underground plant parts generated by the participants are classified into 14 codes, 8 subcategories and 7 categories (Table 1). The highest frequency in both codes is *dense* (f = 91, f = 81) from the category *fibrous root*, subcategory *density*, and the category *taproot*, subcategory *branching*, respectively. The lowest frequency were shown by the code *thin and slender* (f = 61) from the category *taproot*, subcategory *firmness and thickness*.

The descriptions of the stem generated by the participants are classified into 28 codes, 10 subcategories and 3 categories (Table 2). The highest frequency was found for the codes: *rough surface of the stem* (f = 94) within the category *tree*, and *distinct nodes* (f = 94), within the category *herb*. The lowest frequency was shown for the codes *smooth* (f = 61, f = 62) related to the surface of the stem, both tree and herb, respectively.

The descriptions of the leaf generated by the participants are classified into 44 codes, 10 subcategories and 2 categories (Table 3). The highest frequency was shown for the codes: *flattened leaf* (f = 94) and *cylindrical leaf* (f = 92), within the category acicular leaf, and *rough leaf* (f = 91) and *hairy leaf petiole* (f = 91) within the category *foliate leaf*. The lowest frequencies were seen for the codes: *flattened leaf petiole* (f = 65), and *arcuate leaf venation* (f = 64).

The interviews conducted with the participants, before and during the research, indicated that they learnt about the plants in the same way and from the same textbook as those students without any visual impairment. By comparing the content of the textbook for visually impaired students (SBB), it was observed that it has identical content to the one for the students without visual impairments. It differed only in its format, in that it was either printed in Braille or was in an audio

Table 1. The codes, subcategories and categories within the theme underground plant parts.

Theme	Category	Subcategory	Code	Frequency (out of 100)
Underground parts	Taproot	Branching	Dense	81
			Low sparse	77
			Non-branched	67
		Firmness and thickness	Thick and firm	70
			Thin and slender	61
	Fibrous root	Density	Dense	91
			Sparse	71
	Tuberous root	Number and shape	Cluster of thickened roots	69
	Cauline root	Firmness	Firm, short- like small claws	67
	Rhizome	Thickness, length	Equally thickened	68
			Tuberous	70
	Tuber	Shape	Wide and flattened at the ends	62
	Bulb	Shape	Elongated	73
			Rounded	64

Table 2. The codes, subcategories and caterogies within the theme the stem.

Theme	Category	Subcategory	Code	Frequency (out of 100)
Stem	Tree	Fissures in the bark	Deep	79
			Shallow	83
			Longitudinal	79
			Transversal	88
			Irregular	82
		Surface of the bark	Smooth	61
			Rough	94
		Peeling	Falling off in pieces	91
			In thin papery sheets	93
			Absent	87
	Shrub	Thorns/spines	Sharp pointed branches (thorny)	69
			Branch with thorns	84
			Leaves spiny	87
		Branching	Dense	72
			Sparse	69
	Herb	Surface	Smooth	62
			Rough	73
			Hairy	71
			Sticky	79
		Shape	Rounded	88
			Angular	84
		Hollow/solid	Hollow	89
			Solid	91
		Nodes	Distinct	94
			Not distinct	78
		Growth form	Upstanding	94
			Crawling	82
			Runners	79

format (DAISY – the format of an audio books for the visually impaired). This fact leads to the conclusion that the specificities of the way that visually impaired students perceive and describe the morphological characters of the plant organs through touch, smell and hearing are not taken into account. The participants thus learnt about the morphology of the plant parts in a rather unsuitable way, without consideration of their previous knowledge of the plants, their perception or the way that descriptions were either provided or made. This probably affected the quality of their knowledge of the plants. This assumption is in correlation with the results of numerous studies which showed that the low level of students' knowledge is most likely due to the fact that the teaching content was not adapted to the students, or that there was no upgrade to the students' previous knowledge and experience (Muis and Duffy 2013; Tondeur, Valcke, and van Braak 2008; Zurita and Nussbaum 2004).

By observing the participants during their sensory perception of the plants, it was noticed that the majority of them were surprised by the diversity of the forms of the plant organs and the fact they could both perceive it and describe it. This leads to the assumption that before this study, the participants had not in fact had any sensory contact with the plants they were studying. The assumption was confirmed in the pre-interview. It was stressed that the teaching methods applied in the classroom were exclusively verbal-textual, thus the students did not have the opportunity to explore the plants through their senses. This circumstance could have affected the lack of self-confidence in the participants and the attitude that they cannot perceive the plants from their surroundings because they are visually impaired. This is also reflected in the quality of their knowledge about the plants.

The above assumptions are supported by numerous studies: these include Civelek et al. (2014), Falvey (2005), Karal and Reisoglu (2009), Jones et al. (2014), Melber and Brown (2008), Millet et al. (2013), Rule et al. (2010) and Santos and Carvalho (2013). According to the cited studies, visually impaired students do not have self-confidence and belief that they can acquire knowledge in the

Table 3. The codes, subcategories and caterogies within the theme of the leaf.

Theme	Category	Subcategory	Code	Frequency (out of 100)
Leaf	Needle-like	Shape	Flattened	94
			Cylindrical	92
			Multi-angular	90
		Position	Single	89
			In pairs	84
			In groups of 5	79
		Scent	Resin	67
	Foliate	Surface	Rough	91
			Like a plush	87
			Hairy	85
			Smooth	82
		Venation	Pinnate	89
			Palmate	79
			Reticulate	77
			Bean-like	64
		Leaf margin	Finely toothed	91
			Roughly toothed	79
			With fine and rough teeth	81
			Entire	90
		Shape of the leaf blade	Lobed	76
			Rounded	82
			Egg shaped	84
			Kidney-shaped	69
			Lanceolate	83
			Eliptical	80
			Spear like	81
			Heart-shaped	84
			Triangular	82
		Compound leaves	With three leaflets	85
			Palm like	89
			Odd pinnate	74
			Even pinnate	69
		Position	Alternate	71
			Opposite	83
			Whorled	69
			Basal rosette	80
		Leaf petiole surface	Rough	89
			Smooth	88
			Hairy	91
		Leaf petiole shape	Cylindrical	84
			Angular	88
			Furrowed	69
			Flattened	65
			Leaves sessile	87

field of science, because they do not have any previous sensory experience of the topics they learn about and are thus fully directed by adults. In addition, when the teaching content and the guidelines are not harmonised with the sensory perception and visualisation of the blind, the blind students will have difficulties in understanding the concepts and creating a correlation between their previous knowledge and experience, and the new knowledge they are being introduced to. If a visually impaired person learns by implementing the previous sensory experiences or uses descriptions that can be perceived directly by touch, smell and hearing, they will acquire better knowledge and better understand the learned concepts, when compared to the traditional – insctructivist method. The application of a constructivist form of learning based on sensory and mostly heptic perception helps the blind students to create mental images and models and to reduce the extent to which the misunderstand or do not take in the content they are learning about.

The results of this study suggestes that blind people can perceive the basic morphological characteristics of plant parts by using touch, smell and hearing. The analysis of the perceived

characteristics and the generated descriptions of the vegetative plant parts showed that there are no significant differences in the perception and description of the morphological characters of the vegetative plant parts between the blind. However, when comparing the first sensory perception and the description of the morphological characters between different plant parts, a significant difference appears. For example, the first reported characteristic of the stem and the foliate leaves is the roughness of the surface, in the aciculate leaves it is the leaf shape, and in the root, it is branching. Thus, each plant organ has a specific sequencing of the morphological characters. The analysis of the scientific exactness of the description of the vegetative plant parts generated by the blind, showed that the descriptions are absolutely botanically correct when the size of the plant parts is larger than the lower practical limit of the tactile sense of the blind.

The description of the underground plant parts generated by the participants

The first characteristic that the participants perceived and described after tactile contact with the root was branching, this sequencing was common to 95% of the study participants. In the analysed SBB, the description of the root begins with the root shapes. Thus, the morphological descriptions of the roots given in the the textbooks do not correspond to the first sensory experience of the participants.

The participants classified the roots into 3 categories: *densely branched roots* (e.g. *Hypericum perforatum*), *sparsely branched roots* (e.g. *Capsella bursa-pastoris*) and *non-branched root* (e.g. *Daucus carota*). They were able to correctly perceive and describe all the different types of the root.

The next perceived features were thickness and firmness, and then the length, thus in accordance with them, the root was classified as a *taproot, fibrous root, tuberous root* and *cauline root*, this sequencing was common to 91% of the study participants. Within the category *taproot*, following codes were described: *firm and thick* (e.g. *Malva sylvestris*) and *thin and slender* (e.g. *Geranium lucidum*). In the description of the fibrous root, they used the expression *the thread*, and classified and defined this root type using the codes: *dense* (e.g. *Ceterach officinarum*) and *sparse* (e.g. *Allium ursinum*). Interestingly, in the majority of cases the description of the wild onion fibrous root (*Alium ursinum*) contained the epithet *juicy*. The tuberous root of the Lesser Celandine (*Ranunculus ficaria*) was described with the epithet: numerous, soft, juicy, rounded thickened tubers, while the root code of the Common Ivy (*Hedera helix*) were described as short and firm 'claws' to which the plant is attached to the substrate. In the analysed SBB, thickness and firmness were not included in the root description.

In all the analysed SBB, from the same beginning the roots are classified into two main types: the taproot or the fibrous root, and then described in detail. By contrast to this, the participants first perceived the braching, and then the firmness and thickness, and according to those criteria identify the root as a taproot, fibrous root, tuberous root or cauline root. Comparative analysis of the description given in the SBB and the generic description of the participants did not show significant differences.

Based on tactile perception, the participants classified rhizomes according to their thickness: *equally thickened* (e.g. *Polypodium vulgare*) and *unequally thickened, tuberosus* (e.g. *Helianthus tuberosus*). While describing the tuber of the cyclamen (e.g. *Cyclamen hederifolium*), the participants firstly perceived the shape and defined it as a *wide and flattened ball*. Furthermore, the perception and description of the bulbs were also based on the shape: *elongated* (e.g. *Allium ursinum*) and *rounded* (e.g. *Galanthus nivalis*). As was expected, the bulb of the wild onion (*Allium ursinum*) caused also smell perception. Comparative analysis of the descriptions of the rhizomes, tubers and bulbs given in the SBB and the generic description of the participants showed significant differences. The participants describe and distinguish these underground parts based on the shape, while in the SBB differences are based on the structure and the position of the buds.

The description of the stem generated by the participants

The majority of stem characteristics were perceived through tactile sensation, with the exception of aromatic plants (e.g. *Allium ursinum, Thymus* sp.), that cause scent perception. The scent of wild onions was described as a milder smell to that of the Garden Onion, and the Thyme scent was considered very strong when in close proximity, and pleasant when it moves away.

The first tactile perceptions of the stem were thickness and firmness, and this sequencing was common to 97% of the study participants. Based on this feature the plants were classified as herbs and woody plants. In the SBB, the classification of the stems is also based on their life form, but as the main feature of the herbal stems, the colour green is stressed. This characteristic is inessential, since it cannot be perceived by the participants. The colour of vegetative plant organs should be presented to blind students because even if they cannot register it, they can create a mental image of the object being described based on the given description (Hayhoe 2008). However, the colour should not be one of the first sequences when presenting and describing a plant, because the blind cannot register it.

Within the woody plants, the participants perceived two growth forms: trees or shrubs. Their descriptions and classifications were in accordance with the SBB. However, within the shrub category, two subcategories were distinguished: branching (codes: *dense*, e.g. *Juniperus communis;* and *sparse*, e.g. *Corylus avellana*) and the position of the thorns and spines (codes: *branches ends with thorns*, e.g. *Punica granatum; branches with thorns*, e.g. *Rosa canina*, and *leaves spiny*, e.g. *Ilex aquifolium*). These morphological characteristics of shrubs are not included in the SBB.

In the tree species, the following characteristics were perceived: (i) fissures in the bark, (ii) the surface of the bark and (iii) peeling, this sequencing was common to 95% of the study participants. Almost all the participants defined the fissures in the bark with their fingertips, in the following way: *the bark is narrowly fissured if the fingertip can easily cover it; the bark is widely fissured if the whole fingertip can fit into it; the bark is wide and deep if the whole fingertip and nail can fit in.* The orientation of the fissures was defined as: longitudinal, transversal and irregular. In the majority of cases, the bark surface was defined as rough, with exception of the smooth bark on the young stem and branches of the Common Birch (*Betula pendula*). Considering peeling, 3 versions are described: *falling off in pieces* (e.g. *Platanus orientalis*), *falling off in thin papery sheets* (e.g. *Betula pendula*) and *does not peel* (e.g. *Fagus sylvatica*). In all the analysed SBB these features are mentioned, while the bark colour is stressed as the most significant element.

The first characteristic of the herbal stem perceived by the participants is the surface: *smooth* (e.g. *Cardamine bulbifera*), *rough* (e.g. *Galium aparine*), *hairy* (e.g. *Daucus carota*), or *sticky* (e.g. *Viscaria viscosa*), this sequencing was common to 91% of the study participants. In the analysed SBB, the stem surface is not taken into consideration. The second characteristic in the herbal stem description is the shape: *rounded* (e.g. *Taraxacum officinale*), and *angular* (e.g. *Lamium maculatum*), this sequencing was common to 92% of the study participants. In the analysed SBB, this feature is also not taken into consideration, and neither is the presence of the wide central cavity in the stem (e.g. *Taraxacum officinale*), the presence of the nodes (e.g. *Hordeum murinum*), or the growth form: upstanding (e.g. *Achillea millefolium*), crawling (e.g. *Trifolium repens*) or runners (e.g. *Fragaria vesca*).

The description of the leaf generated by the participants

The first perception of the participants and the description of the acicular and foliate leaves is extremely varied. In the foliate leaves, the roughness of the surface is the first perceived characteristic this sequencing was common to 100% of the study participants, while in the acicular leaf it is the shape: *cylindrical* (e.g. *Pinus sylvestris*), *flattened* (e.g. *Taxus baccata*), or *multi-angular* (e.g. *Picea abies*), and the number of needles: *two needles* (e.g. *Pinus sylvestris*), *five needles* (e.g. *Pinus peuce*), or a *single needle* (e.g. *Abies alba*), 94% of the respondents sequenced in this way. When describing the needles in the Spruce (*Picea abies*), Fir (*Abies alba*) and the White Pine (*Pinus*

sylvestris), the participants pointed out the scent of the resin. The description and classification given in the SBB corresponds to that given by the participants.

In the foliate leaves, the participants described the leaf surface using four codes: *rough* (e.g. *Corylus avellana*), *mealy-plushy* (e.g. *Platanus orientalis*), *hairy* (e.g. *Bellis perennis*) and *smooth* (e.g. *Ranunculus ficaria*). In all the analysed SBB, the leaf surface is not taken into consideration. Interestingly, the majority of the participants managed to recognise squamate leaves, sori and the spores on the lower leaf-side of the Golden Fern (*Ceterach officinarum*). The individuals were in the phase of the maturity of sori, thus when the leaves are rubbed, the spores and sporangias stays on the fingertips, and create a feeling of fine grains. It is important to point out that the lower limit of the tactile sensitivity of blind people is 0.96 mm (Alary et al. 2009), thus they are not able to register individual spores, but, they can register a group of spores or sporangia.

After the perception of the leaf surface, the participants percieve a leaf venation: reticulate *meshed* (e.g. *Lamium maculatum*), *pinnate* (e.g. *Carpinus betulus*), and *arcuate* (e.g. *Cornus mas*), this method of sequencing is common to 89% of participants. Although a plant with dichotomous venations was given to the participants (*Ginko biloba*), they were not able to correctly define this type. The reason why they perceive it as a parallel is its dense branching and a small distance between the lateral veins, as well as its inconspicuous venation. In the SBB the type of venation is mostly presented after the leaf shape, whereas the participants first describes the venation, then the leaf margin and finally the leaf shape.

In defining the type of leaf margin, the participants used to cross along it with their fingertip, in both directions from the leaf base towards the tip and *vice versa*. The following codes were described: *roughly toothed* (e.g. *Rosa canina*), *finely toothed* (e.g. *Salix alba*), *irregular toothed* (e.g. *Corylus avellana*), and *entire leaf margin* (e.g. *Olea europaea*). The types of the leaf margin analysed in the SBB are given after the leaf shape and defined as: *the leaf margin is entire or leaf margin toothed*, but without any specification of the type of teeth.

In further sensory perception the participants registered and described the leaf shape, this type of sequencing is common to 90% of participants. They managed to recognise and describe all the types presented in the analysed SBB: *rounded, egg-shaped, kidney-form, lanceolate, elliptical, spear like, heart-shaped* and *triangular.*

Comparative analysis of the generic description generated by the participants and those given in the SBB did not show significant differences. Nevertheless, the sequence of the presentation of the characteristics is rather different. In the SBB, the leaf shape is presented as the crucial morphological characteristic, while according to the perception of the participants, this feature is the last to be considered, after the perception of the leaf surface, the venation and the leaf margins. After defining these characteristics, the participants will also perceive the division of the blade. The descriptions of the single and compound leaves generated by the participants and the ones given in the SBB are rather similar. The participants also perceived the arrangement of the leaves on the stem, but this characteristic is not analysed in the SBB.

The decription of the leaf blade is followed by the perception of the leaf petiole, its surface and overall shape, 86% of respondents used this sequencing. The leaf petiole surface is defined by the codes: *rough* (e.g. *Rosa canica*), *hairy* (*Bellis perenis*) and *smooth* (e.g. *Geranium lucidum*), while the leaf petiole shape featured the codes: *cylindrical* (e.g. *Betula pendula*), *angular* (e.g. *Allium ursinum*), and *furrowed* (e.g. *Arum maculatum*). In the majority of woody species the participants could easily perceive the broadened leaf base, and the leaf sheat in the grasses. In all the analysed SBB, a description of the leaf petiole is not given.

Interestingly, several participants (13%) also used their hearing perception in creating the leaf description (e.g. in contact with the palm and the branch of an Oriental Plain [*Platanus orientalis*] the leaves produced a cracking sound like thick paper).

Recommendations for practice

In order to achieve one of the basic objectives of sequencing teaching and teaching content, it is important to align and closely link the sharing of teaching content (in teaching) with the prior knowledge and experience of the visually impaired students. In this way, visually impaired people construct better and achieve higher quality knowledge (Méheut and Psillos 2004). This implies that the sequencing of teaching content should be based on individual prior sensory experience, so that the participants learn through research activities with a mass appreciation of their physical (sensory), cognitive, mental and other capabilities (Swanson and Hoskyn 1998; Swanson 2001). Bearing this in mind and based on the results obtained in this research and the data obtained in other similar research, the following recommendations are made for sequencing classes in the field of Plant Morphology for the Blind.

Comparative analysis of the ordination and descrption of the morphological features of the vegetative plant parts generated by the participants and the ones given in the SBB resulted in significant differences. It indicates that the teaching process is not based on a constructivist approach, while the learning process for blind students is not in complete compliance with their methods for the ordination and description of the morphological features of the vegetative plant parts. It is assumed that the changes proposed in this research, in both the ordination and the description of the morphological features of vegetative plant parts, would contribute to the greater application of a constructivist approach to the teaching of blind students. By implementing these changes into the current method of teaching the vegetative plant parts, the blind students would start the learning process with the sensory perception of the most significant and easily perceived characters, while gradually and in accordance with their own sensory perceptions and descriptions, they will be able to learn about the more complex morphological characteristics. With this approach, the new teaching content in the plant morphology would be learnt gradually, step by step, in the manner, that each new element is logically connected to the previous ones, so that it upgrades the existing knowledge and leads to new congintion. It is expected that the implementation of the suggested method of the ordination and perception of the morphological features and descriptions of the vegetative plant parts would increase the quality and duration of student knowledge, since they are self-constructed by the blind. The statement can be supported by the study of Jones et al. (2006) in which the blind students who learnt by heptic technology increased their knowledge about cells, compared to those students who learnt through the traditional verbal-textual method. The suggested recommendations imply further work and the gathering of further sensory perceptions that the blind will create by exploring the fresh plant material in the learning process, while reading or listening to the descriptions of the morphological features of the plant organs.

The following changes are suggested to the ordination (Figure 1) and the description of the morphology of the underground plant parts when teaching blind students:

- The description of the morphological features of the root should start with the branching, then the thickness and firmness, and then the density;
- The types of root systems (taproot, fibrous root and tuberouse root) should be given after the descriptions given aboce;
- The types of the root should be defined by the root thickness;
- Descriptions of the types of rhizomes, tubers and bulbs should be based on the shape, not on the anatomical structure and the position of the buds.

The following changes are suggested for the sequencing (Figure 2) and description of the morphology of the stem when teaching blind students:

- In the description of differences between woody and herbaceous stems, greater focus should be placed on the thickness and firmness;

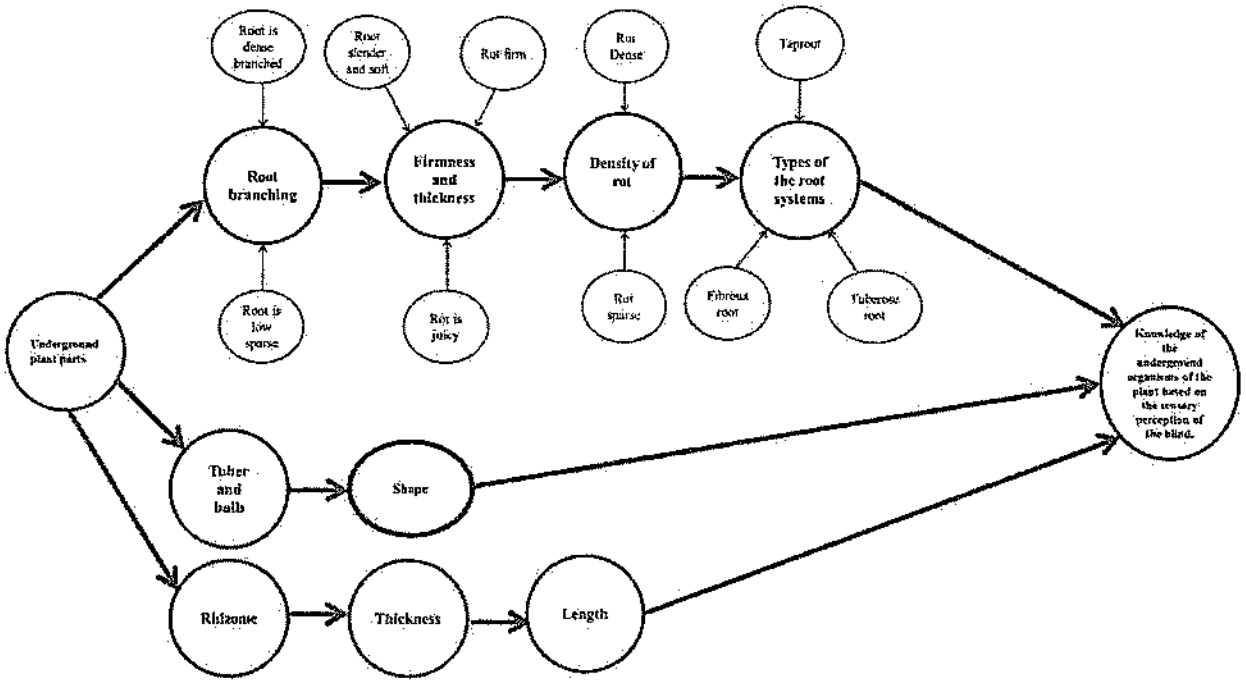

Figure 1. Sequencing in the descriptions of the morphological features of the underground plant parts that can be implemented in the education of the blind.

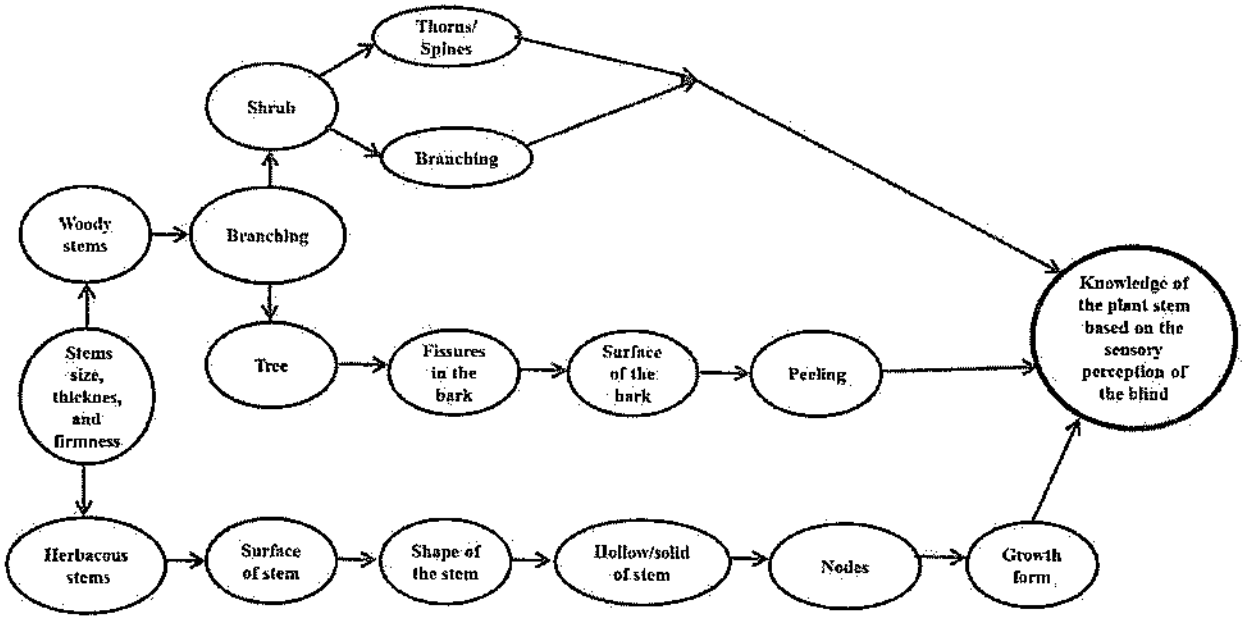

Figure 2. Sequencing in the descriptions the morphological features of the stem that can be implemented in the education of the blind.

- The descriptions of the stem type should not be based on the morphological features, which are impossible for the blind to perceive, such as the stem colour;
- The description of the shrubs should be supplemented by the branching type and the presence of thorns and spines;
- The description of the trees should contain information about the roughness of the surface and the fissures in the bark;

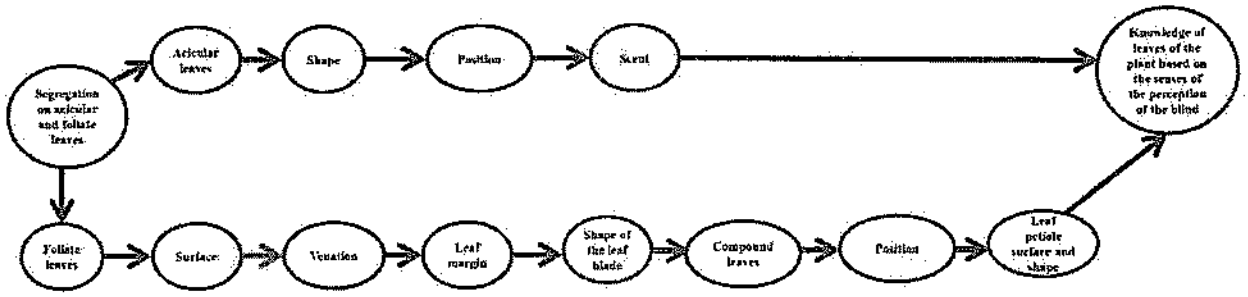

Figure 3. Sequencing the in description of the morphological features of the leaf that can be implemented in the education of the blind.

- In the herbaceus species, the description of the surface and information about the presence of the central cavity should be added; as well as information on the stem shape and the growth form.

The following changes are suggested for the sequencing (Figure 3) and description of the morphology of the leaf when teaching blind students:

- To use the possibility of the perception of the number of needles in distinguishing conifers;
- The description of the foliate leaf type should start with the leaf surface, then the venation, leaf margins and only finally the leaf shape;
- A description of the arrangement of the leaves on the stem should be added, as well as a description of the leaf petioles, as visually impaired people can easily identify this characteristic.

Limitations and recommendations for future research

One of the main limitations of this research was the limited number of plants whose vegetative organs were examined and described by the participants. Another limitation in this study was that the effect of sequencing the description of vegetative plant organs on the quality and durability of knowledge of blind students was not examined. The number of participants in this study was a further limiting factor in terms of making general recommendations for the correction and reconciliation of the sequencing of descriptions of each vegetative plant organs to the sensory perception of blind students.

In order to obtain the most reliable and correct sequencing in the descriptions of the morphological characters, and as well as the most complete description of the plant parts, that should be implemented in the education of the blind, additional similar investigations should be undertaken. Besides this, one of the tasks in future investigations should be the testing of the suggested sequencing of morphological descriptions and the descriptions as to the level and durability of the knowledge of blind students.

Conclusion

The results of the study showed that there is no significant difference in the perception and description of the morphological characters of the vegetative plant parts among the blind participants. Nevertheless, the sensory perception and descriptions of the morphological characteristics of the vegetative plant parts generated by the participants were not in accordance with the SSB. Therefore, it is necessary to make certain changes to the current methodology of teaching the morphology of different plant parts. Suggested improvements include: i) changes in the sequencing of the morphological descriptions of the plants parts, ii) corrections to the existing morphological descriptions of the different plant parts, iii) the creation of new morphological descriptions of the

plant parts based on the sensory perception of the blind. In this way, the presentation of the teaching content on the morphology of vegetative plant parts would be in accordance with the sequencing and perception of the blind. At the same time, this approach would also contribute to the greater implementation of constructivist learning in the biology education of the blind.

Disclosure statement

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DICHOTOMOUS KEYS IN THE BOTANICAL LEARNING OF NON-VISUAL (BLIND) PEOPLE

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Abstract. *Recently, the research about innovative approaches in the education of blind (non-visual- NV) students has intensified; however the use of dichotomous keys (DK) in their botanical education has not yet been examined. This research explored the contribution of two self-generated dichotomous keys (DK) for plant identification (a digital version- DDK and a printed version- DPK), to the botanical education of NV students. The research included 100 students, with an average age of 24, divided into 2 groups. Group E1 determined the plants using the DDK while in Group E2 plants were identified using the DPK. The DDK contributed more than the DPK in helping the NV participants to acquire the quality and durability knowledge they need to identify different plant groups (woody, bushy and herbaceous plants). The NV has the greatest success in the identification of woody plants, and the least success in the identification of herbaceous plants. The members of both groups (E1, E2) had possitive opinion about the contribution of the applicable dichotomous key to their knowledge, the activities in it. Due to this fact, both versions of DKs are recommended as new assistive tools in the botanical education of NV students.*

Keywords: *botanical education, plants identification, dichotomous keys, non-visual people, quasi-experimental design.*

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Introduction

The report by the World Health Organization, "Universal Eye Health", highlights the need for more intensive research in order to improve the quality of life and education of NV people (WHO, 2013). The fact is that only a small number of NV people (i.e. people born without sight and taught without visual references in school) are provided with a contemporary education, as it requires significant material resources (Hashemi et al., 2017; Livingston, McCarty, & Taylor 1997; Lamichhane, 2016, 2017). Education in the field of Natural Sciences is one of the main challenges in the education of NV people (Fraser & Maguvhe, 2008). Across a large number of studies, it has been concluded that with the help of assistive educational technology, NV students can achieve the same quality of knowledge in different natural sciences as students who have no visual impairment (Freire, Linhalis, Bianchini, Fortes, & Pimental, 2010; Rice, Aburizaiza, Jacobson, Shore, & Paez, 2012).

In the biological education of NV students, it is especially demanding to adapt the educational content in topics related to biodiversity, because so much of it is perceived visually. By contrast, the biodiversity education of NV students should be based on touch, hearing and smell (Smith, 1998; Smith, Polloway, Patton, & Dowdy, 1998). In the case of NV people, the absence of the visual sense is compensated for by the better development of other senses, primarily touch, hearing and smell (Morin-Parent, Beaumon, Théoret, & Lepag, 2017). Therefore, they acquaint themselves with their environment only partially, including in their approach to biodiversity. Research has shown that insufficient knowledge of biodiversity has the following consequences: the incomplete interaction of NV people with the environment; a negative impact on mental health and social skills, as well as limiting self-confidence (Binns et al., 2012). In order to mitigate these consequences, it is necessary to allow NV students to perceive their environment based on their available sensory experiences, insofar as it is possible.

The most common ways to educate NV people about biodiversity

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are the verbal-textual methods, the application of models and use of sensory gardens. Some researchers have pointed out that the acquisition of knowledge by the verbal-textual method causes verbalism in NV students. They interpret the content, but do not understand it because they have not adopted it through a sensory experience. They partially understand the concepts which explain the biodiversity surrounding them (Andersen, Dunlea, & Kekelis, 1993; Andersen, Dunlea, & Kekelis, 1984). By applying three-dimensional models in the teaching of NV people, the effects of verbal-textual methods are partially but not entirely removed.

Sensory gardens for NV learners are places which are specially adapted to NV visitors, through providing the maximum sensory stimulation, allowing them to encounter every part of garden by exploring them with their senses. One of the main aims of sensory gardens is the education of NV people and their preparation for task solving in everyday life. Through visits to sensory gardens, NV people are able to experience the richness of various tactile, fragrant and listening experiences, enabling them to explore, identify and understand their surroundings (Chawla & Heft, 2002; Mount & Cavet, 1995). The consequence is positive effects on the psychological and social well-being of the NV individual (Hussein, 2017). Söderback et al. (2004) pointed out that horticultural therapy and staying in nature increase the emotional, cognitive well-being, sensory functioning and the social inclusion of NV people. Due to the fact that sensory gardens are mostly concentrated in large cities and near major health rehabilitation centers, they are barely available to NV people who do not live in their immediate vicinity.

A review of the previous research indicated that the contribution of dichotomous keys (DK) for plant identification to knowledge on biodiversity has been tested only on students without any visual impairment. Recent studies (Anđić, Cvijetićanin, Maričić, & Stešević, 2018; Knight & Davies, 2014) have confirmed the positive contribution of DK to knowledge on biodiversity. Some researchers have suggested that NV students can achieve the same quality of knowledge in different natural sciences, as students who have no visual impairment (Freire et al., 2010; Rice et al., 2012), which forms the basic idea of this research. Thus, one question arises: If DKs make a positive contribution to the knowledge of people without visual impairment, will they also make a positive contribution to the environmental education of NV people when using the example of plants?

The aim of this research was to determine the relation between the contribution of the deliberately generated DKs and the quality and durability of the botanical knowledge of the NV participants, being needed for plant identification (recognizing and naming), as the basis for the sensory exploration of plants. In addition, within this aim, this research hoped to further determine the opinion of the NV participants on the impact of the applied DKs, thus it examined:

1. The similarities and differences in the quality and durability of NV knowledge in identifying plants from different groups (herbaceous, bushy and woody).
2. The opinions of NV participants on the contributions of the specific DK used to:
    - the knowledge they need to identify plants;
    - their desire to learn about plants from their surroundings and the wider environment;
    - the application of the acquired knowledge in everyday life;
    - the application of the acquired knowledge in the biodiversity education of the NV.

The basic hypothesis of this research was that both the generated DKs could be used as new assistive tools in the botanical education of NV students.

It was assumed that due to the use of educational software with speech technology in the DDK, the NV participants would acquire the better quality and longer-lasting knowledge that they need for the identification of plants, and that they would have a more positive opinion on its application, compared to those NV participants who learned using the DPK (a DK printed in Braille).

Research Methodology

General Background

The quasi-experimental design was used in the research. It was realized on the basis of an experiment with parallel groups over a period of 18 months (January 2017 to June 2018), and had two main focuses: 1) the contribution of the use of DKs to the quality and durability of the botanical knowledge of the NV participants; 2) the opinion of the NV participants about the applied DKs.

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Participants

The research included 100 NV participants whose median average age was 24, from Montenegro and Austria. The minimum sample size was determined by G* power program, following the inputs: one-tailed t test, the effect size of d = 80, desired power of .80, the error rate of .05. Results indicated that the minimum number of participants was 45 per group. The final size of the sample was determined on the basis of previous research that examined DK efficiency but which examined students and enthusiasts without visual impairment, and research in the field of the science education of NV students, as well as on the basis of the number of NV who wanted to voluntarily participate in the research and general recommendations for sample size in educational researches (Cohen, Manion, & Morrison, 2008). All the participants had a visual acuity of less than 3/60 and a narrowing of the field of view of 10° for their better visual eye (Yang et al., 2016). The demographic characteristics of the sample is presented in Table 1.

Table 1. Demographic characteristics of the sample (Total *N*=100).

Variables	Type	N	%
Gender	Male	57	57
	Female	43	43
Age (years)	Less than 7	1	1
	7-11	12	12
	11-15	14	14
	15-19	32	32
	19-25	10	10
	25-30	17	17
	30-40	5	5
	40-50	9	9

The NV were divided into two groups (E_1 and E_2), which were equal in the number of NV people (each group had 50 NV people), and which were based on the number of plant species that they could identify on the PRT.

Approval of and agreement for this research was provided by each institution from which NV participants were engaged, including schools, universities and societies. The institution managers and administrative staff, the parents of minor participants, and all the participants themselves were made familiar with the research and procedures within it. All participants were included on a voluntary basis. The anonymity of all participants and confidentiality were guaranteed. All participants were reminded of the guarantees regarding confidentiality and anonymity at every stage of the research process, and were sought permission to record questionnaires and use the questionnaire data.

Research Design

The research was divided into the following phases:

1. Questionnaire 1- semi-structured questionnaire in oral form (adapted to the NV) was used to examine the opinions of the NV participants about plant species that could be identified on the basis of the sensory perception of plants. Moreover, one aim of this questionnaire was to examine the way in which the NV participants had learnt about plants prior to their involvement in this research.
2. The level of prior botanical knowledge of each NV participant was assesed by using a non-standardised pre-test (PRT), which was based on the sensory perception and identification of fresh material of plant species listed in Questionnaire 1.
3. Descriptions of the morphological plant characteristics by NV participants – these descriptions were obtained by giving each NV student the fresh material of one plant species, to be used to examine the plant based on the senses of touch, smell and hearing. The NV participant then described all the reproductive and vegetative plant organs without being required to identify the plant species.

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The descriptions were recorded using an ICD-UX560 Dictaphone. On average, each NV participant took around 15 minutes to study the morphological characteristics of the one plant species, but the time for giving their description was not limited. Each NV participant gave a description of all one hundred plant species. This phase of the research lasted 9 months, because the species did not belong to the same aspect of flora. Some of them flower/produce reproductive structures in spring, some in summer, and some in autumn.

4. Selecting the morphological characteristic of plant for DK – in the creation of the DK, was only used the morphological characteristic of plants which were described by NV participants as the basis for sensory perception and which had a scientific relevance. To begin with, all the descriptions were transcribed and after that coded separately. The coding method used a grounded theory approach (Glaser & Strauss, 1967; Strauss & Corbin, 1990) and was similar to the coding method used in other studies in teaching biology to blind students (Fraser & Maguvhe, 2008). Codes with a frequency of greater than 85 (out of 100) were used to create the content of both DKs.
5. The creation of particular DKs (the DDK and the DPK) by using specific taxonomical markers (the morphological characteristics of plants) obtained in the previous phase of the research. The DDK was created using education software and speech technology, while the DPK was printed in Braille.
6. Formation of groups – The NV participants were divided into two groups (E_1 and E_2). The groups were equal according to NV knowledge on the PRT and in terms of the number of participants.
7. Implementation of DDK and DPK in plants determination - The determination lasted for three weeks, consisting of 8 periods of 60 minutes of teaching. Each NV participant independently determined the plants using the relevant DK and fresh plant species.
8. The opinion of the NV participant about the used DK – structured questionnaire (Questionnaire 2) in oral form (adapted to the NV) was asked with the aim of examining the opinion of the NV students on the DK which they used for plant determination. The intent was to examine the opinions of NV participants about the contribution of the applied DK to the knowledge they needed to identify plants; their motivation to learn about plants, and the opinions of the NV participants about the implementation of the DDK and the DPK in the botanical education of NV students.
9. The examination of the new knowledge of the NV participants – the new knowledge about plant identification was examined using a non-standardised post-test (POT). It was realized immediately after finishing the phases of the implementation of the DDK and the DPK in plant determination.
10. Knowledge durability of NV participants – this was examined through a non-standardised re-test (RET)- which was realized two months after finishing the phases of the implementation of the DDK and the DPK in plant determination.

Approach

In Group E_1, the NV identified plants using a DDK and in E_2 they used a DPK. Both groups performed the determination in a natural environment (parks and walking grounds). In the first round of determination, the researcher identified one species using the DK with each NV participant, in order to demonstrate to them the basic principle of the function of the DK that was used. After that, the NV received the fresh plant material of the next plant from the researcher and independently performed the determination using their specific assigned DK.

In determining, the plant species which have major morphological details and vegetative, reproductive organs were determined first, gradually shifting to smaller plant species. The accuracy of the determination was checked by the researcher. When a NV person accurately identified the plant, the researcher led them to a location where the plant grew in its natural habitat, so that the NV person could complete a mental image of the environment in which the plant species were growing.

Description of the DDK and the DPK

The DDK and the DPK were created by the researchers in three languages (English, German and Serbian) and had the exact same content (100 plant species from the environment of the NV participants). The one-hundred plant species were selected on the basis of the various plant species about which NV students learn at inclusive pre-university level in Austria and Montenegro, as well as the fact that a similar number of species was used in

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previous similar research with students and enthusiasts without visual impairments. The selected plant species grow in the environment of the NV participants in both Austria and Montenegro.

The keys hold the names of the plants which are used in everyday life, as well as their Latin names. In the DDK (Figure 1), educational software with speech technology was applied, while the DPK contents from the DDK were presented with the text in Braille. In both DKs, determination is performed on the same principle. The NV gradually turn from one claim to another. The claims describe the morphological characteristics of the given plant species, moving from the general to the specific characteristics of the plant. At the end of the determination, the NV are focused on a claim which summarizes the properties of the plant from the previous claims and designates the plant.

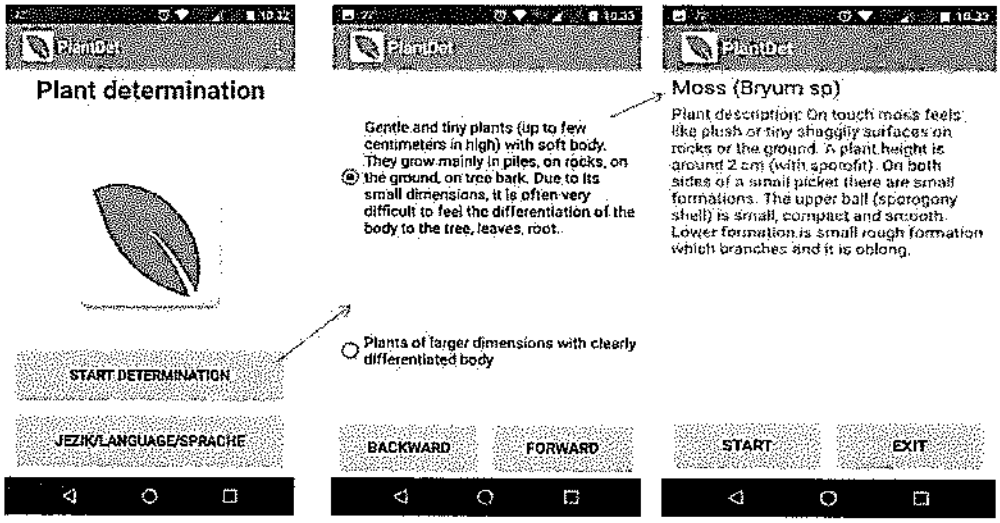

Figure 1. Example of simple determination through the DDK.

Research Instruments

A testing technique was used to analyze knowledge. Testing was carried out in the environment in which the NV were identifying the plants. On all tests, the NV were supposed to identify the plant species based on the sensory perception of fresh plant material. On the PRT, participants were supposed to identify only those plant species which most of the NV study group claimed that they were able to identify (four plants) in Questionnaire 1. Based on those responses, the PRT had four questions. The results of the PRT represented one of the criteria for equalizing the groups. The POT and the RET consisted of a total of 24 questions. Eight questions related to the identification of woody, eight dealt with shrubs and eight concerned herbaceous plants. On the POT and the RET, the participants were supposed to identify the same plant species from different groups of plants. In the selection of plants, we considered all the plants that the majority of NV participants had identified in Questionnaire 1 and those plants which are most common in the natural environment of the NV participants. The examination of the participants' knowledge was the same for all the tests, and was carried out according to the following principles:

- Every participant received one example of a fresh plant species, which was provided by the researchers. The NV participant was supposed to identify the plant species based on sensory exploring.
- On average, the NV participants took around 3 minutes to identify one plant species. The time allowed for the POT and the RET was two school classes (90 minutes) each. In this process, it was considered that all the NV participants had enough time for sensory plant identification. The PRT lasted only one school class.
- The NV participants answered in oral form. Their answers were checked by the researchers and they were written on the record sheet.
- Each answer provided by the NV participants was evaluated as either correct or incorrect because theywere only supposed to identify (name) the plants.

All the tests used in this research were non-standardized because of the lack of standardized test for testing

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the knowledge of NV people in terms of plants identification. Both questionnaires were in oral form adapted to the NV (Ratanasukon, Tongsomboon, Bhurayanontachai, & Jirarattanasopa, 2016). Questionnaire 1 had 10 items with 5 questions and it examined the way in which NV participants had learned about plants prior to the realization of this research, as well as the plant species that they could identify. Questionnaire 2 had twenty items and four blocks of questions (in total 16 question). In the first block of questions, opinions about the contribution of the applied DK to the quality of the knowledge needed to identify the plants on the part of the NV participant that was examined. In the second block of questions, their opinions about the activity in the applied DK were examined. In the third block of questions, their opinions about the impact of the applied DK on their motivation to learn about plants from their surroundings and beyond, as well as the impact of the knowledge acquired through the DK on their everyday life were examined. In the fourth block of questions, the NV were supposed to give their opinion on the possibility of using the DK in the further botanical education of other NV. The questions in Questionnaire 2 were open, ordinal (using the Likert scale of assessment) and combined in type. The Likert scale featured five points: (1 = I don't have an opinion, 2 = Disagree, 3 = Partially Disagree, 4 = Agree, 5= Agree Strongly). The questions were read to the NV participants as well as the available answers (to questions of an ordinal or combined type) and clarified if that was necessary. The NV participants answered the questions orally and the researchers wrote these on the record sheet.

Data Analysis

The contribution of the DDK and the DPK to the quality and durability of the knowledge of the NV in Groups E_1 and E_2 was measured based on the number of accurately identified plant species on the POT and the RET. The difference and similarity in knowledge between the groups on the PRT, POT, or RET, were obtained using a non-parametric Mann-Whitney *U* test and an independent t test. Also, the Mann-Whitney U test was used for analyzing differences in opinions among NV participants between Groups E_1 and E_2 on the questionnaire, the Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test the normality of whether the obtained data on the three tests corresponded to a normal distribution. To determine the difference in knowledge between the POT and the RET within one group, the Wilcoxon test was used. The analysis of the questionnaire was performed by exploratory factor analysis, principal component analysis (the Barlett sphericity test and the Kaiser-Meyer-Olkin test -KMO) and Varimax rotation. The internal consistency of the factors in the questionnaire was computed using the Cronbach Alpha test (α).

Research Results

The results of Mann–Whitney *U* test, indicate ($U = 2469.000$; $Z = -2.856$; $p = .936$) that there was no statistically significant difference between the NV participants in Groups E_1 and E_2 in the claims about the method of learning about plants before the realization of this research. In Questionnaire 1, all the NV participants claimed that they rarely learned about plants on the basis of their personal sensory experience. The NV participants learned about plants from books (E_1: 53%, E_2 55%); from family / friends (E_1: 21%; E_2: 23%); from the media (E_1: 18%, E_2: 14%) and from personal experience (E_1: 8%; E_2: 7%).

The Knowledge of NV participants in terms of Identifying Plants before using the DDK and the DPK

Most NV (E_1: 90%; E_2: 92%) claimed that they could identify 4 plant species: the common daisy (*Bellis perennis* L.), the dandelion (*Taraxacum officinale* L.), the pine (*Pinus sp.*) and the platan (*Platanus sp.*). 17% of the NV in the whole sample correctly identified only one plant (*Pinus sp.*), while the other plants listed in Questionnaire 1 were not identified on the basis of the fresh plant material provided. The Mann-Whitney *U* nonparametric test found that there was no difference in the knowledge of the NV in Groups E_1 and E_2 in relation to the indicated plants ($U = 3286.000$; $Z = -4.228$; $p = 1.717$). This was confirmed by the independent t-test ($t = 8.236$; $df = 99$; $p = 1.336$).

The Knowledge of NV participants in terms of Identifying Plants immediately after the application of the DDK and the DPK

The values of the Kolmogorov-Smirnov normality test and the Shapiro-Wilk test showed that the obtained data did not have a normal distribution (see Table 2).

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Table 2. Tests of normality of distribution in Groups E_1 and E_2 on the POT and the RET.

Test	Group	Kolmogorov-Smirnov			Shapiro-Wilk		
		D	*df*	*p*	*W*	*df*	*p*
POT	E1	.188	50	.002	.985	50	.002
	E2	.158	50	.002	.9623	50	.005
RET	E1	.189	50	.003	.915	50	.003
	E2	.123	50	.002	.948	50	.002

The difference in the knowledge of the NV participants between Groups E_1 and E_2 was used to determine the results as an independent t test. In Group E_1, the NV participants identified 21 out of 24 plant species, while in Group E_2, they identified exactly half (12 out of 24). The difference in the number of identified plants was as follows: 2 woody pants ($t = 3.971$; $df = 99$; $p = .0001$); 3 shrubs ($t = 3.126$; $df = 99$; $p = .0001$) and 4 herbaceous plants ($t = 4.023$; $df = 99$; $p = .0001$). The NV in Group E1 were more successful in identifying the fir (*Abies alba* Mill.), the spruce (*Picea abies* (L.) Karst), the hawthorn (*Crataegus monogyna* Hawthorn), the yew (*Taxus baccata* L.), the oleander (*Nerium oleander* L.), the broadleaf plantain (*Plantago major* L.), the narrowleaf plantain (*Plantago lanceolata* L.), St John's-wort (*Hypericum perforatum* L.), and white clover (*Trifolium repens* L.).

The Knowledge of NV participants in terms of Identifying Plants two months after the application of the DDK and the DPK

Both the Kolmogorov-Smirnov normality test and the Shapiro-Wilk test, shown above in Table 2, demonstrated that the obtained data did not have a normal distribution. Group E_1 showed more durable knowledge and managed to identify 17 out of the 24 species. Group E_2 identified 8 out of 24 species. The differences in the number of identifiable plants between Groups E_1 and E_2 was as follows: 2 woody ($t = 3.759$; $df = 99$; $p = .0001$); 2 shrubs ($t = 4.823$; $df = 99$; $p = .0001$) and 5 herbaceous plants ($t = 4.129$; $df = 99$; $p = .0001$). The NV in Group E_1 were more successful in identifying the fir (*Abies alba* Mill.), the hornbeam (*Carpinus orientalis* Mill), the hawthorn (*Crataegus monogyna* Hawthorn), the yew (*Taxus baccata* L.), the broadleaf plantain (*Plantago major* L.), the narrowleaf plantain (*Plantago lanceolata* L.), St John's-wort (*Hypericum perforatum* L.), slag (*Malva sylvestris* L.), and white clover (*Trifolium repens* L.). The results of the Wilcoxon test, Table 3, show the existence of differences in the number of accurately identified plants from all groups of plants on the post-test and re-tests within Groups E_1 and E_2.

Table 3. The difference in the knowledge of the NV participants between the POT and the RET in each group, the Wilcoxon test.

	Group E1			Group E2		
	Willk λ	*F*	*p*	Willk λ	*F*	*p*
Woody	.745	.082	.017	.835	.071	.012
Shrubs	.972	.335	.014	.865	.224	.009
Herbaceous	.791	.213	.009	.887	.119	.018
Total	.795	.238	.019	.823	.158	.023

The Opinions of the NV participants about the Applied DKs

Exploratory factor analysis, principal component analysis (KMO = 740; Barlett sphericity test = 437.205; df = 66; $p = .000$) and Varimax rotation, demonstrated that there were four latent factors that explain 72.61% of total variance. For further analysis, four specific factors were taken: Factor 1: The opinion of the NV on the contribution

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of the applied DK to their knowledge, needed to identify the plants (that explain 19.62% of total variance); Factor 2: The opinion of the NV on the activity in the DK(that explain 18.15% of total variance); Factor 3: The opinion of the NV on the impact of the applied DK on their motivation to learn about plants and the importance of applying this knowledge in their daily lives (that explain 17.46% of total variance) and Factor 4: The opinion of the NV on the opportunities for using the DKs in their botanical education, (that explain 17.38% of total variance). The range, average values, dispersion of results and Cronbach Alpha coefficient by factors are presented in Table 4.

Table 4. Range, average values, dispersion of results and Cronbach Alpha coefficient by factors.

Factor	*N*	M_{min}	M_{max}	*M*	*SD*	α
The opinion of the NV participants on the contribution of the applied DK to their knowledge, needed to identify the plants	100	2	5	4.255	.682	.84
The opinion of the NV participants on the activity in the DK	100	1	5	3,561	.713	.81
The opinion of the NV participants on the impact of the applied DK on their motivation to learn about plants and the importance of applying this knowledge in their daily lives	100	1	5	3.228	.801	.81
The opinion of the NV participants on the opportunities for using the DKs in the botanical education of NV students	100	1	5	3,11	.905	.86

The difference in opinions among NV participants between Groups E_1 and E_2 was confirmed by the Mann-Whitney *U* test: the contribution of the applied DK to their knowledge, needed to identify the plants. ($U = 1726.000$; $Z = -4.255$; $p = .001$); activities in the DK ($U = 2044.000$; $Z = -5.111$; $p = .001$); the desire to learn about plants in the future using the DK ($U = 1768.000$; $Z = -4.052$; $p = .000$) and the implementation of the relevant DK in the botanical education of NV students ($U = 1556.000$; $Z = -3.859$; $p = .001$). The difference in the opinions of the NV participants in Group E_1 and Group E_2 was also confirmed by the percentage of NV participants who selected the option *I fully agree* in answering questions using the Likert scale, (Figure 2).

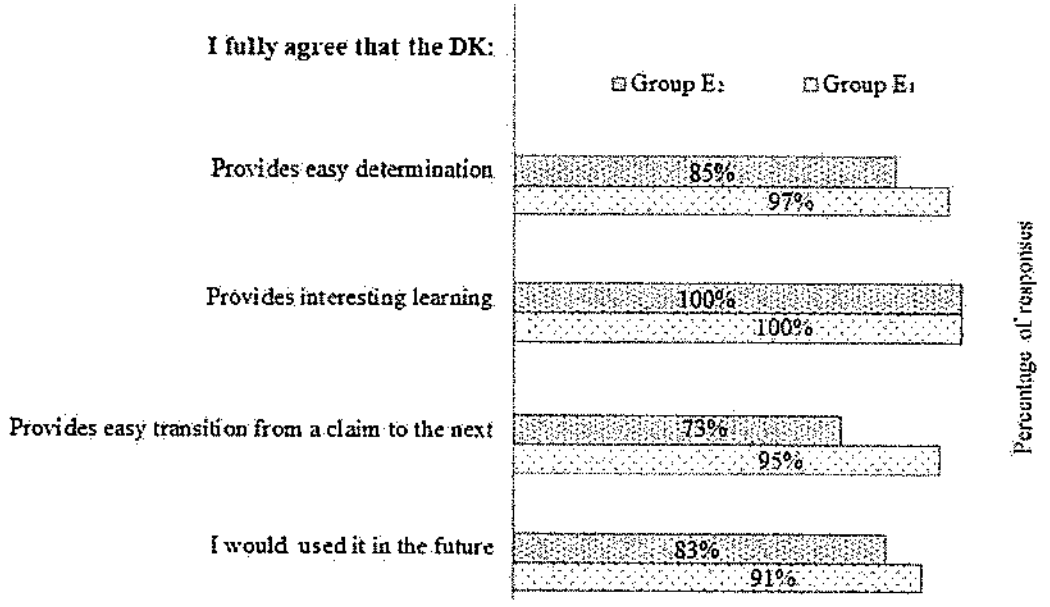

Figure 2. The difference between Groups E_1 and E_2 in the choice of the claim *I fully agree* on the impact of the DK.

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Discussion

The tactile sense of the NV individual was the primary source for the collection of information on the basis of which the plants were identified. In terms of the process among NV participants in the identification of plants, it can be concluded that identification does not begin by defining the shape and size of the plant, but rather with the sensations of touching. Using the example of the leaf, the first reported feature is the surface (bare, hairy, flaky rough or fine, very rough, and so on). Then they determined the firmness (soft, medium, hard plastic), thickness (thin, medium, thick), the nature of the edge of the leaf (unstressed, toothed, wavy) and finally its shape. The senses of smell and hearing helped them collect information to identify a small number of plants. Thus, for example, the sense of smell helps in the identification of aromatic plants rosemary and mother's thymus. Furthermore, Poison ivy (*Hedera helix* L.) was identified by the characteristic "blunt" sound of the fruits when touching.

Most NV could not identify any of the plant species they stated on the Questionnaire 1, based on fresh herbal material, before using the specifically generated DK. A small number of NV identified only one plant species (pine) from the group of woody plants. These data indicate that prior to the determination by means of the DDK and the DPK the NV (PRT) were primarily taught about the plants from the environment verbally, without sufficient sensory experience, which led to the appearance of verbalism (Greenaway & Dale, 2017). This assumption is in line with the responses received from the NV in the survey. Their main source of knowledge about plants was books, while the sensual (personal) experience had little influence.

Immediately after determining with the DDK and the DPK, the NV on average acquired the good knowledge they needed to identify the woody, or shrub plants, and significantly less knowledge for the identification of herbaceous plants. This can be explained by the grating orientation thresholds and its value of 0.96mm for NV (Alary et al., 2009). The morphological details of the woody and bushy plants are larger and beyond their threshold range, so that they heard the touch of the NV participants. The herbaceous plants are generally smaller in size, have finer morphological features comparing to woody and scaly plants. In both groups, most NV claim that the easiest to identify were plants of larger dimensions, and the most difficult plants of smaller dimensions, as well as plants that have similar structures.

A possible reason for the easier identification of the woody and shrubs plants is that the NV had heard most about these plant groups in their everyday life, but had not had the opportunity to investigate them. This probably caused internal motivation to experience them sensually and learn more about them. Most NV in both groups claim that during the determination they placed more attention and focused on the plants they had heard or read about because they wanted to find out more about them. The results obtained are in correlation with the research by Stagg and Donkin (2016) in which enthusiasts without visual impairment participated. In that research, for most enthusiasts, the woody plants were more engaging in terms of their determination by the generated DK, and relatively easy to identify. As one of the reasons for these results, these plants are more popular among enthusiasts than other plants.

Two months after the DDK and DPK determination, the NV participants, on average in both groups, achieved poorer results when identifying plants compared to the immediate POT. When comparing the quality of the knowledge of the NV related to the group of plants, it was noticed that the NV had forgotten some plant species from all the groups of plants. It is assumed that one of the reasons for forgetting is the effect of the active and passive forgetting process, as well as the non-repeating of plant content between the POT and the RET. The possible reason for the fact that some plant species were more quickly forgotten was that these plants did not leave powerful imagery ratings for the NV participants; they were not interesting, attractive during the determination process. This assumption is correlated with neuroscience studies that have examined long-term memory functions in NV. In these studies, it was concluded that there is no difference in the durability in memory between NV and those without visual impairment. NV memorize objects and environments that left them with a strong sensory rating for a longer period of time than those which left a weaker imagery rating, unless these imagery ratings are based on the visual sense (Beni & Cornoldi, 1988; Zimler & Keenan, 1983).

All the NV identified all the plant species listed in Questionnaire 1 on the POT and the RET, even though they could not identify them on the basis of fresh plant material on the PRT. On average, the NV were not successful on either the POT or the RET in the identification of similar plant species; for example, they confused the identification of the white clover (*Trifolium repens* L.) and the red clover (*Trifolium pratense* L.) as well as the

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species from the group of grasses. The small dimensions of these plants and similar structures probably caused the confusion of the NV during the identification. The sense of hearing and smell was not helpful in these cases, because both plants have neither a distinctive odor nor create a distinctive sound when touched. Similar research was undertaken by Stagg and Donkin (2016), which involved students with no visual impairments. The students who used the DK could not recognize similar plant species due to their low visibility.

In the opinion of most NV in both groups, both generated DKs contributed ("fully agree") to improving their knowledge of plants. They consider that the generated DK which they applied was an innovative way to learn about plants in the environment. The possible reason for unanimity in this answer is that the systematically explored the plants for the first time through the application of the relevant DK, which probably caused a positive opinion about DKs in general. With the generated DK the NV were enabled to replace verbal learning with research learning through the observation of plant species using their tactile, smell and hearing senses. The NV in both groups fully agreed with the claim that the generated DK which they used would be suitable for the botanical education of other NV. According to the opinion of the NV in Group E_1, the DDK could be easily be applied in the botanical education of NV students in elementary and secondary schools. The NV in Group E_2 considered that the DPK would be more successful in secondary education than in primary education.

The reason for the greater contribution of the DDK in comparison to the DPK to the knowledge of the NV needed to identify plants is probably the fact that DDK uses education software with speech technology. This made it possible for the NV in Group E_1 to actively communicate with the tablet through the right use of the touch screens, while listening to what they touched, flipping through the contents of the screen while listening, starting again from what they had heard last. This, among other things, made it possible for them to quickly determine the plants, unlike the NV participants in Group E_2, who had to read each claim in Braille. This is in correlation with the research by Cassia et al. (2009), in which it was concluded that the use of assistive technology and educational software contributed more to the quality of the knowledge of NV students and students in comparison to the traditional way of learning, in which the verbal-textual method dominates. Moving from one claim to another in the DDK was facilitated by a simple click that influenced concentration (Andić et al., 2018) and allowed the NV in Group E_1 to focus on the tactile, auditory and smell senses while exploring the plant more than the NV in Group E_2 (Röder et al., 1999). These assumptions are in correlation with many studies in the field of neuroscience which have shown that NV encode auditory verbal material better than those without visual impairment, causing greater brain activity and better memory performance (Röder, Rösler, & Neville, 2001; Kujala, Alho, Paavialinen, Summala, & Näätänen, 1992). Given that the NV using it determined plants more quickly, the DDK indirectly causes the NV to receive faster feedback about the accuracy of their determination than the NV in Group E2, which makes it easier to correct errors in their determination process. Continuous feedback has a motivational impact, stimulating further activity in the determination process, which leads to the transformation of external to internal motivation (Csikszentmihalyi, Abuhamdeh, & Nakamura, 2005).

A possible reason for the better contribution of the DDK than the DPK is in the means of presenting the content and activities within the DK. The auditory presentation of the content made the DDK more attractive and engaging for the NV than a written presentation in the DPK. This assumption correlates with the differences in opinion of the NV in Groups E_1 and E_2. For most of the NV in Group E1, learning with the DDK was easy, interesting, and it would be relatively easy to use the DDK in learning, which is why they wanted to continue to learn about plants in the future. Most of the NV in Group E_2 claimed that their activities in the DPK were tiring after a short time and that their concentration deteriorated during the determination process. They would use the DPK to determine the plants in the future, but the determination would take a shorter time and include a longer break.

Most NV in both groups expressed the need to get to know as many plant species as possible in their immediate surroundings and further afield. Basically, for both groups, the reason for this is the desire for new knowledge, but also the curiosity of getting to know their surroundings, and also distant areas they have read or heard about. They consider ("I fully agree") that the applied generated DK helped them complete their mental picture of the landscape in their environment through the identification of plants, and that, based on listening to information on the plant species that grow in other environments; they could imagine other areas more clearly than before.

When asked "In what way does new knowledge about the plants contribute to your daily life?", most of the NV thought that based on plant identification it would be easier for them to find their way in parks and

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green areas, which made them feel safer, more independent and encouraged them to stay longer outdoors. This indicates that both generated DK can minimize the perception of environments as unfriendly from the side of NV, which is mostly caused by the lack of adaptable teaching and learning materials and negative attitudes towards them (Odame, Hwedie, Nketsia, Peprah, & Nanor, 2019). The obtained opinions of the NV participants are in correlation with the results of the research by Söderback et al. (2004) and Johnson (2012), in which they examined the influence of the sensory garden and gardening on the everyday life of their NV study group and concluded that gardening and plant exploring encourages individualistic and idiosyncratic creativity and thinking while offering diverse learning skills that enhance both land management at the domestic level and environmental interaction.

Conclusions and Implications

This research represents a pioneer study exploring the implementation of the generated DKs in the botanical education of NV students. Both the generated DKs (the DDK and the DPK) are potentially innovative assistive tools in the botanical education of NV students because they contributed to their knowledge in identifying all the plants species that they could not identify previously, before using the generated DK. The NV participants considered that both the generated DKs had helped them to acquire new knowledge that would help them to more easily orient themselves and feel safer when they are outdoors. The contribution of the DDK and the DPK to the quality and durability of NV participant knowledge needed to identify different groups of plants (woody, bushy and herbaceous) was unequal. The way the content was presented to the NV groups in the generated DK, the DK design, the activities in it, the speed of determination by using the DK, and the speed of obtaining feedback on the accuracy of the determination not only affect the quality and durability of NV knowledge, but also the desire (motivation) of NV participants to investigate the plants in their surroundings and the wider environment by using a DK. Therefore, in the botanical education of NV students, priority should be given to the DDK as compared to the DPK. The way of learning for NV participants, using both the generated DK alongside the parallel sensory research of plants on fresh plant species might be used as a new form of explicit instruction, but it could also be used in creating implicit instructions to help NV students determine and learn about plants. It is necessary to significantly increase the extent of the research in this area in order to confirm these claims. In this way, such research would contribute to the adaptation of botanical content to the needs of NV people and to innovation in biology education for NV students.

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Биографија

Проф. др Станко Цвјетићанин

Др Станко Цвјетићанин, редовни је професор на Педагошком факултету у Сомбору,Универзитет у Новом Саду,Република Србија. Професор је и на Медицинском факултету, Универзитет у Новом Саду, на смеру Специјална рехабилитација-инклузивно образовање. Доктор је хемије-методике наставе хемије. .Аутор је и коаутор 20 радова у часописима на SSCI и SCI листи, и преко 40 радова у осталим научним часописима Аутор је 5 универзитетских уџбеника и два практикума. Ментор три одбрањене докторске дисетрације на Универзитету у Новом Саду. Тренутно је ментор у три докторсе дисертације (у изради),Ментор је 6 одбрањених магистарских теза. Руководио је трогодишњим и краткорочним (једногодишњим) покрајинским научним пројектом (АП Војводина,Република Србија). Учествује, као истраживач, у оквиру републичког пројекта (Република Србија) из области образовања (2011-2019). Члан је Комисије за оцену пројеката из области друштвено-хуманистичких наука при Покрајинском секретеријату за високо обратовање и науку АП Војводине. Заменик је председника Одбора за обезбеђење квалитета и интерну евалуацију Универзитета у Новом Саду. Министарство просвете, науке и технолошког развоја Републике Србије оценило је његову научну компетенцију са највишом оценом (А1). Научно интересовање: Екохемија; Екологија и заштита животне средине; Екохемијско образовање; Интердисциплинарни приступ хемији, андрагогији и екологији;Методика наставе хемије; Методика наставе природних наука; Методика упознавања околине,Инклузија у настави природних наука;Стероидна хемија и хемија жучних киселина,Органска хемија и унапређење наставог процеса у земљама Југоисточне Европе.

БИБЛИОГРАФИЈА

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Уџбеници и дидактичка средства

Уџбеници:

1. Цвјетићанин, С., и Сегединац, М. (2008). *Модели екохемијског образовања радника хемијске индустрије*. Сомбор: Педагошки факултет. ИСБН: 978-86-83097-78-4.
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6. Цвјетићанин, С. (2017). *Методика наставе природних наука*. Сомбор: Педагошки факултет. ИСБН: 978-86-6095-067-5.

Практикуми:

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Научни радови:

Број	Аутор, назив рада и часопис
Рад у међународном часопису на SSCI и SCI листи	
1	Cvjetićanin, S., Halaši, R., Halaši, T, & Adamov, J. (2008). Hemija u srpskim časopisima u drugoj polovini 19. veka. *Hemijska industrija, 5*, 305-313.
2	Cvjetićanin, S., Segedinac, M., & Adamov, J. (2008). Attitudes of elementary teachers towards working with combined classes. *Odgojne znanosti, 1*(15), 147-159.
3	Cvjetićanin, S., Segedinac, M., & Letić, Lj. (2009). Hemijska proizvodnja i primenjena hemija metala i nemetala u nastavnom programu hemije za osnovnu školu. *Hemijska industrija, 63*(2), 129-136.
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Рад у часопису међународног значаја верификованог посебном одлуком	
1	Цвјетићанин, С., Сегединац, М., и Летић, Љ. (2008). Наставни садржаји о хемијској производњи у основношколској настави. *Настава и васпитање. 4*, 441-455.
2	Цвјетићанин, С., Сегединац, М., и Николић, Г. (2012). Ефикасност учења о животињама путем откривања у разредној настави. *Настава и васпитање, 2*, 365-383.
3	Pećanac, R., Sakač, M., & Cvjetićanin, S. (2013). A more contemporary approach to computer-based learning, *Teme, 3,* 1451-1465.
4	Cvjeticanin. S., & Andjic. B. (2017). Teacher's Opinion About The Implementation Of Inclusive Education In Teaching Integrated Natural Sciences, *Teme, XLI*(4),999-1016
Монографска студија/поглавље у књизи или рад у тематском зборнику међународног значаја	
1	Obadovic, D., Rancic, I., Cvjeticanin, S., & Segedinac, M. (2012). The impact of implementation of scientific method in teaching sciences on positive pupil's attitude in learning science, *Theory and practice of connecting and integrating in teaching and learning process* (pp. 213-225), Sombor, Faculty of education in Sombor,.
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3	Cvjeticanin, S., Brankovic, N., & Petrovic, D. (2012). Implementation of student mini-projects in the primary science teaching, Theory and practice of connecting and integrating in teaching and learning process, (pp. 21-35), Sombor, Faculty of education in Sombor.
Рад у научним часописима	
1	Цвјетићанин, С., и Сегединац, М. (2008). Ставови учитеља према раду у паровима. *Васпитање и образовање. 3*, 55-65.
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Саопштење са међународног скупа штампано у изводу	
33	Miličić, D., Bošnjak, M., Cvjetićanin, S., Jovanov, B., Marković–

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Број: 04-29/12
Нови Сад, 24. септембра 2015. године

На основу члана 48 став 3 тачка 6 и члана 65 Закона о високом образовању („Службени гласник РС" бр. 76/05, 100/07-аутентично тумачење, 97/08, 44/10, 93/12, 89/13), члана 73 тачка 5 и члана 136 тачка 9 Статута Универзитета у Новом Саду (Савет Универзитета, 28.12.2010. године, 23.03.2012. године, 11.10.2012. године, 26.02.2013. године, 15.11.2013. године и 30.05.2014. године) и члана 8 став 1 и 2 Правилника о начину и поступку стицања звања и заснивања радног односа наставника Универзитета у Новом Саду (Сенат Универзитета, 23.01.2006. године и 27.12.2013. године), Сенат Универзитета у Новом Саду на седници одржаној 24. септембра 2015. године, једногласно је донео

О Д Л У К У

о избору др Станка Цвјетићанина у звање редовног професора на Педагошком факултету Универзитета у Новом Саду, за ужу научну област Методика наставе познавања природе.

О б р а з л о ж е њ е

Након спроведеног поступка у складу са Законом о високом образовању, Статутом Универзитета и Правилником о начину и поступку стицања звања и заснивања радног односа наставника Универзитета у Новом Саду, Сенат Универзитета је разматрио и прихватио Одлуку о утврђивању предлога за избор у звање и заснивање радног односа Изборног већа Педагошког факултета у Сомбору од 27.05.2015. године, Закључка Стручног већа за природно-математичке науке од 17.09.2015 године и Закључка Стручног већа за хуманистичке науке и уметност од 17.09.2015. године и донео Одлуку као у диспозитиву.

ПРЕДСЕДНИК СЕНАТА
Проф. др Радован Пејановић

Prof. dr Tatjana Novović

Diplomirala sam na Filozofskom fakultetu u Sarajevu, na odsjeku pedagogija i psihologija, 1987. godine i stekla pravo na stručni naziv – profesor pedagogije i psihologije. Na Filozofskom fakultetu u Beogradu, magistrirala sam 2004. god. na odsjeku za predškolsku pedagogiju na temu »Efekti projekta *Dječji vrtić kao porodični centar* na saradnju porodice i vrtića«.

Doktorsku tezu na temu »Uloga vaspitača u prvom razredu reformisane osnovne škole u Crnoj Gori«, odbranila sam 2008. godine na Filozofskom fakultetu u Beogradu.

Kao stručni saradnik, psiholog, u JPU »Ljubica Popović« u Podgorici, radila sam u periodu od 1990. do 1996. godine. Nakon toga angažovana sam kao prosvjetni inspektor za predškolsko vaspitanje i obrazovanje u Ministarstvu prosvjete i nauke (1996–2003), a od 2003. do 2007. godine, kao samostalni savjetnik za predškolsko vaspitanje i obrazovanje u Zavodu za školstvo Crne Gore. Od akademske 2007/08. godine angažovana sam kao saradnik u nastavi na Filozofskom fakultetu, u Nikšiću. Od 25. 09. 2009. godine, na osnovu *Odluke o izboru u zvanje* Univerziteta Crne Gore, kao docent realizovala sam nastavu na Filozofskom fakultetu, za predmete: Predškolska pedagogija I, Predškolska pedagogija II, i Savremene tendencije u predškolskoj pedagogiji na Studijskom programu za pedagogiju, Predškolska pedagogija i Savremene tendencije u predškolskoj pedagogiji na specijalističkom Studijskom programu za predškolsko vaspitanje na Filozofskom fakultetu u Nikšiću. Od 2015.godine, u zvanju vanrednog profesora, izvodim nastavu na već pomenutim disciplinama na st.programima za Pedagogiju i Predškolsko vaspitanje i obrazovanje, kao i master programu za Inkluzivno obrazovanje, na Filozofskom fakultetu u Nikšiću.

Tokom proteklog perioda aktivno sam učestvovala i učestvujem u nekoliko važnih projekata od nacionalnog i međunarodnog značaja.

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Dio naučne monografije izdate kod nas (i u okruženju) čiji su izdavači nacionalne akademije nauka i državni univerziteti i dio knjige studijskog karaktera izdate kod nas.

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Učešće u međunarodnim naučnim projektima

Evaluacija reforme obrazovanja u Crnoj Gori (2012) Ministarstvo prosvjete Crne Gore,

Evaluacija efekata predškolskog vaspitanja i obrazovanja, Ministarstvo prosvjete CG, Ministarstvo nauke CG, UCG

Bilateralni projekat sa katedrom za pedagogiju u Zagrebu, pod nazivom, *Interkulturalno obrazovanje i europske vrijednosti*

TEMPUS projekat *FOSFIM (Foundation of study programme for inclusive education in Montenegro*), koji je bio usmjeren na afirmaciju inkluzije na univerzitetskom nivou, regionalni projekat *Regional Support for Inclusive Education* u organizaciji Savjeta Evrope

ERASMUS+ projekat KEY (Keep Educating Yourself)2018-2021.

Učešće u bilateralnom naučnoistraživačkom projektu „Kvalitet procesa predškolskog vaspitanja u Republici Sloveniji i Crnoj Gori" UCG, St.program za pedagogiju na Filozofskom fakultetu u Nikšiću i St.program za pedagogiju i andragogiju u Ljubljani

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Dana, 28. 05. 2015 g.
Date,

Na osnovu člana 72 stav 2 Zakona o visokom obrazovanju (Službeni list Crne Gore br. 44/14) i člana 32 stav 1 tačka 9 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore, na sjednici održanoj 28. maja 2015. godine, donio je

O D L U K U
O IZBORU U ZVANJE

Dr TATJANA NOVOVIĆ bira se u akademsko zvanje **vanredni profesor Univerziteta Crne Gore** za predmete: Predškolska pedagogija I, Predškolska pedagogija II i Pedagogija ranog djetinjstva (specijalističke studije) na Studijskom programu za pedagogiju i Predškolska pedagogija i Pedagogija ranog djetinjstva (specijalističke studije) na Studijskom programu za predškolsko vaspitanje na Filozofskom fakultetu, na period od pet godina.

REKTOR

Prof. Radmila Vojvodić

BIOGRAFIJA

IME I PREZIME: Srđan Kadić

Roden 11.09.1968.godine u Beogradu.

Diplomirao na Prirodno-matematičkom fakultetu, Univerziteta Crne Gore, na Odsjeku za Matematiku i računarske nauke – smjer računarstvo sa prosječnom ocjenom 9, 00 - 1994.godine.

Postdiplomske studije upisao na Odsjeku za matematiku i računarske nauke, smjer računarstvo Matematičkog fakulteta u Beogradu. Ispite na postdiplomskim studijama položio sa prosječnom ocjenom 10, 00. Magistarski rad pod nazivom "Algoritam sortiranja za hardverski akcelerator obrade podataka" odbranio na Matematičkom fakultetu u Beogradu – 2000.godine.

Doktorsku disertaciju pod nazivom "Algoritam provjere serijalizovanosti konkuretnog izvršavanja transakcija" odbranio na Prirodno-matematičkom fakultetu u Podgorici - 16.05.2009.godine.

PODACI O RADNIM MJESTIMA I IZBORIMA U ZVANJA

Od oktobra 1994.godine radi u nastavi na Odsjeku za matematiku i računarske nauke Prirodno-matematičkog fakulteta u Podgorici. Kao asistent odnosno saradnik u nastavi držao vježbe:

- Računari i programiranje, Principi programiranja, Programski jezici, Numerička analiza, Organizacija računarskih sistema Vizuelizacija i računarska grafika, Napredne programske tehnike, Kompjuterska animacija na Odsjeku za matematiku i računarske nauke Prirodno-matematičkog fakulteta u Podgorici.
- Matematika I, Metalurško-tehnološki fakultet u Podgorici.
- Računari i programiranje, Građevinski fakultet u Podgorici.
- Osnovi informatike, Odsjek za Biologiju Prirodno-matematičkog fakulteta u Podgorici.

Od 25.03.2010.godine, u akademskom zvanju docent Univerziteta Crne Gore radi u nastavi na Odsjeku za matematiku i računarske nauke Prirodno-matematičkog fakulteta u Podgorici, drži predavanje i vježbe:

- Računari i programira.ije, Principi programiranja, Programski jezici (do 2014),
- Vizuelizacija i računarska grafika, Napredne programske tehnike, Kompjuterska animacija, Uvod u informacione sisteme, Softver inženjerstvo, Softver za mobilne platforme, Bioinformatika na Odsjeku za matematiku i računarske nauke Prirodno-matematičkog fakulteta u Podgorici.
- Interaktivni dizajn II, Fakultet likovnih umjetnosti u Cetinju.
- Informacioni sistemi u građevinarstvu, Projektovanje informacionih sistema Građevinski fakultet u Podgorici.
- Infromaciono komunikacione tehnologije, Forenzika, Pravni fakultet u Podgorici.

Od 2013.godine obavlja funkciju prodekana za finansije na Prirodno-matematičkom fakultetu u Podgorici.

Na predlog Odjeljenja prirodnih nauka, 2013.godine, imenovan je za člana Odbora za informaciono komunikacione tehnologije.

Na predlog ministarstva Nauke i tehnologije, 2013.godine, imenovan je za člana upravnog odbora projekta "Visoko obrazovanje i istraživanje za inovacije i konkurentnost - INVO".

Od strane Vlade Crne Gore, 2012.godine, imenovan za člana Radne grupe za pripremu i vođenje pregovora o pristupanju Crne Gore Evropskoj uniji za oblast pravne tekovine Evropske unije koja se odnosi na pregovaračko poglavlje 10 – Informatičko društvo i mediji.

PREGLED RADOVA I BODOVA NAKON PRETHODNOG IZBORA

1. NAUČNOISTRAŽIVAČKA DJELATNOST	BROJ BODOVA	
	UKUPNO ZA REFERENCU	ZA KANDIDATA
1.3.1. Monografije – 1. **Crna Gora u XXI stoljeću – u eri kompetitivnosti – Nauka i Tehnologija,** izdavač CANU, knjiga 73/11, **Srđan Kadić,** Informacione i komunikacione tehnologije, 517-537	10	2
1.2.1 Radovi objavljeni u časopisima koji se nalaze u međunarodnim bazama podataka 1. Tomović S., Stanišić P., Kadić S., **Data Mining Approach In Climate Classification And Climate Network Construction – Case Study Montenegro,** Vol. 25 No.4 2018, pp. 1037-1043,Tehnički vjesnik/Technical Gazzete, University of Osijek, Technical Faculty, Slavonski Brod, Croatia, ISSN 1330-3651 [baza podataka: SCIE, priložen rad] https://doi.org/10.17559/TV-20160913205831 2. Kadić S.,Tomović S., **Computer-Based Validation of 3N+1 Hypothesis for Numbers 3^n-1,** Vol. 26 No. 2 2019, pp. 289-293,Tehnički vjesnik/Technical Gazzete, University of Osijek, Technical Faculty, Slavonski Brod, Croatia, ISSN 1330-3651 [baza podataka: SCIE, priložen rad] https://doi.org/10.17559/TV-20161108221649	7 7	7 7
1.3.1. Radovi na međunarodnim kongresima i seminarima 1. Božović V., Kadić S., Kovijanić-Vukićević Ž., Orbits of a k-sets of Zn, Proccedings of the Third Mathematical Conference of Republic of Srpska, 2013, pp. 177 -187, ISBN 978-99976-600-0-8 [priložen rad] **1.3.2. Radovi na domaćim kongresima i seminarima** 1. Ivanović I., Kadić S.,Using OpenFlow standard for Feedback-based NFS server balancing, 2014, 60-63, ISSN: 978-86-85775-15-4, XIX. IT Žabljak, [priložen rad]	2 1	1 1

3. PEDAGOŠKA DJELATNOST	BROJ BODOVA	
	UKUPNO ZA REFERENCU	ZA KANDIDATA
3.1.2 Univerzitetski udžbenik – korišćenje referentnog inostranog udžbenika kod nas 1. Ian Sommerville, Software Engineering, 10th Edition, Pearson 2. S. Marchner, P.Shirley, Fundamentals of Computer Graphics, 4th edition 3. R.Daigneu, Service Design patterns: Fundamental Design Solutions	5	5
3.4.2. Mentorstvo – na dodiplomskom studiju 1. Leon Đuravčaj, XML praktična primjena, odbranjen 03.12.2018.godine 2. Nikolina Sekulić, CSS Layout, odbranjen 30.11.2018.godine 3. Jovan Gajić, Java Script, odbranjen 06.11.2017.godine 4. Ljubomir Stijepović, UpotrebaOpenSource tehnologija na primjeru GIS sistema, odbranjen 29.08.2013.godine	0.5 0.5 0.5 0.5	0.5 0.5 0.5 0.5
3.5. Kvalitet pedagoškog rada		

4. STRUČNA DJELATNOST	BROJ BODOVA	
	UKUPNO ZA REFERENCU	ZA KANDIDATA
4.6. Ostala stručna djelatnost - prenos rezultata naučnog rada u praksu; prenos znanja u proizvodnju ili u rad državnih i drugih organa i organizacija; saradnja u izradi stručnih osnova za nove propise; aktivnosti u organima međunarodnih udruženja **4,6.1 Rad sa talentovanom i darovitim djecom i omladinom** 1. Mensa Crna Gora – pur opravni član Mense International, predsjednik 2000-2012, 2. Fondacija Mladi pronalazači Crne Gore,predsjednik 2010-, **2.1.** First Lego League, 2010-, robotika za djecu uzrasta 10-16 godina internacionlano takmičenje **2.2.** Sajam Pronalazača 2010-2016, program podrške za mlađe pronalazače **2.3.** Invetors's Space – kutak za pronalazače – ETF Podgorica (2013), 10 000 dolara vrijedna donacija Američke Ambasade (prvi 3D štampač itd.) **2.4.** Software Developer Space – PMF Podgorica (2016), donacija vrijedna 215 000 dolara - softver za računarsku salu. **4.6.2 Stručna tijela** 1. Vlada Crne Gore - Radna grupa za pripremu i vođenje pregovora o pristupanju Crne Gore Evropskoj uniji koja se odnosi na pregovaračko poglavlje 10 – Informatičko društvo i mediji. 2. Ministarstvo Nauke i tehnologije - upravni odbor projekta "Visoko obrazovanje i istraživanje za inovacije i konkurentnost - INVO", 3. CANU – Odbor za Informaciono komunikacione tehnologije. 4. Vlada Crne Gore - Radna grupa za praćenje implementacije akcionog plana za sprovođenje Strategije IKT pravosuđa 2016-2020. **4.6.2 Prenos rezultata naučnog rada u praksu** 1. UNDP Montenegro, 2016-2019 – Government Service Buss 2. UCG, 2017-2018, integrisani web portal Univerziteta Crne Gore 3. GTZ/GIZ Montenegro, 2016-2017 – Architectural framework for PSC 4. UNDP Montenegro, 2012-2017 – Informacioni Sistem Socijalnog staranja (SWIS). 5. EUROL 2 – EU Support to Rule of Law, 2016-2017 – Support to ICT Strategy.	20	20

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Broj / Ref 03-3548
Datum / Date 28.10.2019

Crna Gora
UNIVERZITET CRNE GORE
Broj 5256
05.11.2019

Na osnovu člana 72 stav 2 Zakona o visokom obrazovanju („Službeni list Crne Gore" br 44/14, 47/15, 40/16, 42/17, 71/17, 55/18, 3/19, 17/19, 47/19) i člana 32 stav 1 tačka 9 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore na sjednici održanoj 28.10.2019. godine, donio je

O D L U K U
O IZBORU U ZVANJE

Dr Srđan Kadić bira se u akademsko zvanje docent Univerziteta Crne Gore za **oblast Računarstvo i programiranje**, na Prirodno-matematičkom fakultetu Univerziteta Crne Gore, na period od pet godina.

SENAT UNIVERZITETA CRNE GORE
PREDSJEDNIK

Prof. dr Danilo Nikolić, rektor

Kratka biografija Danke Caković

Rođena sam 28.08.1977. godine u Titogradu, gdje sam završila osnovnu školu i gimnaziju. Školske 1996/97 godine upisala sam studije Biologije na Prirodno-matematičkom fakultetu u Podgorici. Diplomirala sam oktobra 2000. godine sa prosječnom ocjenom 9,48 i stekla zvanje diplomirani biolog. Dobitnik sam plakete Univerziteta Crne Gore za najboljeg studenta u oblasti prirodnih nauka, za školsku 1999/2000. godinu. Poslijediplomske studije, smjer Ekologija i geografija biljaka upisala sam školske 2000/01. godine na Biološkom fakultetu Univerziteta u Beogradu. Magistarsku tezu pod nazivom: "Floristička studija planine Sutorman" odbranila sam 05. 02. 2004. godine i stekla zvanje magistra bioloških nauka. Zvanje doktora bioloških nauka stekla sam na Prirodno-matematičkom fakultetu (Studijski program Biologija) Univerziteta Crne Gore, odbranom doktorske teze "Floristička i vegetacijska studija planinskog masiva Rumije" 17.10.2011.

Usavršavanje kroz posjete i saradnje sa međunarodnim institucijama:

Institut za botaniku, Innsbruck – 4 mjeseca (2014/2015/2016/2018/2019) Institut za Botaniku, Graz – 1 mjesec (2010) Univerzitet u Ljubljani, odsjek za Biologiju – 1 mjesec (2009)

Radno iskustvo:

2001. do 2012. – saradnik u nastavi na studijskom programu Biologija. U navedenom periodu bila sam angažovana na izvođenju nastave iz botaničke grupe predmeta (Ekologija biljaka, Anatomija i morfologija biljaka, Sistematika biljaka).

2005. do 2012. – saradnik u nastavi na Poljoprivrednom fakultetu smjer Poljoprivredna proizvodnja, predmet Botanika.

2007. do 2012. – saradnik u nastavi na Farmaceutskom fakultetu, Botanika

2012. do 2017. – profesor (docent) na studijskom programu Biologija i na Farmaceutskom fakultetu 2017. do danas – vanredni profesor na studijskom programu Biologija i na Farmaceutskom fakultetu 2016. do dans – rukovodilac Studijskog programa Biologija

Stručni angažmani:

1. Flora i vegetacija šireg područja Podgorice
2. IPA (Important Plant Area) projekat
3. Biodiversity (habitats/vegetation) mapping for selected locations in the Coastal area of Montenegro
4. Studija biodiverziteta obalnog područija
5. Katalog Flore Crne Gore (I, II i III tom)

6. Monitoring biodiverziteta odabranih lokaliteta u Crnoj Gori
7. Unaprijeđenje ekološke baze za održivo šumarstvo u Crnoj Gori
8. Evolucija dvije grupe biljaka iz Crne Gore i susjednih regiona (Balkansko poluostrvo)
9. Studija "Prirodne vrijednosti poluostrva Vrmac"
10. Strateška procjena uticaja na Program razvoja lovstva
11. Studija zaštite planinskog masiva Sinjajevine
12. Procjene uticaja na životnu sredinu u različitim dijelovima Crne Gore
13. Prilog Studiji zaštite Šaskog jezera
14. Prostorni plan posebne namjene za Nacionalni park Skadarsko jezero, vođa biološkog tima
15. Prostorni plan posebne namjene za Nacionalni park Prokletije, vođa biološkog tima
16. Zaštita i održivo korištenje biodiverziteta Prespanskog, Ohridskog i Skadarskog jezera "Hydromorphological and Shorezone Functionality Index (SFI) of Skadar lake"
17. Predsjenik Komisija za izradu programa za predmet Biologija – Opšta Gimnazija i Matematička gimnazija (predsjednica komisije)
18. Akcioni plan za biodiverzitet Podgorice
19. Upoznavanje sa ciljevima održivog razvoja u srednjim školama u Jugo-istočnoj Evropi
20. Uspostavljanje NATURA 2000 mreže u Crnoj Gori – ekspert za staništa
21. Kartiranje međunarodno značajnih staništa na području NP Skadarsko jezero

Dodatne informacije:

2001. – dobitnik plakete "Najbolji student Univerziteta Crne Gore u oblasti prirodnih nauka"

Članstvo u profesionalnim grupama: IUCN Species Survival Commission, International Association for vegetation Science

Petrović D. & Pulević V.:Botanical Exploration in Crmnica Area – Inheritance and Future, Compilation of Contributions to the Symposium held in Vir (12-13 July 2002), Virpazar, 2002.

Petrović D.: Analyses of Mountain Sutorman Flora (Master's Thesis), Faculty of Biology, Belgrade, 2003.

Petrović D.: Chenopodium multifidum & Medicago Carstiensis two new species for the flora of Montenegro, Third International Balkan Botanical Congress (Sarajevo), 2003.

Stesević D. & Petrović D.: Rare, Endangered and Protected Plants of Mountain Bjelasica, Depart. Biol. Univers. Monten. - Centre Biodivers. Montenenegro. (Podgorica). Monogr. 1, 2003.

Vuksanović S. & Petrović D.: In spite of Prevailing Opinion to the Contrary - Kickxia cirrhosa (L.) Fritisch Grows on the Balkan Peninsula, XI OPTIMA Meeting, (Belgrade) 2004.

Petrović D.: A Contribution to Knowledge of the Mountain Sutorman Flora, 1st

Symposium of Montenegrin Ecologists, (Tivat) 2004.

Petrović D. & Vuksanović S.: A contribution to the Knowledge of District of Ulcinj Flora, 1st Symposium of Montenegrin Ecologists, (Tivat) 2004.

Petrović, D.: IPAs in Montenegro. In: Anderson, S., Kušik, T., Radford, E. (*Eds*) Important Plant Areas in Central and Eastern Europe – Priority Sites for Plant Conservation, 74 – 75. Plantlife International, UK. 2005.

Petrović D, Vuksanović S., Bozović M.: *Cypripedium calceolus* L. - New finding in Montenegro. II International Symposium of the Ecologists of the Republic of Montenegro, (Kotor) 2006.

Petrović D, Ojdanić M, Malidžan D: Bilogy for 8th grade of elementary school, 2007. Agency for books, Ministery of Education and Science.

Malidžan, D., Petrović, D., Ojdanić, M.,: Workbook for Bilogy for 8th grade of elementary school, 2007. Agency for books, Ministery of Education and Science.

Petrović, D. IPAs in Montenegro a progress report. 5th European Conference on the Conservation of Wild Plants in Europe. (Cluj Napoca) 2007:, Romania.

Vuksanović S, **Petrović D:** The flora and vegetation of Salt works in Ulcinj. Natura Montenegrina 6, (Podgorica) 2007.

Petrović D, Malidžan D: Bilogy for 9th grade of elementary school, 2008. Agency for books, Ministery of Education and Science.

Malidžan, D., Petrović, D.: Workbook for Bilogy for 9th grade of elementary school, 2008. Agency for books, Ministery of Education and Science.

Petrović, D, Stešević, D, Vuksanović, S: Materials for the Red Book of Montenegro. Natura Montenegrina 7, (Podgorica) 2008.

Stešević, D., Petrović, D., Vuksanović, S., Bubanja, N., Biberdžić, V.: Contribution to the vascular flora of Montenegro (Supplementum to the Material for vascular flora of Montenegro). Natura Montenegrina 7, (Podgorica) 2008.

Petrović, D: Important Plant Area country reports – Montenegro. In: Radford, E., Odé, B. (*Eds.*) Conserving Important plant Areas: Investing in the green gold of South East Europe, 55-62. Plantlife International, UK. 2009.

Petrović, D. (ed): Važna biljna staništa u Crnoj Gori (IPA projekat): 1-80. Nevladino udruženje "Zelena Gora", 2009.

Petrović, D., Stešević, D.: Materials for the red book of vaskular flora of Montenegro (second contribution). Biologica Nyssana, 1 (1-2), December 2010: 27 – 34, Niš.

Petrović, D., Stešević, D.: Reports 151 – 153, pp 431 – 433 in: Vladimirov, V., Dane, F., Stevanović, V., Tan, K. (ed): New chorological data for the Balkans, 14. Phytologia Balcanica 16 (3): 415 – 445, Sofia, 2010.

Stešević, D., Petrović, D.: Preliminary list of plant invaders in Montenegro. Biologyca Nyssana, 1 (1 – 2): 35 – 42, Niš, 2010.

Petrović, D.: *Rosaceae* (*Rubus*). – In: Kurtto, A., Weber, H. E., Lampinen, R. & Sennikov, A. N. (eds.) Atlas Florae Europaeae. Distribution of Vascular Plants in Europe. **15** (Distribution of the vascular plants in Montenegro): Helsinki University Printing House, 2010, 362 pp.

Petrović, D., Stešević, D.: New data on the distribution of *Micromeria cristata* (Hampe) Griseb. and *Steptorhamphus tuberosus* (Jacq.) Grossh., moving of the westernmost limit of distribution area. Acta Botanica Croatica (ISNN 0365-0588), 70 (2): 259 - 267, Zagreb, 2011. (SCI)

Petrović, D., Hadžiablahović, S., Vuksanović, S., Mačić, V., Lakušić, D. (2012): Catalogue of habitat typest of EU importance of Montenegro, Podgorica-Beograd, 2012.

Caković, D., Stešević, D., Iković, V., Knežević, M., Latinović, N.: Contribution to the knowledge of weed flora in Bjelopavlići plain. Agriculture & Forestry, Vol. 58, Issue 4: 25-41, Podgorica, 2012.
Stešević, D., **Caković, D. (2013):** Towards the Catalogue of Vascular Plants **of Montenegro, Natura Montenegrina 12(1): 231-240, Podgorica 2013.**

Stešević, D., Caković, D. (2013): Contribution to the alien flora of Montenegro and Supplementum to the Preliminary list of plant invaders, Biologica Nyssana 4 (1-2): 1-7, Niš 2013.

Caković, D., Stešević, D., Vuksanović, S.: Some floristic and chorological contribution to the vascular flora of Montenegro (Ulcinj area). Natura Montenegrina, 12 (2): 271 – 279, Podgorica, 2013.

Stešević, D., **Caković, D.**: Katalog vaskularne flore Crne Gore, Tom I: 1 – 363, CANU, Podgorica, 2013.

Stešević, D., Latinović, N., **Caković, D.**: Invasive alien plant species in Montenegro, with special focus on *Ambrosia artemisifolia*. Proceedings from the 4th ESENIAS Workshop: International Workshop on IAS in Agricultural and Non-Agricultural Areas in ESENIAS Region, 16-17 December 2013

Lansdown R., Anastasiu, P., Barina Z., Bazos I., Çakan H., Delipetrou P., Matevski V., Mitić B., **Caković, D.**, Ruprecht E., Tomović G., Tosheva A., Király G.: Review of alien freshwater vascular plants in south-east Europe. Proceedings from the 4th ESENIAS Workshop: International Workshop on IAS in Agricultural and Non-Agricultural Areas in ESENIAS Region, 16-17 December 2013.

Stešević, D., Ristić, M., Nikolić, V., Nedović, M., **Caković, D.**, Šatović, Z.: Chemotype diversity of indigenous Dalmatian Sage (*Salvia officinalis* L.) populations in Montenegro. Chemistry & Biodiversity, Vol. 11: 101 -114, Zürich, 2014. (SCI)

Caković, D., Stešević, D., Vuksanović, S., Kit, T.: *Colchicum cupanii* Guss. Subsp. *Glossophyllum* (Heldr.) Rouy, *Datura innoxia* Mill. And *Eclipta 4rostrate* (L.) L., new floristic records in Montenegro and western Balkan, Acta Botanica Croatica, 73, Zagreb, 2014. (SCI)

Caković, D.: Rosaceae taxa (Amelanchier, Aronia, Chaenomeles, Cotoneaster, Crataegus, Cydonia, Eriobotrya, Malus, Mespilus, Prunus, Pyracantha and Pyrus) – Distribution of the vascular plants in Montenegro). – In: Kurtto, A., Weber, H. E., Lampinen, R. & Sennikov, A. N. (eds.) Atlas Florae Europaeae. Distribution of Vascular Plants in Europe 15 (ISBN 978-951- 9108-16-2) Helsinki University Printing House

Stešević, D., **Caković, D.**, Jovanović, S.: The Urban Flora Of Podgorica (Montenegro, SE Europe): Annotated checklist, distribution atlas, habitats and life-forms, taxonomic, phytogeographical and ecological analysis. Ecologica Montenegrina: 1 – 171, Podgorica, 2014.

Caković, D., Stešević, D., Schönswetter, P. & Frajman, B (2015): How many taxa? Spatiotemporal evolution and taxonomy of Amphoricarpos (Asteraceae, Carduoideae) on the Balkan Peninsula. Organisms Diversity & Evolution (ISSN 1439-6092) (SCI)

Gazdić, M., Pejović, S., Gazdić, J., Perović, M., **Caković, D.**: Floristic composition and ecologycal analysis of the mixed forests (beech, fir, spruce) in the management unit „Bjelasica" (Bjelasica mt., Montenegro). Agriculture & Forestry, Vol 62 (3): 207 – 221, Podgorica, 2016.

Šilc, U., **Caković, D.**, Kuzmič, F., Stešević, D.: Trampling impact of vegetation of embryonic and stabilised sand dunes in Montenegro. Journal of coastal conservation (published online, November 2016). (SCI)

Barina, Z., **Caković, D.**, Pifko, D., Schönswetter, P., Somogyi, G. & Frajman, B (2017): Phylogenetic relationships, biogeography and taxonomic revision of European taxa of *Gymnospermium* (Berberidaceae). Botanical Journal of the Linnean Society, 184: 298 – 311. (SCI)

Caković, D., Stešević, D., Schönswetter, P. & Frajman, B (2017): Long neglected diversity in the Accursed Mountains of northern Albania: *Cerastium hekuravense* is genetically and morphologically divergent from *C. dinaricum*. Plant Systematics and Evolution, published online 30 August 2017. (SCI)

Vulević, A., Dragićević, S., **Caković, D.** (2017): Two moss species from Mt Durmitor new to the bryophyte flora of Montenegro. Acta Bot.Croat. 76(2): 196-199. (SCI)

Dragićević, S., Vulević, A., **Caković, D.** (2017): A rare liverwort in the Mediterranean area, *Crossocalyx hellerianus* (Nees ex Lindenb.) Meyl., newly recorded for Montenegro. Cryptogamie, Bryologie 38 (3): 275 – 280. (SCI)

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Stešević, D., Luković, M., **Caković, D.**, Bubanja, N., Ružić, N., Šilc, U. (2018): Alien species in sand dune plant communities on Velika plaža in Ulcinj (Montenegro). Periodicum Biologorum 119(4): 239-249. (SCI)

Šilc, U., Kuzmič, F., **Cakovič, D.,** Stešević, D. (2018): Beach litter along various sand dune habitats in the southern Adriatic (E Mediterranean). Marine Pollution Bulletin 128: 353-360. (SCI)

V. Kolarčik, V. Kocová, **D. Caković,** T. Kačmárová, J. Piovár, and P. Mártonfi (2018): Nuclear genome size variation in the allopolyploid Onosma arenaria – O. pseudoarenaria species group: methodological issues and revised data. Botany, 96: 397-410.

Milan Gazdić, Albert Reif, Milan Knežević, **Danka Petrović**, Marko Stojanović & Klara Dolos (2018): Diversity and ecological differentiation of mixed forest in northern Montenegro (Mt. Bjelasica) with reference to European classification. Tuexenia 38: 135-154. (SCI)

Massimo Terzi, Nenad Jasprica, **Danka Caković**, Romeo di Pietro: Revision of the central Mediterranean xerothermic cliff vegetation. Applied Vegetation Science, 21(3): 514-532. (SCI)

Urban Šilc, Danijela Stešević, Andrej Rozman, **Danka Caković**, and Filip Küzmič (2019): Alien Species and the Impacton Sand Dunes Along the NE Adriatic Coas. C. Makowski, C. W. Finkl (eds.), Impacts of Invasive Species on Coastal Environments, Coastal Research Library 29.

Ramirez, K., Snoek, B., Koorem, K., Geisen, S., Bloem, J., Ten Hooven, F., Kostenko, O., Krigas, N., Manrubia, M., **Caković, D.,** van Raaij, D., Tsiafouli, M., Vreš, B., Čelik, T., Weser, C., Wilschut, R., van der Putten, W. (2019): Range-expansion effects on the belowground plant microbiome. Nature ecology and evolution 3: 604-611. (SCI)

Rutger A. Wilschut, Stefan Geisen, Henk Martens, Olga Kostenko, Mattias de Hollander, Freddy C. ten Hooven, Carolin Weser, L. Basten Snoek, Janneke Bloem, **Danka Caković**, Tatjana Čelik, Kadri Koorem, Nikos Krigas, Marta Manrubia, Kelly S. Ramirez, Maria A. Tsiafouli, Branko Vreš, Wim H. van der Putten (2019): Latitudinal variation in soil nematode communities under climate warming-related range-expanding and native plants. Global Change Biology, 25(8): 2714-2726. (SCI)

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Datum / Date 16.10.2017

Na osnovu člana 72 stav 2 Zakona o visokom obrazovanju („Službeni list Crne Gore" br. 44/14, 47/15,40/16,42/17) i člana 32 stav 1 tačka 9 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore na sjednici održanoj 16.oktobra 2017.godine, donio je

O D L U K U
O IZBORU U ZVANJE

Dr Danka Caković bira se u akademsko zvanje **vanredna profesorica za oblast Botanika i Ekologija biljaka** na **Prirodno-matematičkom fakultetu,** na period od pet godina.

Senat Univerziteta Crne Gore
Predsjedavajući

Prof. dr Danilo Nikolić,v.f.rektora

KRATKA BIOGRAFIJA PROF. DR DANIJELE STEŠEVIĆ

LIČNI PODACI

Rođena sam 16.07.1976. godine u Titogradu, gdje sam završila osnovnu školu »Savo Pejanović« i srednju školu gimnaziju »Slobodan Škerović«.

PODACI O VISOKOM OBRAZOVANJU

Školske 1994/95 godine upisala sam studije Biologije na Prirodno-matematičkom fakultetu u Podgorici, gdje sam diplomirala 6. 10. 1998. godine sa prosječnom ocjenom 9,45 i stekla zvanje diplomirani biolog.

Poslijediplomske studije upisala sam školske 1998/99. godine na Biološkom fakultetu Univerziteta u Beogradu (smjer: Ekologija i geografija biljaka) i završila ih sa prosječnom ocjenom 10. Magistarsku tezu pod nazivom: "Flora kraških polja u Piperskom kraju Crne Gore" odbranila sam 15. 05. 2001. godine i stekla zvanje magistra bioloških nauka.

Doktorsku disertaciju pod nazivom: "Ekološka-fitogeografska analiza flore šireg urbanog područja Podgorice", odbranila sam 24. 06. 2009. godine, na Biološkom fakultetu Univerziteta u Beogradu i stekla zvanje doktora bioloških nauka. Rješenje o priznavanju Uvjerenja o stečenom naučnom stepenu Doktora bioloških nauka izdato mi je od strane Ministarstvo Nauke i Prosvjete 26. 10. 2009. godine.

PODACI O RADNIM MJESTIMA I IZBORIMA U AKADEMSKA ZVANJA

Od 1999. godine zasnovala sam radni odnos na Prirodno-matematičkom fakultetu u Podgorici (Studijski program Biologija), gdje sam januara 1999. godine izabrana u zvanje asistenta. U toku svog desetogodišnjeg staža asistirala sam u laboratorijskim vježbama na predmetima: *Anatomija biljaka, Ekologija biljaka, Ekologija životinja, Sistematika i filogenija viših biljaka, Limnologija, Sistematika i filogenija nižih biljaka, Biologija mora, Botanika* na akademskim studijskim programima Biljna proizvodnja i Farmacija.

Zvanje docenta na Prirodno-matematičkom fakultetu u Podgorici (predmeti *Sistematika i filogenija viših biljaka I i II*, na studijskom programu Biologija i *Botanika*, na studijskom programu Biljna proizvodnja) stekla sam 27.05.2010. godine. Školskih 2010/2011 i 2011/2012. godine bila sam angažovana kao predavač Botanike na Farmaceutskom fakultetu. Od školske 2012/2013 držim dio predavanja iz "Bioloških zbirki" koje se slušaju na specijalističkim studijama, na studisjkom programu Biologija. Od izbora u zvanje docenta, nastavila sam da držim vježbe na predmetima *Sistematika i filogenija viših biljaka I i II*, na studijskom programu Biologija.

Zavanje vanrednog profesora na Prirodno-matematičkom fakultetu u Podgorici (predmeti *Sistematika i filogenija viših biljaka I i II*, na studijskom programu Biologija i *Botanika*, na studijskom programu Biljna proizvodnja) stekla sam 24.06.2015. godine.

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92. **Stešević, D.**, Anđić, B. Stanišić-Vujačić, M., **(2019):** *Physcomitrium eurystomum* Sendtn., new moss species in the bryophyte flora of Montenegro. Acta Botanica Croatica DOI: 10.2478/botcro-2019-0027 (accepted for publication by November 18, 2019).

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Датум, 24.06.2015 г. 1875
Подгорица, ... год.

Ref: _____
Date, _____

Na osnovu člana 72 stav 2 Zakona o visokom obrazovanju (Službeni list Crne Gore br. 44/14) i člana 32 stav 1 tačka 9 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore, na sjednici održanoj 24. juna 2015. godine, donio je

O D L U K U
O IZBORU U ZVANJE

Dr DANIJELA STEŠEVIĆ bira se u akademsko zvanje **vanredni profesor Univerziteta Crne Gore** za predmete: Sistematika i filogenija viših biljaka I i II, na akademskom studijskom programu Biologija **na Prirodno-matematičkom fakultetu** i Botanika, na akademskom studijskom programu Biljna proizvodnja, na Biotehničkom fakultetu, na period od pet godina.

R E K T O R

Prof. Radmila Vojvodić

Kratka biografija Branko Anđić

Anđić Branko je rođen 16.03.1988 u Beranama. Osnovnu školu "Radomir Mitrović" je završio u Beranama. Srednju medicinsku školu „Dr Branko Zogović" u Beranama je pohađao u generaciji 2002 – 2006. Prirodno-matematički fakultet, studijski program biologija u Podgorici je upisao 2006. godine. Diplomu bečelora je stekao 2010., a diplomu specijaliste ekologije 2011. godine. Master studije na studijskom programu biologija, smjer ekologija PMF-a u Podgorici je upisao školske 2011/2012. Odbranivši master tezu pod nazivom: "Brioflora poluprirodnih habitata gradskog područja Podgorice.", 12.03.2014. je steklao diplomu mastera ekologije. Doktorske studije na PMF-u, studijski program biologija, opšti smjer u Podgorici je upisao 2015/2016. U JU OŠ "Radojica Perović" u Podgorici zaposlen je od 01.09.2012.

Oblast istraživanja kojom se bavi je metodika nastave biologije. Predstavljao je radove na nacionalnim i međunarodnim kongresima, kao i objavio više naučnih radova iz ove oblasti. Autor i koautor je priručnika za nastavnika, udžbenika i radnih sveski koji se koriste u nastavi biologije u crnogorskim školama. Boravio je na stručnom i naučnom usavršavanju na pet evropskih univerziteta: Univerzitet Karl-Franzens, Graz (studijski boravak u trajanju od šest mjeseci); Johannes Kepler Univerzitet, Linz Austrija (studijski boravak u trajanju od dvanaest mjeseci); Univeritet Bath u Engleskoj (studijski boravak od mjesec dana); Univerzitet u Mariboru (studijski boravak u trajanju od tri mjeseca). Na univerzitetu u Beču - Centru za socijalne i naučne inovacije uspješno je završio međunarodnu Interreg Danube "Excellence-in-ReSTI" akademiju projektnog menadžmenta u trajanju od dvanaest mjeseci.

Pored metodike nastave biologije bavi se i briologijom. Iz ove oblasti ima učešća na konferencijama, naučne radove i položene kurseve.

Branko Anđić, bibliografija

Naučni radovi objavljeni u međunarodnim časopisima indeksiranim u bazama SCI:

- **Branko Anđić**, Stanko Cvjeticanin, Mirjana Maričić, Danijela Stešević (2019): Sensory perception and descriptions of morphological characteristic of vegetative plant organs by the blind: implementation in teaching. *Journal of Biological Education; https://doi.org/10.1080/00219266.2019.1687107.*
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Radovi u međunarodnim časopisima koji se ne nalaze u bazi podataka, a imaju redovnu međunarodnu distribuciju i rezime na stranom jeziku:

- **Branko Anđić**, Stanko Cvjeticanin, Mirjana Maričić, Danijela Stešević (2018): Digital dichotomy key in botanical education of elementary school students, *Teaching Innovations* doi: 10.5937/inovacije1804046A.
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Udžbenici za preduniverzitetski nivo obrazovanja

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Učešće u međunarodnim projektima:

- Digital teaching technologies as scaffolding tools in inclusive education (2018/2019), funded by the Council of Europe and the European Union and implemented by the Council of Europe.
- Epiphytic organisms as bio indicators of the state of environment, with particular accent on air quality, in the cities Podgorica and Graz, with special emphasis on location on which can be expected presence of vector that can threatened human health. Bilateral scientific technological cooperation Montenegro - republic of Austria 2017/2018. Year