



Faculty of Sciences
University of Novi Sad

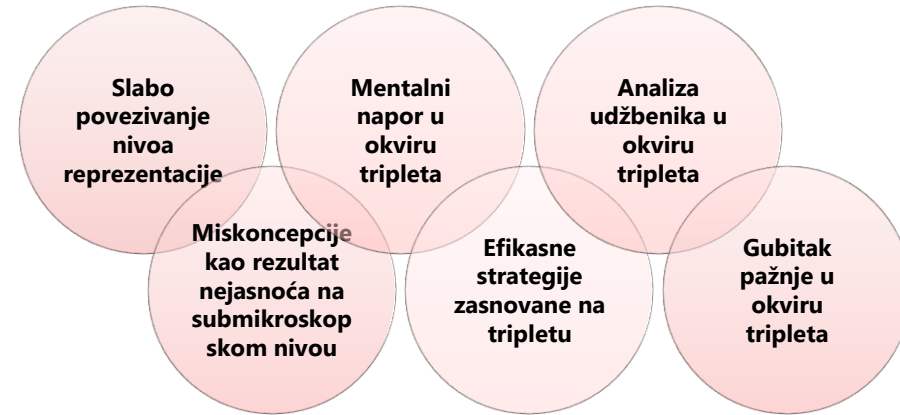
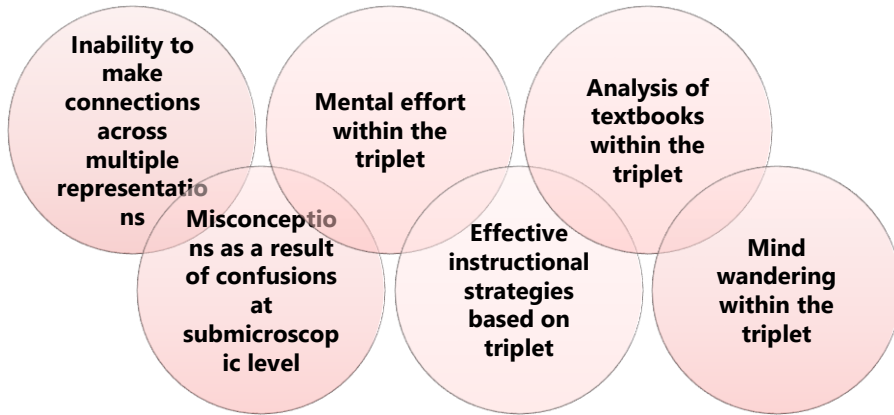
The Accuracy of Pre-service Teachers' Macro–Submicro–Symbolic Language

Jezička preciznost studenata-nastavnika u makro-submikro-simboličkom domenu

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● Language within the triplet

- Language of scientists
- Language of teachers
- Language of textbooks writers

● Jezik u okviru tripleta

- Jezik naučnika
- Jezik nastavnika
- Jezik pisaca udžbenika

● Textbooks examples

- Each period, except the first, ends with the **element** that has 8 electrons in the highest energy level¹
- How can we explain the difference in the intensity of the purple color in the three beakers? Which beaker contains the smallest number of **colored particles**²
- **Benzene** contains six carbon and six hydrogen atoms³

● Primeri iz udžbenika

- Svaka perioda, izuzev prve, završava se **elementom** koji ima 8 elektrona u najvišem energetsom nivou¹
- Na koji način možemo objasniti razliku u intenzitetu ljubičaste boje u tri čaše? Koja čaša sadrži najmanji broj **obojenih čestica**²
- **Benzen** se sastoji iz šest atoma ugljenika i šest atoma vodonika³

¹ Mandić, Lj., Korolija, J., Danilović, D. (2009). Hemija za 7. razred, Beograd: Zavod za udžbenike i nastavna sredstva

² Adamov, J., Makivić, N., Olić, S. (2012). Hemija za 7. razred, Beograd: Gerundijum

³ Nedeljković, T., Anđelković, D. (2010). Hemija 8, Beograd: Novi Logos

Aim of research

To examine the precision of pre-service teachers' language within macro-submicro-symbolic domain.

Research tasks

- To determine whether pre-service teachers make sharpened distinction between macroscopic and submicroscopic levels in their explanations.

- To determine whether pre-service teachers make sharpened distinction between submicroscopic reality and symbolic representations in their explanations.

Cilj istraživanja

Ispitati jezičku preciznost studenata-nastavnika u okviru makro-submikro-simboličkog domena.

Istraživački zadaci

- Ispitati da li studenti-nastavnici prave jasnu razliku između makroskopskog i submikroskopskog nivoa u svom govoru.

- Ispitati da li studenti-nastavnici prave jasnu razliku između submikroskopske stvarnosti i simboličke reprezentacije u svom govoru.

Context of the study

- Two main models: bottom-up and concurrent
- The case of Faculty of Sciences, Novi Sad (concurrent model): compulsory chemistry courses + regulated number of credits in educational courses and school practice

School practice courses

- Two courses: Primary school (SP1) and Secondary school (SP2)
- Two main parts:
 - (i) observations of classes performed by licensed mentor-practitioner
 - (ii) teaching under supervision of licensed mentor-practitioner

Kontekst istraživanja

- Inicijalno obrazovanje nastavnika hemije: obavezni kursevi hemije + propisan broj kredita iz obrazovnih kurseva i školske prakse (PMF, Novi Sad)

Školska praksa

- Dva kursa: Osnovna škola (ŠP1) i Srednja škola (ŠP2)
- Dve osnovne komponente:
 - (i) Posmatranje časova koje izvode licencirani mentori-praktičari
 - (ii) Izvođenje nastave uz nadzor mentora-praktičara

● Participants

- 16 female students enrolled in School practice I course
- Final year of bachelor degree

● Data collection

- 80 classes were observed
- All classes were voice-recorded
- Short interviews were conducted after each independently held class

● Uzorak ispitanika

- 16 ispitanika ženskog pola, upisanih na kurs Školska praksa I
- Završna godina osnovnih studija

● Prikupljanje podataka

- Posmatrano ukupno 80 časova
- Svi časovi su zvučno snimljeni
- Nakon svakog održanog časa sprovedeni su kratki intervjui

I research question:

Macro-submicro language

- Type I: imprecise expression of the particle type
- Type II: neglecting particle terms and prevalent use of macroscopic terms
- Type III: mixing chemical terms with everyday life terms

I istraživački zadatak:

Makro-submikro jezik

- Tip I: neprecizno izražavanje u nivou čestica
- Tip II: zanemarivanje čestičnih termina i prevalentna upotreba makroskopskih termina
- Tip III: mešanje hemijskih termina i termina iz svakodnevnog života

- **Type I:**
imprecise expression of the particle type

Type	No.	Statement/phrase
I	S1	Molecules of sodium chloride are obtained in reaction
	S2	On the left side we have three molecules of sodium hydroxide
	S3	The molecules of soap can remove the stain
	S4	On the third carbon atom, OH molecule is located on the left side
	S5	How do we call the molecule of copper (II) sulfate?

- **Tip I:**
neprecizno izražavanje u nivou čestica

Tip	Br.	Iskaz/fraza
I	I1	U reakciji nastaju molekuli natrijum-hlorida
	I2	Na levoj strani imamo tri molekula natrijum-hidroksida
	I3	Molekuli sapuna mogu da uklone fleku
	I4	Na trećem ugljenikovom atomu, OH molekul se nalazi na levoj strani
	I5	Kako zovemo molekul bakar(II)-sulfata?

- **Type II:**
neglecting particle terms and prevalent use of macroscopic terms

Type	No.	Statement/phrase
	S6	Water is composed of hydrogen and oxygen
	S7	Carbohydrates contain atoms of carbon, oxygen and hydrogen
	S8	From one molecule of sucrose, glucose and fructose can be obtained
II	S9	The oligosaccharides contain 2-10 monosaccharides
	S10	To equalize this equation, we should first count the number of oxygen
	S11	How many hydrogens are there on the left side?
	S12	Which atoms have that sugar?

- **Tip II:**
zanemarivanje čestičnih termina i prevalentna upotreba makroskopskih termina

Tip	Br.	Iskaz/fraza
	I6	Voda se sastoji iz vodonika i kiseonika
	I7	Ugljeni hidrati sadrže atome ugljenika, kiseonika i vodonika
	I8	Iz jednog molekula saharoze dobijaju se glukoza i fruktoza
II	I9	Oligosaharidi sadrže 2-10 monosaharida
	I10	Kada izjednačavamo ovu jednačinu, prvo treba da prebrojimo broj kiseonika
	I11	Koliko imamo vodonika sa leve strane?
	I12	Koje atome ima taj šećer?

- **Type III:**
mixing chemical terms with everyday life terms

Type	No.	Statement/phrase
III	S13	Tap water is a pure water
	S14	Strong metal salts act to denature proteins in much the same manner as acids and bases

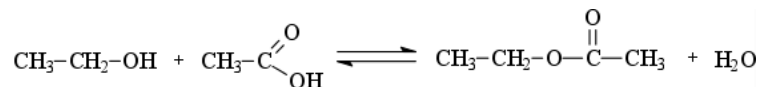
- **Tip III:**
mešanje hemijskih termina i termina iz svakodnevnog života

Tip	Br.	Iskaz/fraza
III	I13	Česmenska voda je čista voda
	I14	Soli jakih metala denaturišu proteine na sličan način kao i kiseline i baze

II research question:

Submicro-symbolic language

- Student 1. *"In the esterification reaction, ester and water are formed. We know that the water is made up of two hydrogen atoms and one oxygen atom. So we have OH and H and we get water, and all that remains combine in a new compound."*



*"So, on the left side we will have CH₃CH₂, and on the right side CH₃COO and one **free bond** which we can use to connect the left and right side of the compound"*.



Reasoning at the symbolic level:
student perceive model as reality

II istraživački zadatak:

Submikro-simbolički jezik

- Student 1. *„U reakciji esterifikacije nastaju estar i voda. Znamo da je voda sačinjena iz dva atoma vodonika i jednog atoma kiseonika. Dakle, imaćemo OH i H i dobijamo vodu, a sve što ostane kombinujemo u novo jedinjenje."*



*„Dakle, na levoj strani ćemo imati CH₃CH₂, a na desnoj CH₃COO i jednu **slobodnu vezu** koju možemo iskoristiti da povežemo levu i desnu stranu jedinjenja"*.

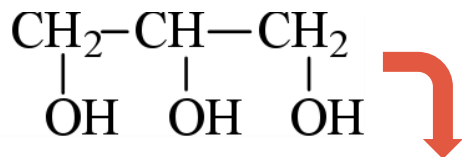


Rezonovanje na simboličkom nivou:
Student doživljava model kao realnost

II research question:

Submicro-symbolic language

- Imprecisions in writing chemical formulas



Pre-service teachers do not realize the importance of proper writing of formulas and presume that students would understand them in proper way.

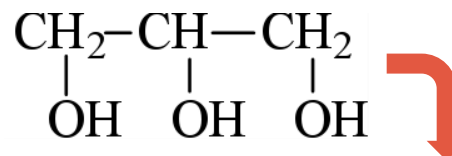
- Reaction = equation (very common)

e. g. We will write a reaction of sodium hydroxide and hydrochloric acid

II istraživački zadatak:

Submikro-simbolički jezik

- Nepreciznosti pri pisanju hemijskih formula



Studenti-nastavnici ne shvataju važnost ispravnog pisanja formula i prepostavljaju da će ih učenici razumeti na ispravan način.

- Reakcija = jednačina (vrlo često)

npr. Napisaćemo reakciju natrijum-hidroksida i hlorovodonične kiseline

- Inadequate language within the triplet
 - Macro-submicro relation
 - Submicro-symbolic relation
- Worrying attitudes of pre-service teachers about the importance of precise language
- **Limitation:** Studies with larger samples are needed before making any generalisations.

- Neadekvatan jezik u tripletnom domenu
 - Makro-submikro
 - Submikro-simbolički
- Zabrinjavajući stavovi studenata-nastavnika o važnosti preciznog izražavanja
- **Ograničenje:** Istraživanja na većem uzorku su neophodna pre izvođenja generalnih zaključaka.

Thank**You**

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