INQUIRY BASED CHEMISTRY ACTIVITIES IN THE IN-FORMAL EDUCATIONAL SETTING FOR GIFTED STUDENTS

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PROJECT RESEARCH GROUP

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NATIONAL PERSPECTIVES - ACTIVITIES FOR GIFTED STUDENTS IN SLOVENIA:

1. Chemistry competitions
2. Elective courses in chemistry - lower and upper secondary school
3. Primary and secondary school students‘ research activities in collaboration with universities and institutes
4. Activities in KemikUm Centre at the UL

Chemistry solves crimes

Chemistry is experimenting

Molecular gastronomy

KemikUm drives on methane

GIFTED STUDENTS IN CHEMISTRY

- Same aspects of giftedness in science/chemistry (Taber, 2010):
  - Continued scientific and technological progress depends upon s**ufficient numbers of young people selecting scientific courses in post compulsory education and aspiring to enter science related professions.**
  - Gifted students actually **appreciate being challenged** in their learning, often recognising that work that is not challenging them is not helping them learn, and consequently is not **valuable/relevant** (in terms of everyday life, society's needs, personal interests, career aspirations, or even just being clearly useful to meet intrinsic learning goals) for their education.
  - **Highly-able/gifted students** are likely to become the researchers, innovators, academic scholars, and inspirational teachers of the future.
  - Types of modern chemistry courses:
    - **Context-based courses**
    - **Enquiry approach** – lab-work; problem solving; HOCS; NOS; Science-Technology-Society links; working in groups; self-regulated learning;

Taber, K. (2010). Challenging gifted learners: general principles for science educators; and exemplification in the context of teaching chemistry. *Science Education International,* 21(1), 5-30.

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DiSSI ACTIVITIES – SECONDARY SCHOOL STUDENTS

70 high school students from the BIC Ljubljana were involved in research on understanding green chemistry, extraction of essential oil and its properties, pectin isolation and microcapsulation.


Principi zelene kemije s pektinsko mikrokapsulacijo eteričnih olj plodov limonovca (*Citrus limon* L.)

Miha Slapničar[1], Matej Vošnjak[2] in Iztok Devetak[2]

TEORETIČNI UVOD

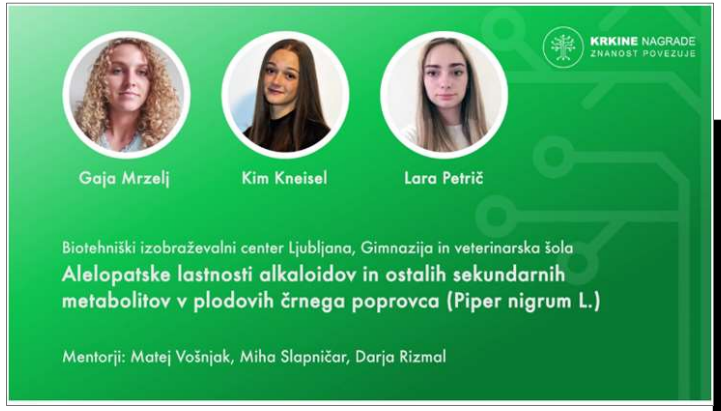
NAMEN RAZISKAVE IN RAZISKOVALNA VPRAŠANJA

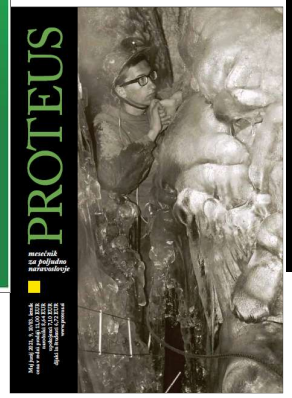
METODA

REZULTATI

ZAKLJUČEK

LITERATURA






Antimikotične lastnosti piperidinskih alkaloidov iz plodov črnega poprovca (*Piper nigrum* L.)

Miha Slapničar, Hana Grintal, Ana Lucija Čuk, Matej Vošnjak

Research projects: 10 students from the BIC Ljubljana prepared five different research projects on the topic of chemistry of natural compounds.

Pectin microspheres of encapsulated citrus essential oil

Allelopathic properties of alkaloids and other secondary metabolites in the fruits of black pepper (Piper nigrum L.)

Study of the potential antifungal properties of piperidine alkaloids in the fruits of black pepper (Piper nigrum L.)

Study of physicochemical parameters and properties of different types of honey by experiments

Plant and fungal toxins, chemical and socio-cultural view

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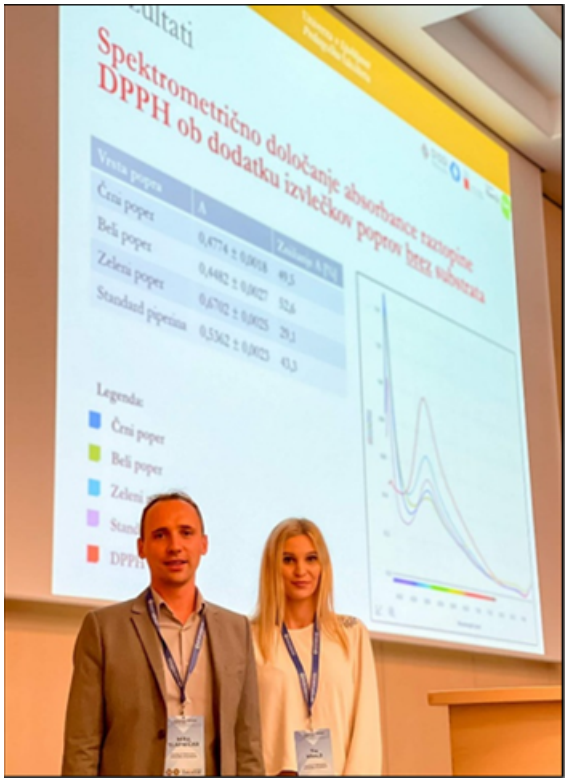
DiSSI ACTIVITIES – PRE-SERVICE CHEMISTRY TEACHERS

Research projects: 3 pre-service chemistry teachers prepared three different research project on the topic of chemistry of natural compounds.

- *Study of the antioxidant capacity of piperine and other piperidine alkaloids in radical reactions in bovine liver cells*
- *Repurposing citrus peel at chemistry class in secondary school*
- *Insecticidal effects of aqueous extracts of piperidine alkaloids and other secondary metabolites of various species of pepper on the regulation and control of brown marbled stink bug (Halyomorpha halys L.)*




Univerza v Ljubljani
Pedagoška fakulteta

DiSSI

Center Kem'k

Študija antioksidativne sposobnosti piperina in ostalih piperidinskih alkaloidov pri radikalskih reakcijah v celicah govejih jeter

Miha Slapničar, Tia Kralj, Iztok Devetak in Matej Vošnjak

22. 9. 2021


KRKINE NAGRADE

Spoštovana gospa Tia Kralj!

Veseli nas, da ste sprejeli izziv in svojo raziskovalno nalogo prijavili na razpis za 51. Krkine nagrade. Dokazali ste, da imate znanje in pogum, ki sta ključna za uspešno raziskovalno delo.

Z zadovoljstvom vam sporočamo, da ste se na podlagi ocene članov Znanstvenega odbora Sveta Sklada Krkinih nagrad uvrstili med prejemnike Krkine posebne pohvale za raziskovalno nalogo. Iskreno vam čestitamo.

Prejemnike 51. Krkinih nagrad in priznanj za dodiplomske in podiplomske raziskovalne naloge bomo razglasili 15. oktobra. Takrat si boste lahko ogledali tudi 31. spletni simpozij, s predstavitvijo nagrajenih nalog.

Veselimo se z vami in vam želimo veliko ustvarjalne energije in vztrajnosti tudi v prihodnje.

dr. Aleš Rotar
predsednik Sveta Sklada Krkinih nagrad

ZNANOST POVEZUJE.

KRKA

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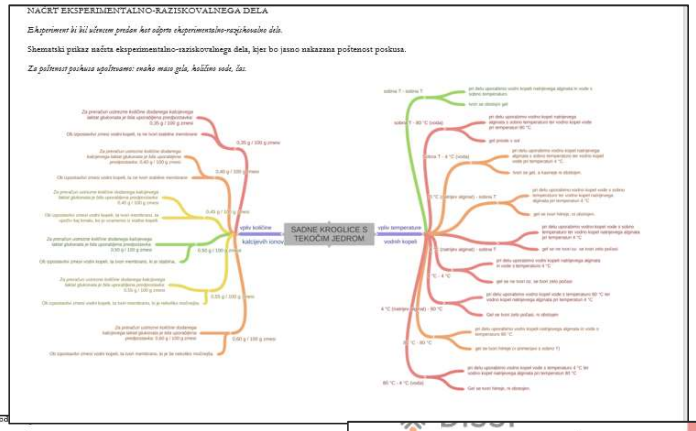
DiSSI ACTIVITIES – PRE-SERVICE CHEMISTRY TEACHERS

They developed DiSSI modules for gifted students from different topics using IBSE approach.


NAČRT EKSPERIMENTALNO-RAZISKOVALNEGA DELA

Eksperiment bi bil učencem predan kot odprto eksperimentalno-raziskovalno delo.

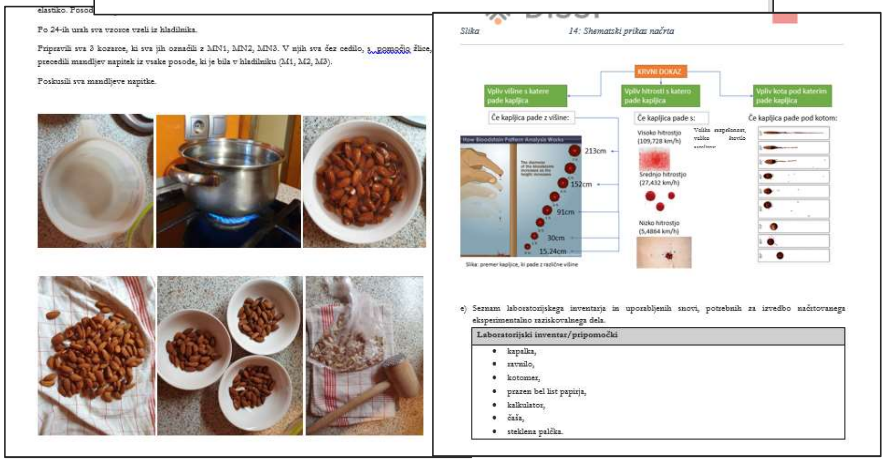
Shematski prikaz načrta eksperimentalno-raziskovalnega dela, kjer bo jasno nakazana poštenost poskusa.

Za poštenost poskusa uporabimo: enako maso gela, količino vode, čas.

SADNE KROGLICE S TEKOČIM JEDROM

vpliv količine kalcijevih ionov

vpliv temperature vodnih kopeli


Fo 24-ih urah sva vzorce vzeli iz hladilnika.

Pripravili sva 3 kozarce, ki sva jih označili z MN1, MN2, MN3. V njih sva dez cedilo, s pomočjo žlice, precedili mandljev napitek iz vsake posode, ki je bila v hladilniku (M1, M2, M3).

Poskusili sva mandljeve napitke.

Slika 14: Shematski prikaz načrta

KRIVNI DOKAZ

Vpliv višine s katere pade kapljica

Vpliv hitrosti s katero pade kapljica

Vpliv kota pod katerim pade kapljica

Če kapljica pade z višine:

Če kapljica pade s:

Če kapljica pade pod kotom:

Visoka hitrost/o (109,728 km/h)

Srednja hitrost/o (27,432 km/h)

Nizka hitrost/o (5,4864 km/h)

213cm

152cm

91cm

30cm

15,24cm

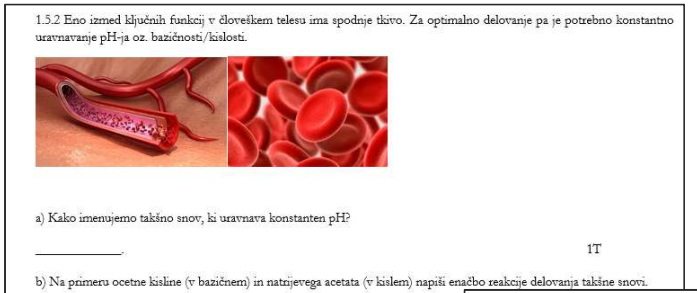
Slika: premer kapljice, ki pade z različne višine

e) Seznam laboratorijskega inventarja in uporabljenih snovi, potrebnih za izvedbo načrtovanega eksperimentalno raziskovalnega dela.

Laboratorijski inventar/pripomočki

- kapalka,
- zavrnilo,
- kotomer,
- prazen bel list papirja,
- kalkulator,
- čaša,
- steklena palčka.

They developed a series of chemistry problems as a enrichment activity for gifted students.

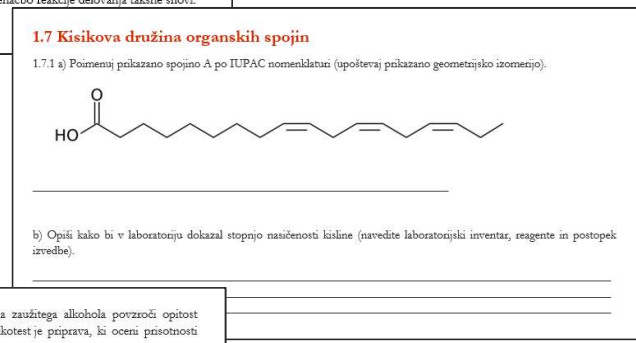

1.5.2 Eno izmed ključnih funkcij v človeškem telesu ima spodnje tkivo. Za optimalno delovanje pa je potrebno konstantno uravnavanje pH-ja oz. bazičnosti/kislosti.

a) Kako imenujemo takšno snov, ki uravnava konstanten pH?

_____. 1T

b) Na primeru ocetne kisline (v bazičnem) in natrijevega acetata (v kislem) napiši enačbo reakcije delovanja takšne snovi.

Ocetna kislina (v bazičnem):

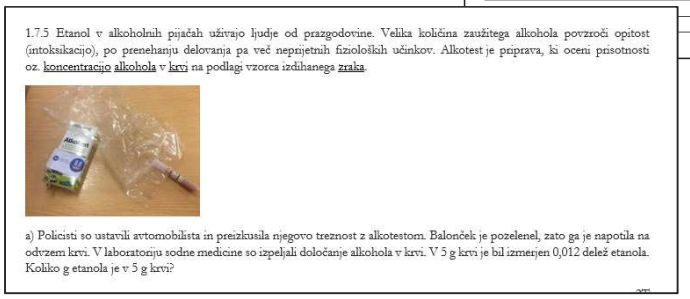

1.7 Kisikova družina organskih spojin

1.7.1 a) Poimenuj prikazano spojino A po IUPAC nomenklaturi (upoštevaj prikazano geometrijsko izomerijo).

HO

O

b) Opiši kako bi v laboratoriju dokazal stopnjo nasičenosti kisline (navedite laboratorijski inventar, reagente in postopek izvedbe).


1.7.5 Etanol v alkoholnih pijačah uživajo ljudje od prazgodovine. Velika količina zaužitega alkohola povzroči opitost (intoksikacijo), po prenehanju delovanja pa več neprijetnih fizioloških učinkov. Alkotest je priprava, ki oceni prisotnosti oz. koncentracijo alkohola v krvi na podlagi vzorca izdihanega zraka.

a) Policisti so ustavili avtomobilista in preizkusila njegovo treznost z alkotestom. Balonček je pozelenel, zato ga je napotila na odvzem krvi. V laboratoriju sodne medicine so izpeljali določanje alkohola v krvi. V 5 g krvi je bil izmerjen 0,012 delež etanola. Koliko g etanola je v 5 g krvi?

DiSSI ACTIVITIES – PRE-SERVICE CHEMISTRY TEACHERS

Workshops analysis and evaluation – pre-service teachers

55 pre-service teachers developed DiSSI modules targeted to deal with gifted students at lower and upper secondary school

- forensic chemistry,
- chemistry in the gastronomy
- application of triple nature of chemical concepts with application of inquiry-based science education method.

Pre-service teachers (master students) also developed enrichment activities (tasks that teachers can use) for gifted students at higher cognitive levels.

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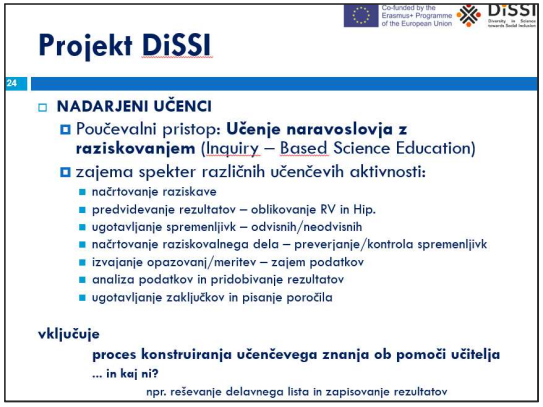
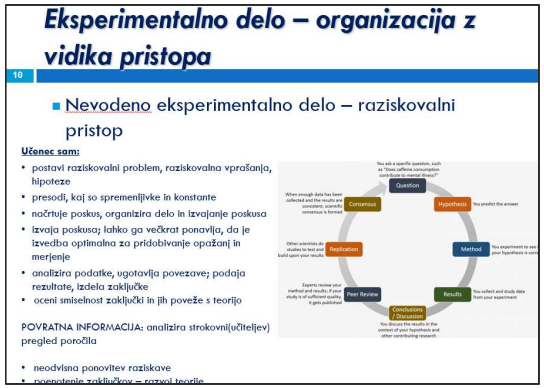
DiSSI ACTIVITIES – IN-SERVICE CHEMISTRY TEACHERS

In-service science teachers were engaged into DiSSI workshop about density and viscosity of substances

Lectures – presenting the projet and IBSE





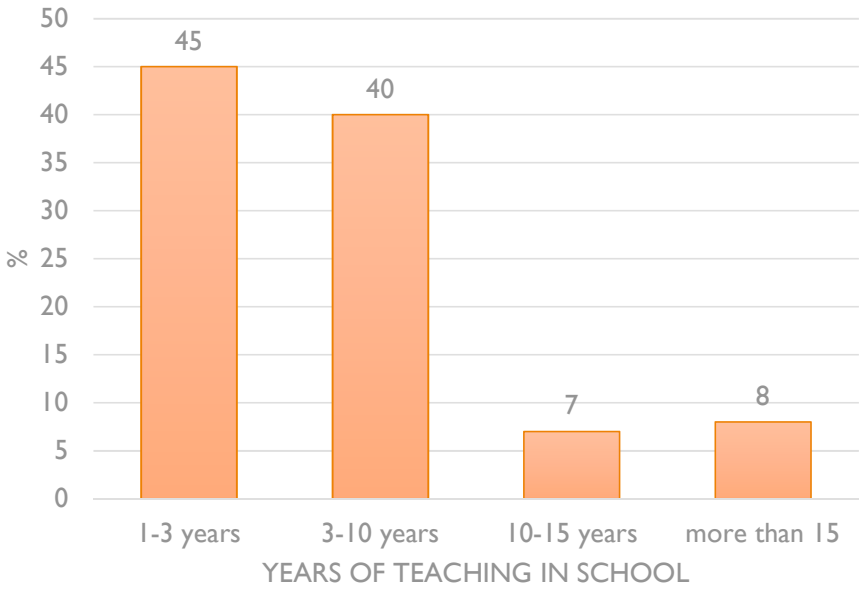
Workshops – doing DiSSI

DiSSI ACTIVITIES – IN-SERVICE CHEMISTRY TEACHERS

Workshops analysis and evaluation

Sample: 54 females; 6 males Σ 60 in-service teachers

Teaching experiences



Teachers' activities for gifted students

Question	Yes [%]	No [%]
Do you try to identify gifted students for science?	83	17
Do you do enrichemnt activities for gifted students?	50	50
Do you have extra activities for gifted students douring class?	57	43

DiSSI ACTIVITIES – IN-SERVICE CHEMISTRY TEACHERS

Workshops analysis and evaluation

Pre-workshop

Question	Very familiar [%]	Familiar [%]	Not familiar [%]	Not familiar at all [%]
How familiar are you with IBSE?	12	70	17	1

Question	Very often [%]	Often [%]	Rarely [%]	Almost never [%]
How often have you used IBSE in the past?	1	37	52	10

Post-workshop

Question	Very familiar [%]	Familiar [%]	Not familiar [%]	Not familiar at all [%]
How familiar are you with IBSE?	33	62	5	0

DiSSI ACTIVITIES – IN-SERVICE CHEMISTRY TEACHERS

Workshops analysis and evaluation

Pre-workshop

Question	Very effective [%]	Effective [%]	Not effective [%]	Not effective at all [%]
How effective is IBSE for an avereage student?	20	77	3	0
How effective is IBSE for a gifted student?	77	23	0	0
Question	**Very competent [%]**	**Competent [%]**	**Poorly competent[%]**	**Un-competent[%]**
How competent do you feel about using IBSE in your class?	10	67	22	1

Post-workshop

Question	Very effective [%]	Effective [%]	Not effective [%]	Not effective at all [%]
How effective is IBSE for an avereage student?	48	42	10	0
How effective is IBSE for a gifted student?	77	23	0	0
Question	**Very competent [%]**	**Competent [%]**	**Poorly competent[%]**	**Un-competent[%]**
How competent do you feel about using IBSE in your class?	17	80	3	0

DiSSI ACTIVITIES – IN-SERVICE CHEMISTRY TEACHERS

Workshops analysis and evaluation

Post-workshop

Question	Very often [%]	Often [%]	Rarely [%]	Almost never [%]
How often do you plan on using IBSE in your class?	10	80	10	0
How often do you plan on using IBSE with gifted students?	23	68	9	0

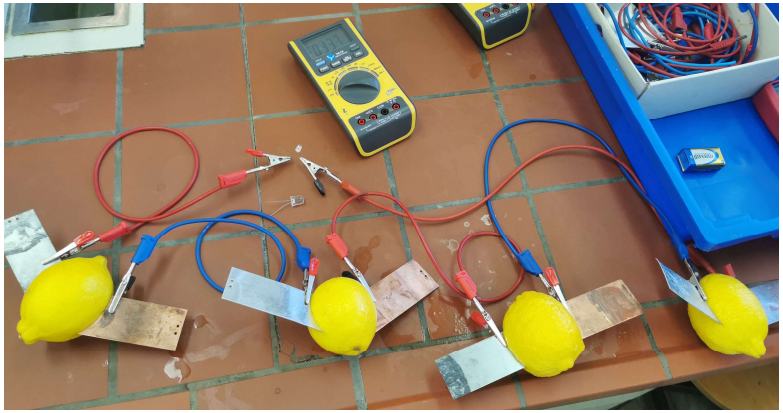
Statement	Agree or totaly agree [%]	Neither agree nor disagree [%]	Disagree or strongly disagree [%]
Today's workshop was thought provoking.	94	3	3
Today's workshop was relevant to me.	92	7	1
Today's workshop will help me teach more effectively.	92	5	3
Today's workshop was well organized.	94	5	1
Today's workshop engaged and kept my interest.	95	1	4
Today's workshop met its stated objectives.	100	0	0

DiSSI ACTIVITIES – PRE-SERVICE PRIMARY SCHOOL TEACHERS

Workshops analysis and evaluation

- 27 pre-service primary school teachers conducted DiSSI activities.
- Out of 27, 11 were identified as gifted students.
- Provided only by certain learning goals from 5th grade science curriculum, students had to come up with research questions, hypothesis and define variables.
- They then conducted experiments and presented their results.

- Their IBSE activity:
  - ✓ factors influencing disolving,
  - ✓ making fruits galvanic cell and
  - ✓ factors infuencing burning.



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DiSSI ACTIVITIES – PRE-SERVICE PRIMARY SCHOOL TEACHERS

Workshops analysis and evaluation

Pre-workshop

Question	Very familiar [%]	Familiar [%]	Not familiar [%]	Not familiar at all [%]
How familiar are you with IBSE?	0	56	44	0

Question	Very competent [%]	Competent [%]	Poorly competent[%]	Un-competent[%]
How competent do you feel about using IBSE in your class?	0	48	48	4

Post-workshop

Question	Very familiar [%]	Familiar [%]	Not familiar [%]	Not familiar at all [%]
How familiar are you with IBSE?	56	44	0	0

Question	Very competent [%]	Competent [%]	Poorly competent[%]	Un-competent[%]
How competent do you feel about using IBSE in your class?	15	78	7	0

DiSSI ACTIVITIES – PRE-SERVICE PRIMARY SCHOOL TEACHERS

Workshops analysis and evaluation

Pre-workshop

Identified as gifted (n = 11)

Question	Very familiar [%]	Familiar [%]	Not familiar [%]	Not familiar at all [%]
How familiar are you with IBSE?	0	45	55	0
Question	**Very competent [%]**	**Competent [%]**	**Poorly competent [%]**	**Un-competent [%]**
How competent do you feel about using IBSE in your class?	0	36	55	9

Not identified as gifted (n = 16)

Question	Very familiar [%]	Familiar [%]	Not familiar [%]	Not familiar at all [%]
How familiar are you with IBSE?	0	62	38	0
Question	**Very competent [%]**	**Competent [%]**	**Poorly competent [%]**	**Un-competent [%]**
How competent do you feel about using IBSE in your class?	0	56	44	0

DiSSI ACTIVITIES – PRE-SERVICE PRIMARY SCHOOL TEACHERS

Workshops analysis and evaluation

Post-workshop

Identified as gifted (n = 11)

Question	Very familiar [%]	Familiar [%]	Not familiar [%]	Not familiar at all [%]
How familiar are you with IBSE?	27	73	0	0
Question	**Very competent [%]**	**Competent [%]**	**Poorly competent [%]**	**Un-competent [%]**
How competent do you feel about using IBSE in your class?	9	73	18	0

Not identified as gifted (n = 16)

Question	Very familiar [%]	Familiar [%]	Not familiar [%]	Not familiar at all [%]
How familiar are you with IBSE?	75	25	0	0
Question	**Very competent [%]**	**Competent [%]**	**Poorly competent [%]**	**Un-competent [%]**
How competent do you feel about using IBSE in your class?	19	81	0	0

DiSSI ACTIVITIES – PRE-SERVICE PRIMARY SCHOOL TEACHERS

Workshops analysis and evaluation – pre-service teachers

Post workshop

Question	Very often [%]	Often [%]	Rarely [%]	Almost never [%]
How often do you plan on using IBSE in your class?	7	82	7	4
How often do you plan on using IBSE with gifted students?	30	63	7	0

Statement	Agree or totaly agree [%]	Neither agree nor disagree [%]	Disagree or strongly disagree [%]
Today's workshop was thought provoking.	96	0	4
Today's workshop was relevant to me.	100	0	0
Today's workshop will help me teach science more effectively.	100	0	0
Today's workshop engaged and kept my interest.	93	7	0

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DiSSI MODULES FOR THE GIFTED STUDENTS IN CHEMISTRY - INQUIRY-BASED LAB ACTIVITIES

1. Environmental chemistry
2. Forensics chemistry
3. Chemistry of natural compounds
4. Molecular aspects of modern gastronomy
5. Green chemistry

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DiSSI MODULES - ENVIRONMENTAL CHEMISTRY

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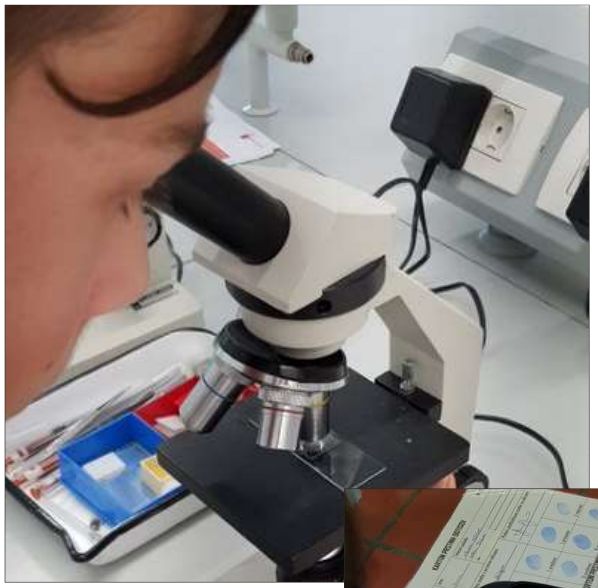
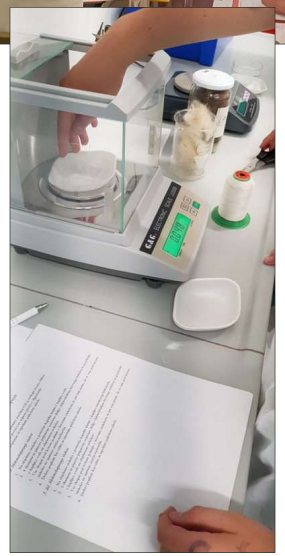
DiSSI MODULES - FORENSICS CHEMISTRY





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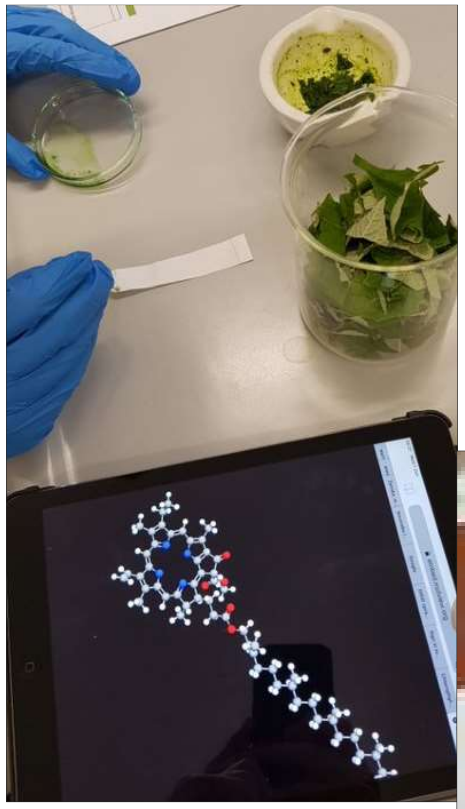
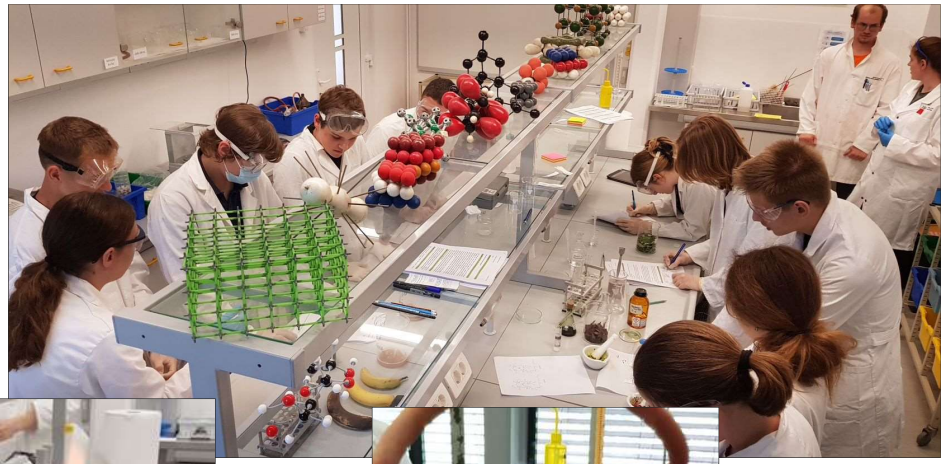
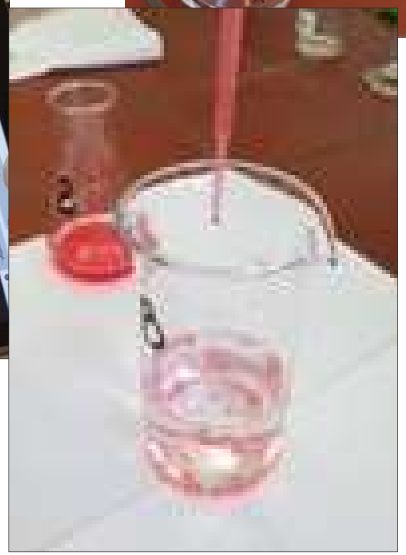
DiSSI MODULES - CHEMISTRY OF NATURAL COMPOUNDS







DiSSI MODULES APPLICATION

Workshops analysis and evaluation – students

Sample: 74 girls; boys 54 Σ 128 students

8th grade: 44
9th grade: 84

Gifted: 63 yes; 65 no
Gifted for Chemistry (students‘ opinion): 61 yes; 76 no

DiSSI MODULES APPLICATION

Workshops analysis and evaluation – students

Pre-workshop

Question	Strongly agree or agree [%]	I don't know [%]	Strongly disagree or disagree [%]
I generally have fun when I am learning science topics.	73	19	8
I am happy doing chemistry problems.	61	24	15
I enjoy acquiring new knowledge in chemistry.	81	13	6
I am interested in learning about chemistry.	66	21	13
I plan to use science in my future career.	25	43	32

Post-workshop

Question	Strongly agree or agree [%]	I don't know [%]	Strongly disagree or disagree [%]
The lesson in today's science class was interesting.	95	4	1
I was focused at this lesson.	71	18	11
I enjoyed science lessons today.	83	15	2
Today I understood well what we learned in class.	80	13	7
I was attentive in todays' class, from the beginning to the end.	69	18	12

DiSSI MODULES APPLICATION

Workshops analysis and evaluation – students (Pre-workshop)

Identified as gifted (*n* = 63)

Question	Strongly agree or agree [%]	I don't know [%]	Strongly disagree or disagree [%]
I generally have fun when I am learning science topics.	76	18	6
I am happy doing chemistry problems.	73	16	11
I enjoy acquiring new knowledge in chemistry.	88	6	6
I am interested in learning about chemistry.	70	17	13
I plan to use science in my future career.	27	51	22

Not identified as gifted (*n* = 65)

Question	Strongly agree or agree [%]	I don't know [%]	Strongly disagree or disagree [%]
I generally have fun when I am learning science topics.	69	20	11
I am happy doing chemistry problems.	49	32	19
I enjoy acquiring new knowledge in chemistry.	74	20	6
I am interested in learning about chemistry.	61	25	14
I plan to use science in my future career.	23	35	42

DiSSI MODULES APPLICATION

Workshops analysis and evaluation – students (Post-workshop)

Identified as gifted (*n* = 61)

Question	Strongly agree or agree [%]	I don't know [%]	Strongly disagree or disagree [%]
The lesson in today's science class was interesting.	95	3	2
I was focused at this lesson.	74	13	13
I enjoyed science lessons today.	90	7	3
Today I understood well what we learned in class.	85	10	5
I was attentive in todays' class, from the beginning to the end.	72	13	15

Not identified as gifted (*n* = 53)

Question	Strongly agree or agree [%]	I don't know [%]	Strongly disagree or disagree [%]
The lesson in today's science class was interesting.	94	4	2
I was focused at this lesson.	68	25	7
I enjoyed science lessons today.	74	24	2
Today I understood well what we learned in class.	74	17	9
I was attentive in todays' class, from the beginning to the end.	66	25	9

CONCLUSION

Pre-service teachers

- The **familiarity and competence** for applying DiSSI IBSE activities **shifted from unfamiliar to familiar**.
- They **evaluate the workshop as a successful activity** for them to develop DiSSI IBSE competences.
- They **will often apply DiSSI IBSE in teaching science** when staring to work as in-service teachers.
- Before workshop pre-service teachers had **similar views on IBSE regardless their identification as gifted students** in the past.
- After workshop gifted pre-service teachers expressed **lower level of familiarity and competence** to apply DiSSI IBSE than those who were not identified as gifted – **higher self-reflection** regarding learning process and developed competences.

CONCLUSION

In-service teachers

- Majority of in-service teachers **try to help gifted students develop their potentials**, but they rarely use IBSE in their teaching.
- In-service teachers also **agree that the workshop was interesting and relevant** for them, and gave them confidence to apply DiSSI IBSE in their teaching, and they will use this approach more often in the future.
- The familiarity with IBSE **shifted from familiar to very familiar** after the workshop.
- After the workshop in-service teachers perceive **DiSSI IBSE as more effective teaching approach for average students**, than before the workshop, but there were no change in their opinion abut the effectiveness for gifted students.

CONCLUSION

Lower and upper secondary school students

- Students **find science interesting in general**, but majority does not plan to use science in their future professions (this is also true for the gifted students).
- Higher levels of interest for science, specially for **solving chemistry problems**, were expressed by **students**, who were identified as **gifted**.
- They expressed **positive attitudes towards DiSSI activities**.
- **DiSSI activity** implementing IBSE approach is **more adequate for gifted students**, because they find it more enjoyable, they can stay focused till the end, and they understand its purpose clearly.

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