



Portfolio

methods, tools and
materials for linguistic
and cultural sensitive
science teaching

for Science Teacher Education



ESTA
Educating Science
Teachers for All



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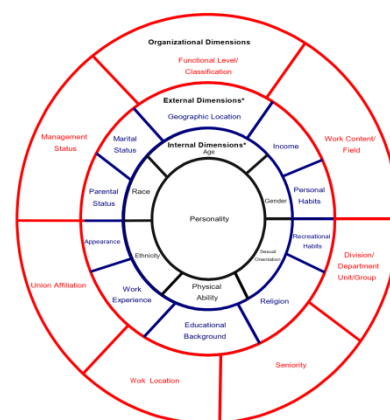
Need for the Changes within the Project ESTA in Science Teacher Education at our University

Most of our students never experienced high heterogeneous classes. In our science study groups, students work in small groups, but these groups are homogeneous. Students are not aware of the different dimensions of diversity and how this may influence their teaching. Our students are teachers to be, so it is very important to prepare them to deal with heterogeneity and diversity in science classes.

Students, future science teachers, must be introduced and sensitized to the different dimensions of the diversity wheel.

The dimensions of the diversity wheel that influence the most on teaching and learning in chemistry classrooms:

- 1) language and linguistic skills,
- 2) culture,
- 3) cognitive differences, including differences in content knowledge,
- 4) students with special needs.



To prepare future teacher to deal with heterogeneity and diversity in chemistry classes, they should walk through to class that follows three main steps:

1. **Sensitizing chemistry student teachers for heterogeneity and diversity** (chemistry student teachers are taught how to recognize the influence of such differences on their teaching in the future, including the influences differences may have on students' overall learning)
2. **Studying different diagnostic methods** (helping student teachers study how to recognize and diagnose differences) Student teachers are given information about the different instruments and tools that are available to analyze the differences in different dimensions of chemistry class (knowledge in the Pre-Actional phase).
3. **Dealing with heterogeneity** (chemistry students also study how to develop such instruments for their own needs and to match them to the needs of their future classes. This knowledge can or must be used in practice (Actional phase).

Finally, student teachers have become acquainted with different methods and media offerings that can be used to deal with differences in future chemistry classes. The tools are presented with an eye toward issues such as integration and inclusion, as well (Post-Actional phase). Students need to have experience in a real classroom during this course.

Collection of Methods, Tools and Instruments from the University of Limerick and Ludwigsburg University of Education

Methods for making our students (future chemistry and biology teachers) sensitive for different dimensions of diversity

One of obstacles in chemistry and science classes is dealing with heterogeneity and diversity. Pre-service chemistry teachers need to be aware of the differences in their classrooms. They must be prepared to diagnose and handle differences to obtain the best possible learning outcomes for their students. As a part of ESTA project activities, the paper „Learning to Teach at Heterogeneous and Diverse Chemistry Classes - Methods for University Chemistry Teacher Training“ (<https://www.ejmste.com/download/learning-to-teach-at-heterogeneous-and-diverse-chemistry-classes-methods-for-university-chemistry-5552.pdf>) has been analyzed. The approach (model) described in the paper is presented here.

Future teachers' efforts were organized by following three main steps: 1. Sensitizing chemistry student teachers for heterogeneity and diversity 2. Studying different diagnostic methods 3. Dealing with heterogeneity.

1. Methods used for sensitization to heterogeneity and diversity

The student teachers rarely know more than one dimension of the heterogeneity and diversity in chemistry classrooms. Therefore, they must be sensitized at the beginning and they need to recognize the effects or influences on teaching. The sensitization of the student teachers about individual dimensions of the heterogeneity or diversity should be repeatedly done during the teacher training program in chemistry education. To sensitize future chemistry teachers to the different dimensions of the diversity wheel, the seminar could start with a role-playing exercise. Student teachers take the role of different students in a regular, fictional school class. The role-playing considers several dimensions. It should be performed at the beginning of the long internship.

The roles include a student with special needs, a young refugee, an average student and gifted student. After finding themselves in the roles student teachers are then led to role-play a chemistry lesson situation, for example, with the topic “Working like a scientist”. They need to work in groups, conduct experiments and make notes on their work-sheet. The lecturer should try not to interfere in the role-playing exercise. He or she will intervene if necessary, for example, the student teachers cannot adapt the given role. Thus, student teachers need to solve the problem in their own groups playing their given role.

After the role-playing game chemistry student teachers should reflect upon it. Important questions in this phase are:

1. Which dimension of heterogeneity and diversity did you notice in the exercise?
2. How did you perceive the heterogeneity and diversity?
3. How did you learn from your role and experience the lesson?
4. How was your role influenced by other students?
5. How did heterogeneity impact or influence the lessons?
6. How did you feel in the game? Did your feelings and impressions change during the lesson?

Particularly interesting are questions 3-6, which are intended to highlight (non-)consideration of heterogeneity and diversity in chemistry teaching. This helps to sensitize the students to this topic so that heterogeneity becomes a natural part of the lesson planning. Furthermore, student teachers must experience how they feel in heterogeneous classes in order to understand their behavior.

As a summary of this phase, the students could prepare a presentation about heterogeneity and diversity to complete the role-playing part of the unit. The focus should be on the influences of heterogeneity and diversity on chemistry teaching. Following this, examples from the practice called vignettes (Campbell, 1996) are presented to the participants and reflected upon.

A vignette is a short story without an ending. It is short, but not too short to present an issue. It is detailed, but not so detailed that the underlying issue gets lost. A vignette presents an issue, such as the Underrepresentation of girls in advanced math courses, in a context with which individuals can identify. A good vignette: has fewer complexities and personalities than real life. sets up a situation in which there is no one "right" answer. is flexible enough that individuals from different groups (teacher/administrator, female/male, liberal/conservative) can identify with the story and bring their perspective forward in discussions of solutions. The major purpose of a vignette is to serve as a springboard for discussion. To be most useful, the discussion should focus on solutions to the issue being raised in the vignette. Vignettes should provide people with an opportunity to try out ideas and build on the ideas of others with a specific issue in mind. Hopefully, the discussions will help participants find better solutions to the equity problems facing math and science education, as well as providing participants with a positive learning experience (Campbell, 1996).

The vignettes in the presentations describe scenes in which a student has misunderstood (misinterpreted) a word in a sentence, for example, synonyms found in both scientific language and everyday language. The student teachers work on two main topics: (i) What is the problem with the presented situation? and (ii) What caused this problem? Thus, the intention is to promote student teachers' diagnostic abilities. In the example above, student teachers must recognize that the vignettes describe students' linguistic difficulties while learning chemistry (Markic et al., 2013). Thus, they experience the effect of linguistic influences on chemistry learning, with an emphasis on the meaning of diagnosis for (the Croatian) language and science language.

2. Methods for learning about different diagnostic tools regarding to the dimensions in the sensitisation

It is important to show the existence and diversity of the various instruments for diagnosis in chemistry teaching, which can be used for future teachers' own teaching. The reflection of the instruments is important to identify (dis-)advantages or the implementation for own teaching but also to reflect on combining the instruments (and diagnostic of their own language in the classroom) with their own role as a future teacher.

Some of instruments which can be used in original or adapted form are Multiple-Choice-Test (Chandrasegaran et al., 2007), C-Test (for diagnosis of scientific language), Two or Three-tier misconception tests, etc.

3. Methods for learning about dealing with heterogeneity and diversity in chemistry classrooms

Making a lesson plan for the mixed-ability classroom could be an open-ended task. The aim is to simulate a real-life situation where the teacher has to make a lesson plan because the chemistry schoolbook is not suitable for everyone and there is no extra material available. The lecturer only suggested that the future teachers would pick up a topic that they think is difficult to learn in chemistry, like electrochemistry, atomic model, the periodic table, and chemical bond. After the topic is chosen, the student teachers decide their target group and start to develop their material.

Suggested development of the materials should be given after the evaluation, which includes observing the presentation, reading the materials, and then discussing each item. The materials could be disseminated to anyone interested and can be located on several web pages. The aim is to develop both materials which include theory and experiments like hands-on activities suitable for the different dimensions of heterogeneity.

After the process of creating a lesson plan for the mixed-ability classroom, the future teachers could be interviewed. The aim is to get feedback and find out how to further develop teacher training and research about heterogeneity and diversity in chemistry classes. The following questions could be asked: 1) How did the lesson plan construction meet your expectations? 2) What were the most important things you learned about heterogeneity and diversity? 3) What do you still want to learn about those issues? 4) What kind of effect did the course have on your readiness to teach diverse groups of students? 5) What are your strengths/weaknesses and upcoming challenges as a future teacher facing diverse student groups?

Methods, Tools and Instruments for dealing with linguistic diversity

1. Making science students teachers sensitive for linguistic heterogeneous classes

We should ask ourselves: How to make our future teachers sensitive to language differences in their science classes?

The first method which can be used for sensitization future teachers for language differences in their science classes is to do a seminar (or a task) in English, asking future teachers to talk in English. One possibility is to introduce one simple experiment (e.g. filtration of sand and water). We present the experiment and explain/talk about what we are doing. Finally, future teachers need to write a lab report on their own. In the next step, they need to compare it with a peer and finally with another three peers, following the method “1-2-4-all”. The goal is not to write and have a “perfect” lab report but more to reflect on how they felt while doing such an activity. The last step is to ask some questions for the reflection.

A second method is the use of role-play. Future teachers play the role of students in a mock science class and each of them plays the role of the student described on a card they get at the beginning of the role-play. Depending on the number of future teachers (student teachers) in the course, the number of roles will be different: about 70% of the pretend students are “normal students” (somebody who does not cause any problem in the class, is not one of the best but also not the worst considering knowledge), 1-2 high achievers, 1 student with language problems (e.g. refugee), one student from a lower social background, one to two students with special needs (e.g. one is sitting in the teacher’s chair with wheels or one student has earphones). One student is usually autistic.

The student teachers take on the role of the class and they need to conduct an experiment. This differs, depending on the room: sometimes we are in the lab and perform an experiment, but sometimes we are in our seminar room. In the seminar room, we can not experiment, but here the experiment is called “Which skittle colour is most represented in the bag?”

The questions for the reflective activity can also be used here. Important questions for the reflection regarding future teachers’ sensitization to language differences in their science classes could be:

1. Which dimension of heterogeneity and diversity did you notice in the exercise?
2. How did you perceive the language heterogeneity and diversity?
3. How did you learn from your role and experience the lesson?
4. How was your role influenced by other students?
5. How did language heterogeneity impact or influence the lessons?
6. How did you feel in the game? Did your feelings and impressions change during the lesson?

2. Making science students teachers diagnose in linguistic heterogeneous classes

The next step is teaching student teachers about conducting diagnostics in science classes.

It could be done in two steps.

- a) First we give a short presentation on performing diagnostics which is based on the paper of Tolsdorf and Markic (2016) *Language in science classrooms: Diagnosing students’ linguistic skills*. To inform student teachers about different tools for performing diagnostics, the Prezzi tool (<https://prezi.com/view/bcZDMff3WwpkRkaYtLz8/>) can be used. It is about methods for language sensitive science teaching and learning focused at the (i) level of the word, (ii) level of the sentence and (iii) text level.
 - i) Working at the word level, (at least) three techniques could be used: Field of words, Word-Rail and Catalogue of words
 - ii) Working at the level of the sentence, four techniques are proposed: Concept map, Block-diagram, Sentence pattern and Beginning of the sentence.
 - iii) Working at the text level, (at least) four techniques could be used: Sequence of pictures, Cloze, Text Puzzle and Sentence puzzle.

Student teachers should read the Prezzi tool at home and prepare for the class. The presentation can be recorded and uploaded or different free videos (e.g. from youtube or different platforms).

- b) In the second step, which is in the class, student teachers develop diagnostic instruments for one topic from science lessons. For this, they use their knowledge from the preparation and the Prezi Tool

<https://prezi.com/view/bcZDMff3WwpkRkaYtLz8/>) Student teachers usually work in groups of 3 and use Google Docs which is created by the lecturer. They usually do this during the class and after about 20 minutes, the lecturer enters the Google Docs and comments on their work. This also works very well online.

Methods, Tools and Instruments for dealing with cultural diversity

Science capital was introduced by Archer and colleagues in their analysis of the reasons why science aspirations and science identities differ between social groups (Archer et al., 2015a).

The concept describes three types of resources that contribute to a person's success in the field of science

- (i) Science-related cultural capital comprises a person's science knowledge and attitudes towards science. Positive attitudes towards science contribute to success in the field of science
- (ii) Science-related behaviours and practices constitute the second type of science capital. This type comprises, for example, science media consumption, visits to science museums or participation in science clubs. The integration of science-related activities in a person's personal life can contribute to knowledge acquisition and strong personal attachments to science
- (iii) The third type of science capital is science-related social capital. It describes the science capital available through social relations, for example, knowing someone who works in science or possessing a supportive home environment.

Families use their science capital for social reproduction. This means that parents who possess science capital tend to support their children's success in the field of science with the means they possess. For example, they can seek to promote their children's interest in science, consciously or unconsciously. This happens by establishing science-related activities in family life such as talking about science, watching documentaries, etc. The students in this type of environment always have a person at hand who will help them overcome their misconceptions and who will explain chemistry content to them.

Questions:

- (i) How does the school contribute to students' acquisition of chemistry capital?
- (ii) How does chemistry capital in the home environment contribute to students' individual chemistry capital?
- (iii) What individual strategies do students employ for acquiring chemistry capital?

Other Methods, Tools and Instruments

Flipped classrooms

Phase 1 is the preparation at home based on online educational materials. Here the students work on educational videos, texts, interactive presentations (e.g. Prezi, www.prezi.com), tests and collaborative tools. The learning media are accompanied by assignments to work on. In phase 2, the students meet for the in-class actions at the university. Here they discuss, repeat and reflect on their preparation and get short theoretical input from the lecturer. They need to implement the gained knowledge in a practical task, such as the development of diagnostic-instruments and language-sensitive working sheets, jigsaw classroom activities, experiments in the lecture and other practical tools for their future teaching. In phase 3, the pre-service teachers reflect and/or deepen on the topic at home with the help of the mentioned digital education materials.

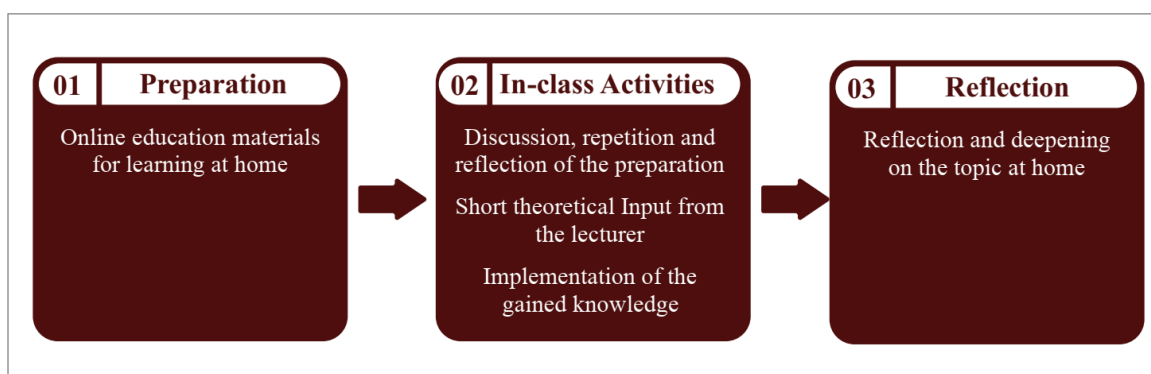


Figure 1. Concept of the used flipped classroom

Three main research questions for the evaluation:

How do pre-service primary science teachers experience the developed lecture, and what are the wishes and ideas for the improvement of it?

How does the concept of the newly developed lecture change TPACK of pre service primary science teachers regarding the usage of digital media in their future classes?

How does the concept of the newly developed seminar change the beliefs of pre service primary science teachers regarding the usage of digital media in their future classes?

The study shows that a flipped classroom seems to be a fitting opportunity to combine theoretical and practical elements in a lecture and lead the students to work effectively.

Digital media in science teaching

New learning media for example explanatory videos, online courses and online resources can support students' learning and can lead to individual and adaptive learning in heterogeneous groups. The digital exchange of knowledge, media and concepts can improve learning broadly.

But of course, there are some challenges, that needs to be faced. Digital media are expensive and based on the general innovation, after a few years, it will be difficult to work with some devices. To use digital media successfully in teaching, educators need knowledge and suitable beliefs regarding digital media. Further, a society, that has a negative attitude regarding digital media in school can be a challenge.

There is no fundamental superiority in the learning success, if student learn digital. Here too, as has always been the case, it is the didactic concept that is crucial for a successful students' learning. There are new possibilities, but they need to be used effectively by teachers and learners.

Possible adaptation to the local context

Here, we will describe methods, approaches, instruments and curriculum plans and activities for tertiary science students which take into account the new knowledge of how to deal with heterogeneity and linguistic and cultural diversity.

1. Name of the course

Our course will be held through seminars and laboratory exercises with pre-service science teachers. The laboratory exercises and seminars are designed for teacher training modules at the University of Mostar.

At the University of Mostar, the official language is Croatian. However, Bosnia and Herzegovina is a country with three official languages: Croatian, Bosnian and Serbian, so our science students are often heterogeneous groups. Considering methods, tools and instruments presented by ESTA project partners from University of Limerick and Ludwigsburg University of education, we redesign the course in the way to sensitise science students for heterogeneity and linguistic and cultural diversity.

In this course, students will receive instructions for exercises in different languages. Each student will receive instruction in the language of another nationality, for example Serbs in Croatian, Bosnians in Serbian, and Croats in Bosnian. They will work individually and then comment on the results in the given language. A student whose native language is Croatian will correct those whose second language is Croatian and similar.

In order to better sensitization of students (pre-service science teachers) for heterogeneous classes, we chose topics they are not familiar with, with respect to their previous education. It is an analysis of organic compounds with sophisticated equipment such as gas chromatography, infrared spectroscopy, and electrochemistry methods. Students know the theoretical foundations but do not know the possibilities of their analysis. We think that students enrolled in, for example, a simple exercise, such as water-steam distillation, could not be successfully sensitized to linguistic diversity. The reason lies in the fact that they already know the material and can fully understand the procedure no matter in which language it is described.

To sensibility of linguistic diversity, the following issues will be commented on after the course reflection:

- Which linguistic differences were observed in the exercise methodology?
- Which nomenclatures of chemicals, organic compounds, accessories and parts of the instrument are different and which are the same?
- Assess the main differences in the language of chemistry.
- Estimate of technical and everyday terms similarity.
- Comment with students on whether they have had difficulty in understanding of the scientific or general language terms.

The second exercise may be given to everyone in English. They will do the exercise in a group of three and comment on the results together. Similar procedure and questions for reflection can be used.

The course will be developed and integrated into the curriculum pre-service teachers.

As part of the mandatory experiments in the laboratory, we have included those that are aimed at researching and demonstrating the basic properties of wine, essential oils and corrosion processes. A special interest is on the research and application of green chemistry. Furthermore, similar issues are important for Herzegovina as Mediterranean part of Bosnia and Herzegovina, and in this way our students can apply the learned knowledge through issues that are important to all of us. For these experiments we use classical procedures, but also instrumental techniques such as spectrometry, chromatography and voltammetry.

Introducing new methods (like conductivity measurement) is very important because experimental work is essential in the teaching and learning of chemistry. In this way not only the knowledge is adopted, but also social and language skills are developed. Also, by learning chemical terminology in different languages, pre-service teachers will be prepared for teaching in multicultural classes in Bosnia and Herzegovina.

These exercise would be incorporated in our sciences subjects in University of Mostar.

Exercise 1: Determination of acid (K_a) and base (K_b) ionization constant from pH and conductivity measurements

A most of chemistry textbooks have examples in which the acid ionization constant of a weak acid, K_a , is calculated from a given concentration and the pH of the solution. However, in the laboratory course K_a is determined from an acid-base titration curve. But, if we use uncharged acid and base, we can determine K_a or K_b from the conductivity measurements and pH. Determination of K_a or K_b values from pH measurements is well-known, but determination of K_a from conductivity measurements is less known and therefore a new for students. In this laboratory exercise, students will show that K_a and K_b are constants and they will compare and contrast pH and conductivity approaches. However, through these exercise students will also be sensitized to diversity and heterogeneity in their community.

I. Diagnostic tools

1. Upotrijebi sljedeće pojmove kako bi završio rečenice.

Arrhenius	Brønsted-Lowry	vodikov ion
Konjugirana baza	Konjugirana kiselina	Hidroksidni ion
koncentracija		

Prema _____ teoriji, kiseline su tvari koje u vodenoj otopini disociraju dajući _____, a stupanj kiselosti otopina tih tvari ovisi o _____ u otopini. Bazično svojstvo neke tvari _____ je povezao s disocijacijom tvari na _____ u vodenoj otopini.

Prema _____ teoriji, kiselina je kemijska vrsta koja daje _____, a baza je vrsta koja prima _____. U kiselobaznoj reakciji, svaka kiselina ima _____, a svaka baza ima _____

2. Kiselina A i kiselina B imaju jednake koncentracije i testirana je njihova provodnost. Kada su elektrode stavljene u kiselinu A – žarulja slabo svijetli, a kad su elektrode stavljene u kiselinu B – žarulja jako svijetli. Označite točan odgovor.
 - a. Kiselina A je jača kiselina od kiseline B
 - b. Kiselina B je jača kiselina od kiseline A
 - c. Kiselina A i kiselina B su jednake jakosti
 - d. Ne može se usporediti jakost kiselina iz ovog eksperimenta.

Table. Observation of specific chemical terminology

English	Croatian	Bosnian	Serbian
acetic acid	acetatna kiselina octena kiselina	acetatna kiselina octena kiselina	acetatna kiselina sirćetna kiselina
molar conductivity	molarna provodnost	molarna provodljivost	molarna provodljivost
ammonia			
Acid or base ionization constant			
solution			
infinite dilution			
<i>fraction of dissociation</i>			

Also all new words (new chemistry terms from the lecture) will be listed and their meaning will be discussed.

At the end of the exercises student will create Block diagram for this lecture in their maternal languages.

Exercise 2: Sensitization for heterogeneity with essential oils

Background

Since olden times, plants have been used for their medicinal benefits, flavours, aroma, spike or smells. To determine which chemicals are responsible for fragrance properties in plants, scientists extract and analyse their essential oils in the laboratory. Gas chromatography (GC), in combination with various detectors such as flame ionization detection (FID), is used to detect and quantify essential oil compounds. The aims of this exercise are double, to sensitize students to different natural fragrance and to sensitise students to diversity and heterogeneity people in Bosnia and Herzegovina.



Figure 1. The exercise will be conducted in two parts

The first part

Students will receive natural essential oil (e.g. lavender) at the beginning of the exercise. They will observe the appearance of the essential oil, smell it and give their observations. The following issues will induce discuss the application of medicinal and aromatic herbs in different cultures and nationalities. What spices are used in their kitchen? What herbs do they use to treat disease or make teas? Which kind of natural aroma do they like the most?

Analysis of the essential oils will carried out using GC/FID system, using silica capillary columns. Students will carried out analysis of essential oil according a protocol they got on one of the three B&H languages. A detailed exercise protocol will be wrote in three B&H languages and in English after the procurement of FID detectors.

The second part

After the analysis, students will discuss the results. Which compounds are most present in the essential oil and in what percentage? What components are responsible for the specific fragrance of lavender essential oil?

Table 1. Observation of specific chemical terminology

English	Croatian	Bosnian	Serbian
Essential oil	Eterično ulje	Eterično ulje	Esencijalno ulje
Gas chromatography	Plinska kromatografija	Plinska hromatografija	Gasna hromatografija
Flame ionization detector			
Mass spectrometry			
Chromatogram			
Chromatograph			
Qualitatively			
Quantitatively			
Column			
Ion source			
Oven			
Vial			
Linalool			
Linalyl acetate			
ect....			

The second part of exercise will discuss the meaning of specific words in this exercise.

Consideration and discussion of the meaning and interpretation of specific terms.

Diagnosing difficulties in heterogeneous groups.

Students will become familiar with the methodology and tools for developing sensitivity to the linguistic diversity as proposed in the ESTA Workshops.

Flame ionization detector (FID) and its gases (hydrogen, synthetic air with flow regulator valve and gas flow fuse) are missing for this exercise, which we would upgrade to an existing gas chromatograph (GC). GC divides the mixture of different components in the essential oil, FID detector gives data on the share of individual components. It is crucial for the quality and application of the essential oil. This exercise with specific equipment has multiple effects. Course participants acquire specific knowledge of natural compounds and their analysis, notice the specifics of chemical terminology, students are sensitized to the specifics of the language in B&H, and finally they acquire general knowledge about working with heterogeneous groups. This exercise would be incorporated in course Methodology of teaching chemistry and the Methodology of teaching biology.

Exercise 3: Corrosion protection with eco-friendly inhibitors

Background

The experiments about corrosion of metals (electrochemical behaviour of metals) are needed to acquaint students with differences in chemistry language. Corrosion inhibitors are substances, which in small concentrations decrease or prevent the degradation of metal. Unfortunately, many of the inhibitors used are compounds with toxic properties. However, an increasing awareness of health and ecological risks has drawn attention to finding nontoxic and environmental friendly corrosion inhibitors. Green inhibitors can be used in the form of extracts, essential oils or pure compounds. The natural compounds are biodegradable, easy available and non-toxic. Plants, which contain heterocyclic constituents (phenolic, aromatic compounds, etc.) can act as potential inhibitors. First students will start discussion about influence of metal corrosion on environment. Then the discussion will be about classic toxic and new eco friendly inhibitors.

Students will study electrochemical behaviour of metals and alloys (iron, copper, stainless steel...) in different harsh environments without and with inhibitor using electrochemical methods. Also they will conduct characterization of the surface films (without and with inhibitor) using Fourier-transform infrared spectroscopy (FTIR). A detailed exercise protocol will be written in three B&H languages and in English.

After calculations students will discuss the results. Does the eco-friendly inhibitor protect the metal surface? What potentiodynamic polarization parameters (corrosion potential, corrosion current...) mean? Is the inhibition efficiency high enough? In what way is inhibitor bonded to metal (discussion on FTIR results)?

Thus, the experiment about corrosion behaviour of metals and corrosion inhibition can be adopted in course Methodology of teaching chemistry to acquaint the students with the behaviour of metals in various environments.

Also, students (pre-service teachers) will be acquainting to the methodology and tools for developing sensitivity to the linguistic diversity by discussing the meaning of specific words used in this exercise.

Table 2. Observation of specific chemical terminology

English	Croatian	Bosnian	Serbian
alloy	slitina	legura	legura
chemical compound	kemijski spoj	kemijsko jedinjenje	kemijsko jedinjenje
open circuit potential	potencijal otvorenog kruga	potencijal otvorenog kola	potencijal otvorenog kola
corrosion current density			
cyclic voltammetry			
electrochemical impedance spectroscopy			
fourier-transform infrared spectroscopy			
inhibition efficiency			
hydrogen bond			

In our laboratory we have the equipment to corrosion investigations, but we need some accessories like reference, counter and working electrodes, gas for deaeration etc. Aims of this exercise are to learn basics of electrochemical methods and FTIR and to learn chemical terminology in different languages. In this way they can start constructive discussion about obtained results.

Exercise 4: Having coffee with a chemist.

Determination of caffeine in coffee

Background

The citizens of B&H are unique in their passion for the hot black coffee, which has become part of the local culture of living. Whatever we named the coffee (kava, kafa or kahva), it has a special tradition in Bosnia and Herzegovina. Coffee in this area has long been called *razgovornica*, an "excuse to talk", which gives it the character of a social phenomenon. According to the data of the World Health Organization, at least about one and a half billion cups of coffee are drunk on the planet every day. In this lab, student will measure the caffeine content in coffee (or tea) using Fourier transform infra-red (FT-IR) spectroscopy. FT-IR is an excellent tool for qualitative and quantitative analysis.

In selected experiment, Fourier transform infra-red (FTIR) spectroscopy and attenuated total reflectance (ATR) techniques should be used for the analysis of caffeine in samples. The infra-red spectrometry is one of the standard technique currently used to identify caffeine. This experiment deals with both, the classical separation procedure and the instrumental technique, IR spectrometry. During the discussion, expressions in all three languages (Croatian, Serbian, Bosnian) will be used to describe the classical technique with which students are familiar.

It will be especially challenging to acquire knowledge of instrumental techniques, with which they are less familiar, in one of the BiH languages that is not their native language.

Table 3. Observation of specific chemical terminology

English	Croatian	Bosnian	Serbian
solvent	otapalo	rastvor	rastvor
separation	odjeljivanje	raspodjela	raspodjela
partition coefficient	koeficijent odjeljivanja	koeficijent raspodjele	koeficijent raspodjele
absorption	apsorbancija	apsorbansa	apsorbansa
transmittance	transmitacija	transmitansa	transmitansa
wavelength	valna duljina	talasna duljina	talasna duljina
vibration's band	Vibracijska vrpca	vibraciona traka	Vibraciona traka
attenuated total reflection	Prigušena totalna refleksija	Atenuirana totalna refleksija	Atenuirana totalna refleksija
....			

Learning about different cultures not only brings students new knowledge, but also encourages their tolerance, which is necessary for coexistence. Multicultural education helps to eliminate discrimination. School is a great place to rise above intolerance and discrimination. Growing up in a multicultural environment and attending a school with a multicultural composition provides an opportunity to get to know another culture and language more closely. Growing up in this environment builds a sense of appreciation, acceptance and understanding of others.

Materials are developed to:

- Highlight similarities
- Use culturally diverse reading materials
- Learning about other cultures powered by science

Example: One of the themes that is common to all cultures of the world is the origin of the world. It is a topic that tickles the imagination, and especially, as he matures, every man begins to preoccupy himself with it, because he wants to connect this topic with the purpose of his existence.

This same aspiration is present in all the communities of the world and it is precisely one of the aspects that connect people in one community because they share something in common, which is the same belief. In the world there are really many versions of the explanation of how the creation happened.

One such exercise is a discussion on this topic and it can be ideal for learning about other cultures because it will help pupils/students to see some other ways of thinking, and above all to accept them. In this kind of exercise, the students would be divided into several groups, and each group would be in charge of processing one version. Of course, one should take into account the scientific assumption that the world was created with a big bang approximately 15 billion years ago. We are often wrongly taught that the world was created in a second with a big bang, however, the big bang is the moment when the universe began to expand from a point of immense density, and there is still the question of what came before the big bang. It is an opportunity for students to learn this information and expand their thinking. It is also significant that one of the oldest theories about the origin of the world originates from Egypt and ancient Greece.

After that comes the most important part of the exercise, in which the students have to present the theories of origin according to the religions that are part of their culture. The emphasis is on that part where students learn about the beliefs of colleagues with whom they are in contact. The center of every religion is one or more supernatural beings, that is, God, who is considered to be the creator of the world and man and to govern man's destiny. Respect for God is expressed through different rites, such as worship, which has different names in different religions, but generally has the same purpose. This is exactly what the students need to see, that we are connected by the same idea and wealth of ways to show respect, which is what makes one culture.

This can be compared to languages, the purpose of every language is to communicate, so we do not all speak the same language, but it is known that there are about 6,800 languages in the world. This diversity must be seen as an asset and speaking multiple languages is considered a success, so why not see different cultures as an asset and not as something that separates us.)

- Using diagnostic tools

Example:

In our specific example, a quiz was made with questions concerning various questions from biology and chemistry, but the emphasis was on the evolution of man. By taking the quiz, students will remember that the ancestor of all people on Earth was Homo habilis, or capable man, and that he lived in Africa 1.5 to 2.3 million years ago. The goal of the exercise is for the students to understand that all people, regardless of religion, race, nation, language they speak, or in which part of the world they live, have a common ancestor that unites us all. At first, the life of Homo habilis consisted of a struggle for existence and survival. The evolution of man proceeded in the following sequence: Homo habilis, Homo rudolfensis, Homo erectus and in the end man as we know him today and we call the species Homo sapiens was born. One of the most important items that marked the evolution of the genus Homo was the increase in brain mass and, in parallel, a higher form of intelligence developed. With the development of higher intelligence, the preoccupation of the genus Homo is no longer mere survival, he finds many ways to use the space around him to his advantage, begins to develop sign language and begins to wonder where he came from. Man always ties his origin to a supernatural being that is beyond his understanding, but he tries to get closer to it by making sacrifices. This is how the first rituals are created. Man begins to create communities characterized by a common way of communication, symbols, attitude towards the environment and belief in a common God. In ancient times, such communities were isolated from each other, which is a prerequisite for the development of different cultures and is reminiscent of Mayr's theory of speciation through geographic isolation. In this way, we will remember the evolution of man and understand the source of diversity. An important part of the quiz is making students aware that geographical coordinates have their fingers involved in creating diversity. For example, the environmental conditions in Africa and Europe are not the same. The central parts of Africa are on the equator and are closer to the Sun, so the temperatures are higher and the climate is generally dry, with a lot of insolation. As we know, the black color of the skin is adaptation or protection against the harmful effects of the Sun. So in this case it is about differences for the purpose of survival of the species and different skin color should not be a subject of discrimination, if it is already completely clear why it developed.

The importance of the exercise is that the students look for answers in nature, and in this way, with the help of real facts, that is, knowledge, they will find a way to overcome prejudices much more easily. It is important that students understand the source of differences and what were the preconditions for their emergence, that is, that these processes cannot be influenced. As already stated, we all have a common origin, and differences are just variations on the same theme. If there weren't so much diversity, people would be like robots and clones, without individuality.

Using digital media

Most often, after processing the new material, teachers spend a short repetition in the next class to determine whether the material has been adopted. With the help of online tools, repetition does not have to be reduced to just repeating learned facts, but a problem can be created that encourages students to think and develop the ability to solve, which is a competence that is never more necessary today.

Example: The fact that it is possible to make so-called online trips because schools usually do not have the means to take students to, for example, museums. Today it is possible to make an online visit to the museum because many cultural

institutions have digitized their collections and they are available online for free. There is a very useful application, Google Arts and Culture, that offers exactly these benefits. Such a platform could be very useful in teaching biology. One of the most interesting teaching units is certainly the Living World in the Past. Each geological era is characterized by fossil finds from that era that are preserved in museums around the world, and the collections of these museums are digitized. It is a great opportunity for students to dive into some part of the geological past through these digitized museum collections and try to visualize what the world looked like back then.

In biology classes, phylogeny is often discussed because the theory of evolution rests on it. Today, so much information is available online that certain tools allow the teacher to allow the student to be a real little evolutionary biologist. Namely, there are online databases specifically Genbank and Ensembl, and the free online tool Clustal Omega that offers DNA and protein sequences characteristic of different animal species and allows the user to order these sequences based on similarity. These tools therefore represent an excellent opportunity for the student to use them to create a phylogenetic tree.

Good Practice Tools for Supporting Language Diverse Classes

Illustrated and labelled work places supports dealing with scientific terms and laboratory equipment



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