Special Issue Paper

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Integrating ethics and democratic principles in chemistry education: a case study

https://doi.org/10.1515/cti-2024-0010
Received February 28, 2024; accepted September 26, 2024; published online October 9, 2024

Abstract: This study presents a novel approach to integrating ethics and core values into chemistry education through the module "Culture of Democracy Through the Didactics of Chemistry." Developed as part of a broader initiative aimed at educating future teachers for democracy and human rights, this module explores the ethical dimensions of chemical knowledge and its social and environmental impact. Utilizing the Council of Europe's Reference Framework of Competences for Democratic Culture, it introduces pre-service teachers to concepts such as responsibility, human dignity, and the rule of law. The module involved six pre-service teachers and two schoolteacher-mentors. Key activities included student-led discussions, such as exploring personal responsibility and moral dilemmas in chemistry, exemplified by the Heinz dilemma, and engaging in discourse on the possibility of breaking a law for morally justifiable reasons to comprehend the delicate balance between legal duties and moral responsibilities. Through reflective exercises and collaborative learning, pre-service teachers engage critically with the ethical implications of their future profession. Initial feedback highlights the value of integrating ethical discussions into chemistry education, fostering deeper reflection and a sense of responsibility among pre-service teachers. The study provides a valuable framework for educators integrating ethics into science curricula, fostering responsible chemistry practice aligned with social values.

Keywords: attitudes; knowledge and critical understanding; competences for democratic culture; pedagogical-content knowledge; skills; values

1 Introduction

In the contemporary educational landscape, integrating ethical considerations into science curricula is increasingly recognized as essential for fostering responsible citizenship and professional conduct among future educators. Chemistry, as a central science, presents numerous opportunities to explore ethical issues that intersect with societal and environmental concerns. Ethics in education is fundamental to cultivating an environment where students learn not only academic content but also the principles that underpin moral and civic responsibility. Ethical considerations in education encompass various dimensions, from ensuring fairness and inclusivity to fostering a culture of integrity and respect.

The importance of incorporating ethics into school education has been highlighted by numerous scholars. For instance, Sporre (2020) conducted an international comparison of curricula from several countries, emphasizing the crucial societal relevance of what children learn in school through ethics and values education, which is guided by the school curricula. Stuckey et al. (2013) advocate for a context-based approach to chemistry education that includes ethical considerations, arguing that it makes the subject more relevant and engaging for students.

Nevertheless, for quality education in schools, it is crucial to have high-quality initial teacher education and training. By equipping future teachers with the skills and knowledge needed to incorporate ethics into their

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teaching practices, we can ensure that they effectively guide students in developing moral reasoning and decision-making skills, fostering a culture of integrity and respect in the classroom.

Vošnjak and Devetak (2023) explored the impact of context-based teaching through a novel elective science fiction course for pre-service teachers. Their study highlighted how incorporating science fiction in school science classes can enhance understanding of scientific and technological ethics. Furthermore, Bullough (2011) reviewed a collection of articles on ethical and moral matters in teaching and teacher education, noting that ethics are central to a teacher's disciplinary knowledge. He emphasizes that understanding a discipline is not merely cognitive attainment but also an ethical achievement. The paper discusses the role of teachers in navigating ethical conflicts in their profession, emphasizing how such conflicts shape both their moral and professional development. This study underscores the importance of teacher preparation programs that integrate ethical reasoning and moral leadership as fundamental components, thereby preparing teachers to effectively manage the complexities of ethical dilemmas in educational settings.

The integration of ethical considerations in education aligns closely with the teaching of democracy and human rights. Human rights education is grounded in the universal values of dignity, equality, and respect, which are also the core principles of ethical education. Democracy and human rights education aims to empower students to become active, informed, and responsible citizens. As Osler and Starkey (2006) argue, teaching democracy involves more than imparting knowledge about democratic structures; it includes nurturing the skills and values necessary for participation in democratic life, such as critical thinking, responsibility, and respect for diverse perspectives. Furthermore, Lovat and Clement (2016) found that integrating ethical education within the curriculum promotes social cohesion and a stronger commitment to democratic values among students.

Recent research underscores the importance of these connections. For instance, the work of Thornberg and Oğuz (2016) emphasizes that ethical education can enhance students' moral reasoning and sensitivity to social issues, which are essential for active democratic participation. Furthermore, the Global Education Monitoring Report by UNESCO (2016) highlights the importance of education in promoting sustainable development, peace, and human rights, indicating that ethical education is critical for global citizenship. This holistic approach to education ensures that students not only excel academically but also develop the ethical and civic qualities necessary for contributing positively to society.

The roles of schools and communities in fostering ethical education are pivotal for developing responsible and morally aware citizens. Teachers play a crucial role as moral exemplars, and their ethical conduct can significantly influence students' character development and ethical understanding. By teaching students to critically examine ethical dilemmas and understand the importance of human rights, educators help foster a sense of global citizenship and social responsibility. By embedding ethical discussions within the science curriculum, educators can help students recognize the broader implications of scientific work. For example, understanding the ethical dimensions of chemical research and its applications can lead students to consider issues such as environmental justice, public health, and the responsible use of technology.

This study aims to present practical examples of activities from the "Culture of Democracy Through the Didactics of Chemistry" module, which is intended for pre-service teachers (PSTs). Both current and future teachers can adapt these activities for use in the classroom. By fostering critical reflection and collaborative learning, the module seeks to cultivate a sense of responsibility and ethical awareness among future educators. Additionally, feedback from both PSTs and instructor (university professor) is included to enhance the practical applicability of these activities.

2 Methodology

2.1 Materials

The module "Culture of Democracy Through the Didactics of Chemistry" (Stojanovska, 2021) was developed as part of the project "Preparing Future Teachers in the Western Balkans: Educating for Democracy and Human Rights" (European Wergeland Centre, n.d.), funded by the Norwegian Ministry of Foreign Affairs in collaboration

with the Macedonian Bureau for Development of Education. Over the three-year project duration, our goal was to enhance the quality of teacher education across several Balkan countries by fostering exchange and cooperation among universities and higher education institutions focused on teacher training. The primary emphasis was placed on developing novel and innovative teacher education modules, with a strong focus on practice-oriented teaching aimed at fostering citizenship, democracy, and human rights.

This module, designed to integrate democratic principles and values into the education of future teachers, featured specific chemistry content. Utilizing educational resources from the Council of Europe, such as the Living in Democracy Series (Council of Europe, n.d.), an educational resource aimed at promoting democracy and human rights among teachers, parents, and principals, Teaching Controversial Issues (Council of Europe, 2015), a publication supporting and advocating for the teaching of controversial issues in schools across Europe, and the Reference Framework of Competences for Democratic Culture (Council of Europe, 2018a, 2018b, 2018c), addressing competencies intended for integration throughout the education system, the aim was to promote citizenship, democracy, and human rights. The Reference Framework of Competences for Democratic Culture provides a model for acquiring competencies necessary for effective participation in a democratic society. These competencies for democratic culture (CDC), also known as the butterfly model (Figure 1), are grouped into values, attitudes, skills, and knowledge and critical understanding (Council of Europe, 2018a). They include responsibility, autonomous learning skills, knowledge and critical understanding of the world, valuing human dignity and human rights, and valuing democracy, justice, fairness, equality, and the rule of law (Council of Europe, 2018a).

Values are fundamental beliefs that guide individuals' actions and decisions across various situations. They serve as guiding principles, offering standards for evaluating actions, justifying opinions, and influencing behavior. In the context of democratic culture, specifying the values that underpin competencies is essential. Without these values, competencies could serve different political orders, including anti-democratic ones. Therefore, the values within the Framework model are crucial for defining democratic competence. An *attitude* is an individual's overall mental orientation toward someone or something, comprising beliefs, emotions, evaluations, and behavioral tendencies. A *skill* is the ability to perform complex, well-organized patterns of thinking or behavior adaptively to achieve specific goals. *Knowledge* refers to the information possessed by an individual, while understanding involves comprehension and appreciation of meanings. "*Critical understanding*" underscores the importance of actively reflecting on and critically evaluating information in the context of democratic processes and intercultural dialogue, rather than relying on automatic or unreflective interpretation.

The Framework also includes descriptors for each of the 20 competencies within the model, along with guidance on implementing the Framework within education systems (Council of Europe, 2018b). The descriptors clearly indicate one of the three levels of proficiency: basic, intermediate, and advanced.

The module developed as part of the project activities was intended for lower and upper secondary school teachers, combining pedagogical-content knowledge with democratic principles. It included a school practice component, conducted in collaboration with chemistry teachers from local schools. The introduction of

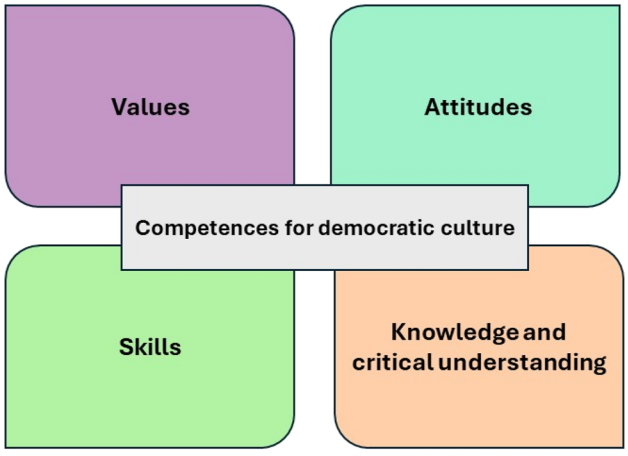

Figure 1: The model of competences for democratic culture (Council of Europe, 2018a).

democratic content enhances the learning experience and enriches the course's value by placing studied content within a broader context. PSTs gain insight into additional skills relevant not only in the classroom but also in daily life, encouraging reflection on personal values and the importance of listening to diverse perspectives. Critical thinking holds particular significance in the field of chemistry, and the incorporation of democratic topics further enhances the synergy between these seemingly distinct domains.

2.2 The participants

Implemented for the first time at the Institute of Chemistry, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University in Skopje during the Winter semester 2020/21, the module became a part of the curriculum for chemistry PSTs. Despite challenges posed by the COVID-19 pandemic, lectures and school practice were successfully delivered online using Microsoft Teams. As the first module of its kind in Macedonia integrating chemistry and democracy, it involved six PSTs, current university students at the Institute of Chemistry and two schoolteacher-mentors (one teacher in lower secondary and one in upper secondary school), who were responsible for the school practice of PSTs.

2.3 The lesson plan design and implementation

This semester module adhered to the prescribed curriculum while integrating content on democracy. This study specifically focuses on two sessions of the module for detailed analysis and discussion. Generally, these sessions encompass methodology of teaching chemical content, content dedicated to integrating democratic principles into teaching, and school practice that PSTs implement in lower and upper secondary schools under the mentorship of chemistry teachers. For the purposes of this paper, the analysis will concentrate on the portions of these two sessions that relate to integrating democratic principles into chemistry teaching.

Namely, in the second session (Table 1), the instructor introduced the Heinz dilemma, sparking a discussion on the ethical considerations of violating laws. PSTs then imagined scenarios where such dilemmas arise and discussed them in a group setting, aiming to explore the delicate balance between legal obligations and moral responsibilities (Gollob et al., 2008).

This session covers various teaching methods in chemistry, including the use of conversation during instruction. It can take several forms, including teacher-led conversation, heuristic conversation, catechetical conversation (with precisely defined questions), free-form teaching conversation, spontaneous student questions, and discussion. Introducing controversial issues involves discussion, exchanging opinions and viewpoints,

Table 1: Summary of the lesson plan for session 2.

Date: 19.10.2020; 21.10.2020
Topic of the session: Introduction of the subject. Chemistry curricula
Chemistry education with didactics content: Primary and Secondary Education Act. Chemistry curricula. Importance of science and science education in contemporary societies
Democracy content: Rule of law and responsibility
CDC addressed: C1 – D1, D4, D6; C3 – D13, D19; C7 – D39, D42
PSTs's preparation: Exploring chemistry curricula and the Primary and Secondary Education Act
Session step by step (brief version):
Instructor: Introduction of the subject. Explores the website mon.gov.mk. Introduces the Heinz dilemma and discusses with PSTs
Task for PSTs: PSTs discuss scenarios where people might justifiably break laws or rules and share examples in a plenary session
Instructor: Acquaints PSTs with the chemistry curricula. Explores the website bro.gov.mk
Task for PSTs: To examine chemistry textbooks and identify differences in plenary discussions
Time allocation: Lecturing: 40 %; activities: 60 %; school practice:/
Homework/Individual tasks:/

and fostering empathy and a better understanding of others' perspectives. This represents an excellent opportunity to incorporate such discussions into the session.

During the seventh session (Table 2), PSTs brainstormed ideas from Activity 2.4: "Other People's Shoes" (Council of Europe, 2015). They formulated questions on controversial topics, comparing and summarizing their findings. In a model class learning activity, the instructor discussed suitable controversial issues for classroom debate and initiated a discussion on the process of discovering a new medicine, encouraging PSTs to consider the factors scientists should contemplate during drug development. PSTs were tasked with identifying and justifying statements in favor of different positions, and also required to write a short essay on adapting discussions or debates to chemistry content, providing a good-practice example in chemistry teaching.

During these sessions, several CDC were planned to be employed, aligning with the Framework's comprehensive conceptual model of competencies necessary for individuals to function as democratically and interculturally competent citizens. For each competence, descriptors are provided (Council of Europe, 2018b). The descriptors operationalize competencies, serving as valuable tools for curriculum planning, teaching, learning, and assessment. They consist of statements describing observable behaviors that indicate a person has attained a specific level of proficiency in a competence.

The corresponding descriptors for CDC planned in this study are as follows:

For session 2:

CDC1–D1: Argues that human rights should always be protected and respected.

CDC1–D4: Argues that all public institutions should respect, protect, and implement human rights.

CDC3–D13: Expresses the view that all citizens should be treated equally and impartially under the law.

CDC3–D19: Expresses the view that information on public policies and their implementation should be made available to the public.

CDC7–D39: Shows that he/she accepts responsibility for his/her actions.

CDC7–D42: Shows that he/she takes responsibility for own mistakes.

For session 7:

CDC5–D27: Gives space to others to express themselves.

CDC6–D36: Discusses what can be done to help make the community a better place.

CDC12–D70: Listens carefully to differing opinions.

CDC12–D73: Can listen effectively in order to decipher another person's meanings and intentions.

CDC15–D88: Can express his/her thoughts on a problem.

Table 2: Summary of the lesson plan for session 7.

Date: 23.11.2020; 25.11.2020
Topic of the session: Teaching methods in chemistry
Chemistry education with didactics content: Identification and implementation of specific teaching methods in chemistry
Democracy content: Teaching controversial issues
CDC addressed: C5 – D27; C6 – D36; C12 – D70, D73; C15 – D88; C17 – D103; C18 – D109
PSTs's preparation: Activity 2.4: Other people's shoes (https://rm.coe.int/16806948b6). Think of a controversial issue and pose it in the form of a question
Session step by step (brief version):
Instructor: Exploring various teaching methods and their suitability for chemistry teaching
Task for PSTs: To select topic from the chemistry textbook and suggest fitting teaching methods for each lesson
Instructor: Teaching controversial issues in chemistry classes
Task for PSTs: To observe and deliver different types of lessons at the university and in the school. Critical review of their own and other PSTs teaching. Select and explain implementation of at least one CDC descriptor
Time allocation: Lecturing: 30 %; activities: 10 %; practice: 60 %
Model class: Instructor-prepared lessons with PSTs as active participants, including teaching controversial issues
Homework/individual tasks: Short essay – How to adapt discussion or debate with chemistry content? Illustrate one good-practice example in chemistry teaching

CDC17–D103 Can encourage the parties involved in conflicts to actively listen to each other and share their issues and concerns.

CDC18–D109: Can reflect critically on himself/herself from a number of different perspectives.

A brief explanation of a specific CDC is provided below.

CDC1: Values human dignity and rights, emphasizing universal and essential protections for a life of dignity, freedom, equality, justice, and peace.

CDC3: Values democracy, justice, fairness, equality, and the rule of law, advocating for equal participation in governance and just treatment for all.

CDC5: Respect involves positive regard for others' beliefs, opinions, and practices, recognizing their importance and dignity.

CDC6: Civic-mindedness is an attitude about community belonging, solidarity, and active participation in community life, emphasizing responsibility and accountability.

CDC7: Responsibility focuses on reflecting on and being accountable for one's actions, sometimes requiring the courage to challenge norms.

CDC12: Skills of listening and observing are crucial for understanding and learning from others, paying attention to verbal and non-verbal cues.

CDC15: Linguistic, communicative, and plurilingual skills involve clear, respectful, and adaptable communication in diverse situations.

CDC17: Conflict-resolution skills aim to manage and resolve conflicts peacefully, recognizing power dynamics and fostering mutual understanding.

CDC18: Knowledge and critical understanding of the self involve self-awareness of cultural affiliations, biases, emotions, and motivations, especially in cooperative contexts.

3 Results and discussion

3.1 Implementation of CDC activities for session 2

The instructional session began with the instructor acquainting the students with laws related to the educational process. Following this introduction, students were tasked with listing at least three provisions they believe should be included in the Primary and Secondary Education Act, providing justifications for their selections. This exercise served as a precursor to a broader discussion initiated by the instructor, focusing on whether teachers and students should adhere to the law, alongside other rules and norms, and the underlying reasons for such obedience. In the discussion, the PSTs addressed the justification for fully covering the travel expenses of teachers working in district schools, as well as the regulation of financial support for working with talented students.

Subsequently, the instructor introduced the Heinz dilemma, a classic moral quandary (Letch & €ileli, n.d.). Heinz's wife was diagnosed with cancer, and the doctor informed him that a new drug could potentially save her life. However, the drug was prohibitively expensive, priced at ten times the production cost. Despite desperate attempts to gather funds, Heinz could only manage to collect half the required amount. When he asked the chemist for a discount or to allow him to pay the remaining amount later, his requests were rejected. Faced with the imminent death of his wife, Heinz broke into the laboratory and stole the medicine.

In the moral dilemma, Heinz faces a challenging decision. Through a plenary discussion, students engaged in a critical analysis of this dilemma, evaluating the reasons for adherence to legal norms. Some argue that he should steal the medicine because saving his wife's life is more important than obeying the law against theft. However, others suggested that he should not steal the medicine because he might get caught, and stealing is wrong. This scenario raised complex questions about the balance between moral responsibilities and legal duties.

Continuing the discussion on legal obedience, the instructor prompted students to list various reasons why breaking the law might be considered wrong. Students explored a spectrum of reasons, including self-interest, concern for others, and considerations for the well-being of society as a whole.

The class progressed to a more nuanced debate as the instructor considered with the students the possibility of breaking a particular law for a morally justifiable reason. Following this, the instructor introduced an interactive element, prompting students to share their experiences with rule-breaking, using Google Forms to ensure anonymity. Namely, they needed to answer whether they had been in a situation to break a rule, to explain it briefly, what was the reason for it, and what was the outcome.

Two PSTs reported not wearing a mask during the COVID-19 restrictions, one when getting off the bus and the other in the park. However, their outcomes differed, despite the similar nature of the situations: one received a warning, while the other was fined. Another PST confessed to using class funds to buy food while waiting for their sister from school but felt guilty afterward and spent a week collecting money to reimburse the funds. Additionally, a PST shared an incident where they discharged a fire extinguisher in the school corridor out of curiosity, resulting in a fine and disciplinary action. Other examples discussed included crossing the street on a red light and late semester enrollment.

Next, PSTs were then encouraged to imagine scenarios within the educational context where individuals might examine breaking the law or other rules and norms for seemingly good reasons. It was crucial their texts to conclude with a dilemma rather than a predetermined decision. This is essential for framing questions in the classroom that stimulate discussion and critical thinking. The instructor presented a scenario to the students: A pupil from Kruševo is on the way to a chemistry competition in Skopje with their father. Due to a traffic jam, they risk being late. The student, anxious about the competition's importance, asks their father to drive faster. When they reach Skopje, they encounter a red light at an empty intersection. The dilemma is whether the father should pass the red light or wait. This scenario was designed to encourage discussion about possible solutions, which the students then used to write short stories. In a subsequent plenary discussion, PSTs shared their examples, and the instructor emphasized the distinction between moral responsibilities, which individuals undertake based on their values and beliefs, and legal duties, which are mandated by governmental authorities. A brief summary of their scenarios is given below.

PST 1: "Today, despite being in the clinic all night for stomach pain, I came to work exhausted. I asked the students to work quietly on free activities for the next lesson, but then an inspection occurred, putting me in a difficult situation. Do you think I made the right decision by coming to school? Should I have given them free activities? What do you think the outcome will be, and what would you have done in my situation?"

PST 2: "Sara has two courses left from her first year at university, and she needs to pass them to enroll in the third year. However, if she doesn't pass, she will fall into a private quota, which her parents cannot afford. To avoid this, Sara plans to cheat on one of the two courses. Do you think her decision is correct? What do you think the outcome of her decision will be?"

PST 3: "One day, the I-3 class agreed to skip a class. The students were divided; some wanted to skip, while others did not. However, they knew that by skipping, they would hurt their dedicated professor, whom they all admired. This created a dilemma: should they skip class or not, considering their professor's feelings?"

PST 4: "As a student, I was late for class because I stopped to help an elderly woman cross the street. Now, I wonder if I will be excused from class. Do you think my reason for being late is valid? What would be the best way to handle this situation?"

PST 5: "In III-1 class, the teacher instructed everyone to wear the school uniform. While most students complied, Anna showed up in ripped jeans and a plain T-shirt. The teacher noticed and sent her home to change, causing Anna to miss a significant portion of the class. Do you think the teacher's decision was fair?"

PST 6: "Rushing to an exam, I spotted a kitten trapped in a manhole. I had to decide: should I help the kitten or go to my exam? This situation raises the question: should we treat animals and people the same way in similar situations?"

3.2 Implementation of CDC activities for session 7

Before starting the planned activity, the instructor underscored the importance of discussion in the teaching process, particularly in chemistry classes. Additionally, the instructor emphasized the need for teachers and

students to be mindful of each other's opinions, attitudes, and working conditions. The lesson continued with an emphasis on the impact of science, highlighting that science and technology are omnipresent and aimed at making life easier and the world a better place. However, achieving scientific breakthroughs often requires difficult decisions and sacrifices. The instructor discussed the integration of scientific information with personal values to make important life decisions, mentioning current controversies or dilemmas related to science and society. Topics such as food safety, global warming, climate change, medical knowledge, nuclear energy, and genetic engineering were introduced as potential discussion points in science classes.

Next, the instructor asked the PSTs to consider the factors a researcher needs to study when developing a new drug and the process leading to its ultimate use. To stimulate discussion, the instructor asked the PSTs to respond to the question, "Are doctors allowed and should they conduct experiments on people when creating a new drug?" PSTs were instructed to think for a minute about their answer and choose either "yes" or "no", with no undecided answers permitted. Following this, the instructor posed another question: "Did you make your decision by reason or by heart?" Once again, PSTs were given a minute to think about their answer. Based on their beliefs, PSTs were divided into four groups: (1) Yes, by reason; (2) Yes, by heart; (3) No, by reason; and (4) No, by heart. PSTs from each group were then given the opportunity to explain their choice and point of view. To encourage empathy and explore diverse perspectives, PST from one group moved to another group to understand their viewpoint ("put yourself in other people's shoes"). This method enabled PSTs to identify alternative perspectives and learn to appreciate a range of opinions.

Given the ongoing COVID-19 situation, PSTs naturally linked this topic to the development and testing of vaccines. The discussion delved into various aspects such as the duration of testing, potential side effects, the influence of other medications, and the competition among pharmaceutical companies at local, regional, and global levels. A PST with a background in pharmacy elaborated on the complex process of analysis, outlining the manpower and costs involved, the use of laboratory mice, monitoring of side effects, the medication's effects on organs like the brain and liver, and the need for volunteers for testing.

Regarding PSTs' beliefs, three PSTs opted for "No, by reason," arguing against initiating experiments on humans, stressing the importance of voluntary participation. Two PSTs chose "Yes, by reason," asserting that human reactions can differ from those of animals, and highlighting that medical progress often necessitates human trials, citing the example of diseases like measles. One PST selected "No, by heart," expressing concerns about the potential life-threatening consequences and expressing empathy for those at risk.

To explore additional activities from the book (Council of Europe, 2015), PSTs were tasked with formulating a controversial issue as a question and writing a short essay on adapting discussions or debates within chemistry (science) content, providing an illustrative example of good practice in chemistry teaching that involves a controversial issue.

Some of their suggestions, as well as a detailed explanation of one of them, is given below.

1) Internet and gaming addiction: Are teens at risk? Should access restrictions be imposed?
   PSTs emphasized that the use of computers and the internet provides numerous benefits but also raises concerns about the growing issue of internet addiction among adolescents. Some of the benefits included access to vast sources of information, educational materials, fascinating books, movies, and opportunities to make new friends worldwide. Improving the communication skills and helping with learning foreign languages were also mentioned. It was noted, however, that young people are increasingly immersing themselves in the virtual world, often to escape from real-life problems or seek entertainment. This trend has led to a significant issue of internet addiction among adolescents in today's world.
2) Is marijuana use harmful or beneficial to human health? (Should the use of marijuana be legalized?)
   The discussion included PSTs' opinions that marijuana is harmful to human health, potentially causing serious negative effects on the brain, such as depression and schizophrenia, and disrupting the function of the lungs and heart. Additionally, some PSTs believed that marijuana is beneficial for human health, particularly for people suffering from cancer, due to its content of substances with healing properties.
3) Should vitamins be consumed without consulting a doctor?
   Detailed explanation is given in Table 3.

Table 3: A brief summary of an activity designed by one of the PSTs.

Part 1. Introduction
Time frame: 5 minutes
Class activities: In the introductory part of the lesson, short questionnaires are distributed to the students. They have to answer two questions: (1) Do you think that vitamins should be consumed only after consulting a doctor? ("yes" or "no"), and (2) How did you reach your conclusion? ("by reason" or "by heart")
Part 2: Main class activities
Time frame: 30 minutes
Class activities: The students are divided into four groups, and the results are presented using a bar chart. One student from each group explains their answer to the rest of the class
Assumptions about possible reasons:
YES, WITH REASON
– We should seek advice from a doctor and get an analysis to check for vitamin deficiencies because unnecessary intake can lead to hypervitaminosis
– It is essential to get expert advice. I know someone who took up to 2,000 mg of vitamin C without consulting a doctor and developed kidney and bile problems, worsening their health
– Consultation is necessary because a lack of vitamin K can cause bleeding under the skin and in the muscles
YES, WITH HEART
– We need to consult a doctor because when I injured my leg, I needed 1,000 IU of D_3, and B_1, B_6, and B_{12} vitamins for faster recovery
– Analysis and expert advice are essential. I thought I was getting enough vitamins from food, but when I got sick, my weak immunity made recovery difficult. Vitamins would have mitigated the symptoms.
NO, WITH REASON
– We can take vitamins without consulting a doctor if done in moderate amounts. Excess water-soluble vitamins are excreted through urine, feces, and sweat. My friend takes 500 mg of vitamin C daily without issues
– No consultation is needed because you can take 1,000 mg of B_{12} daily to boost energy when immunity is low
NO, WITH THE HEART
– No need for advice; when I had dermatitis, I took 100 IU of vitamin E without consulting and my skin healed in three months
– I don't consult a doctor because I don't have health insurance. I get vitamins through food and take 500 mg of vitamin C and a B-complex
– I don't seek advice because of a previous misdiagnosis. I was treated with Ca instead of vitamin K for bleeding
Students present their reasons in front of their classmates and the instructor. Each student listens to the others without judgment. By hearing different life experiences, they learn not to rush to conclusions and become better listeners and advisors
Part 3: Reflection
Time frame: 10 minutes
Class activities: A brief discussion is conducted to explore the reasons behind the students' answers, and conclusions are drawn from their explanations.

Some other topics that could be used in such class discussions include genetically modified organisms (GMO) i.e. modifying the genetic makeup of crops and organisms or the use of chemical pesticides and herbicides in agriculture.

Throughout the discussion, PSTs expressed their appreciation for engaging in conversations about controversial topics in class. They highlighted the value of hearing diverse opinions and having the opportunity to express their own views. PSTs emphasized the importance of patience, active listening, and empathy during these discussions, noting that they help prevent hasty conclusions and promote a better understanding of others' perspectives. Overall, PSTs expressed a need for more frequent discussions on various topics as part of their learning experience.

As home activity, PSTs were required to plan and develop the lesson based on the given task, integrating the competence descriptors.

4 Conclusions

The integration of ethical considerations into chemistry education, as demonstrated in the "Culture of Democracy Through the Didactics of Chemistry" module, enhances both scientific understanding and the development of

responsible, ethical, and engaged citizens. By fostering critical reflection, collaborative learning, and a sense of responsibility among future educators, this module prepares PSTs to navigate and contribute to a complex world. The discussions on the rule of law, human dignity, and controversial scientific topics illustrate the module's effectiveness in promoting democracy, human rights, and civic-mindedness. Through these activities, PSTs developed essential competencies such as respect, civic-mindedness, communication, and conflict resolution, aligning with broader educational goals and ensuring their readiness for future challenges.

Acknowledgments: The author expresses sincere gratitude to Prof. Dr. Rolf Gollob from Zurich University of Teacher Education for his invaluable advice and assistance in preparing the module.
Research ethics: Not applicable.
Informed consent: Informed consent was obtained from all individuals included in this study, or their legal guardians or wards.
Author contributions: The author has accepted responsibility for the entire content of this manuscript and approved its submission. The author conceived the original idea, and was responsible for data collection and analysis.
Use of Large Language Models, AI and Machine Learning Tools: None declared.
Conflict of interest: The author states no conflict of interest.
Research funding: None declared.
Data availability: Not applicable.

References

Bullough, R. V., Jr. (2011). Ethical and moral matters in teaching and teacher education. *Teaching and Teacher Education*, *27*(1), 21–28.
Council of Europe. (2015). *Teaching controversial issues*. Council of Europe Publishing. https://rm.coe.int/16806948b6.
Council of Europe. (2018a). *Reference framework of competences for democratic culture: Volume 1: Context, concepts and model*. Council of Europe Publishing. https://www.living-democracy.com/wp-content/uploads/2019/10/Reference-Framework-of-competences-Vol-1_EN.pdf.
Council of Europe. (2018b). *Reference framework of competences for democratic culture: Volume 2: Descriptors of competences for democratic culture*. Council of Europe Publishing. https://www.living-democracy.com/wp-content/uploads/2019/10/Reference-Framework-of-competences-Vol-2_EN.pdf.
Council of Europe. (2018c). *Reference framework of competences for democratic culture: Volume 3: Guidance for implementation*. Council of Europe Publishing. https://www.living-democracy.com/wp-content/uploads/2019/10/Reference-Framework-of-competences-Vol-3_EN.pdf.
Council of Europe. (n.d.). Living democracy. Retrieved May 21, 2024, from https://www.living-democracy.com/
European Wergeland Centre. (n.d.). Preparing future teachers in the Western Balkans. Retrieved May 21, 2024, from https://theewc.org/projects/preparing-future-teachers-in-the-western-balkans/
Gollob, R., Huddleston, T., Krapf, P., Rowe, D., & Taelman, W. (2008). Taking responsibility. In R. Gollob & P. Krapf (Eds.), *Living in democracy. EDC/HRE lesson plans for lower secondary level* (pp. 109–157). Council of Europe Publishing. https://www.living-democracy.com/pdf/en/V3/V03.pdf.
Letch, N., & €ileli, M. (n.d.). The forensic psychologist in the courtroom. In *Psychology in action* (Chapter 16). Retrieved from https://www2.iccb.org/iccb/wp-content/pdfs/adulted/healthcare_curriculum/curriculum&resources/context_social_studies/F.%20HC%20Context%20Social%20Studies%20Resource%20File/84.pdf
Lovat, T., & Clement, N. (2016). Service learning as holistic values pedagogy. *Journal of Experiential Education*, *39*(2), 115–129.
Osler, A., & Starkey, H. (2006). Education for democratic citizenship: A review of research, policy and practice 1995–2005. *Research Papers in Education*, *24*(4), 433–466.
Sporre, K. (2020). Ethics in compulsory education – Human dignity, rights and social justice in five contexts. *HTS Teologiese Studies/Theological Studies*, *76*(1), a5821.
Stojanovska, M. (2021). *Culture of democracy through the didactics of chemistry*. Oslo: European Wergeland Centre. https://theewc.org/content/uploads/2021/10/Marina-Stojanovska-knjiga-FINAL.pdf.
Stuckey, M., Hofstein, A., Mamlok-Naaman, R., & Eilks, I. (2013). The meaning of 'relevance' in science education and its implications for the science curriculum. *Studies in Science Education*, *49*(1), 1–34.
Thornberg, R., & Oğuz, E. (2016). Moral and citizenship educational goals in values education: A cross-cultural study of Swedish and Turkish student teachers' preferences. *Teaching and Teacher Education*, *55*, 110–121.

UNESCO (2016). *Global Education Monitoring Report 2016: Education for people and planet: Creating sustainable futures for all*. UNESCO Publishing, ISBN 978-92-3-100167-3. https://uis.unesco.org/sites/default/files/documents/education-for-people-and-planet-creating-sustainable-futures-for-all-gemr-2016-en.pdf.

Vošnjak, M., & Devetak, I. (2023). The context of science fiction in the pre-service teachers' chemistry education. *Chemistry Teacher International*, *5*(2), 113–124.