

PHILOSOPHICAL PERSPECTIVES THAT DESCRIBE HOW THE WORK IN CHEMISTRY EDUCATION

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Abstract- Chemistry education can be philosophically viewed from two perspectives, namely that of practitioners and of chemistry educators. The two perspectives results in varied learning processes, method of teaching methods. Each of the two perspectives proposes creativity and reasoning in teaching learning process. This paper addresses the philosophical, teaching, methodological and reasonable aspects.

Keywords: chemistry education, philosophy of chemistry, teaching method, creativity and reasoning

1. INTRODUCTION

The relationship between chemistry (science) education and philosophical aspects of chemistry (science) has a long history. According to [7], over the last 100 years, there have been three major movements in philosophy of chemistry (science): empiricism, historicism, and naturalized philosophy of science. But the historical reconstructions of science content are not as fruitful as many science educators would like us to believe [25,26] and the development of new perspectives on how philosophical aspects of chemistry can inform education has had rather slow progress [8].

Interestingly, a recent review of the literature in chemistry education has recognized the need for research in chemistry education based on history and philosophy of science, while the philosophy of chemistry is gradually emerging as a distinctive epistemology for chemistry [28] --- More work that investigates what constitutes the nature of chemistry [2] --- philosophically, epistemologically, and historically--how it may become integrated into the curriculum is needed so that a better understanding of what chemistry education is all about may be obtained [32].

A crucial question is thus raised for teacher chemical education: What pedagogical content knowledge do teachers need to have in order to support the learning of philosophical perspectives themes in chemistry education? Philosophers think about the meaning of things and interpretation of that meaning. There is a constant need to update the skills of teachers engaged in teaching chemistry, and so chemistry education speaks to this need [31].

2. LITERATURE REVIEW

2.1 Philosophies

There are three major branches of philosophy. Each branch focuses on a different aspect and is central to our teaching. The three branches and their sub-branches are: (1) Metaphysics (ontology and cosmology): What is the nature of reality? Educational Examples: Do you think human beings are basically good or evil? What are conservative or liberal beliefs? -Ontology: What issues are related to nature, existence, or being? Is a child inherently evil or good? How might your view determine your classroom management? -Cosmology: What is the nature and origin of the cosmos or universe? Is the world and universe orderly or is it marked by chaos? What would one or the other mean for a classroom?; (2) Epistemology (Knowing based on: Scientific Inquiry, Senses and Feelings from authority or divinity, Empiricism, Intuition, Reasoning or Logic): What is the nature of knowledge? How do we come to know? Educational Examples:--How would an anthropologist look at this classroom? A political scientist? A biologist?--How do we know what a child knows?--Deductive: reasoning from the general to the particular All children can learn. Bret is a fifth grader. He has a learning disability. Can Bret learn?--Inductive: reasoning from the specific to the general. After experimenting with plant growth under varied conditions, students conclude plants need water and light; (3) Axiology (Ethics and Aesthetics): What values should one live by? Educational Examples: -- Is morality defined by our actions, or by what is in our hearts?--What values should be taught in character education? --Ethics: What is good and evil, right and wrong? Is it ever right to take

something that does not belong to you? –Aesthetics: What is beautiful? How do we recognize a great piece of music? Art? Can there be beauty in destruction? 15,30].

Metaphysics attempts to find unity across the domains of experience and thought. At the metaphysical level, there are four broad philosophical schools of thought that apply to education today. They are idealism, realism, pragmatism (sometimes called experientialism), and existentialism. These four general frameworks provide the root or base from which the various educational philosophies are derived. Two of these general or world philosophies, idealism and realism, are derived from the ancient Greek philosophers, Plato and Aristotle. Two are more contemporary, pragmatism and existentialism. However, educators who share one of these distinct sets of beliefs about the nature of reality presently apply each of these world philosophies in successful classrooms [15,28,30].

Idealism is a philosophical approach that has as its central tenet that ideas are the only true reality, the only thing worth knowing. In a search for truth, beauty, and justice that is enduring and everlasting, the focus is on conscious reasoning in the mind. Plato, father of Idealism, believed that spiritual or mental world is eternal, permanent, orderly, regular, and universal. There is also the world of appearance, the world experienced through sight, touch, smell, taste, and sound, that is changing, imperfect, and disorderly. This division is often referred to as the duality of mind and body. Reacting against what he perceived as too much of a focus on the immediacy of the physical and sensory world, Plato described a utopian society in which "education to body and soul all the beauty and perfection of which they are capable" as an ideal. In his allegory of the cave, the shadows of the sensory world must be overcome with the light of reason or universal truth. To understand truth, one must pursue knowledge and identify with the Absolute Mind. Plato also believed that the soul is fully formed prior to birth and is perfect and at one with the Universal Being. The birth process checks this perfection, so education requires bringing latent ideas (fully formed concepts) to consciousness. In idealism, the aim of education is to discover and develop each individual's abilities and full moral excellence in order to better serve society. The curricular emphasis is subject matter of mind: literature, history, philosophy, and religion. Teaching methods focus on handling ideas through lecture, discussion, and Socratic dialogue (a method of teaching that uses questioning to help students discover and clarify knowledge). Introspection, intuition, insight, and whole-part logic are used to bring to consciousness the forms or concepts which are latent in the mind. Character is developed through imitating examples and heroes [19].

Aristotle, a student of Plato who broke with his mentor's idealist philosophy, called the father of both Realism and the scientific method, believe that reality exists independent of the human mind. In this metaphysical view, the aim is to understand objective reality through "the diligent and unsparing scrutiny of all observable data." Aristotle believed that to understand an object, its ultimate form had to be understood, which does not change. For example, a rose exists whether or not a person is aware of it. A rose can exist in the mind without being physically present, but ultimately, the rose shares properties with all other roses and flowers (its form), although one rose may be red and another peach colored. Aristotle also was the first to teach logic as a formal discipline in order to be able to reason about physical events and aspects. The exercise of rational thought is viewed as the ultimate purpose for humankind. The Realist curriculum emphasizes the subject matter of the physical world, particularly science and mathematics. The teacher organizes and presents content systematically within a discipline, demonstrating use of criteria in making decisions. Teaching methods focus on mastery of facts and basic skills through demonstration and recitation. Students must also demonstrate the ability to think critically and scientifically, using observation and experimentation. Curriculum should be scientifically approached, standardized, and distinct-discipline based. Character is developed through training in the rules of conduct [11,19].

For pragmatists (Experientialism), only those things that are experienced or observed are real. In this late 19th century American philosophy, the focus is on the reality of experience. Unlike the Realists and Rationalists, Pragmatists believe that reality is constantly changing and that we learn best through applying our experiences and thoughts to problems, as they arise. The universe is dynamic and evolving, a "becoming" view of the world. There is no absolute and unchanging truth, but rather, truth is what works. Pragmatism is derived from the teaching of Charles Sanders Peirce (1839-1914), who believed that thought must produce action, rather than linger in the mind and lead to indecisiveness. John Dewey (1859-1952) applied pragmatist philosophy in his progressive approaches. He believed that learners must adapt to each other and to their environment. Schools should emphasize

the subject matter of social experience. All learning is dependent on the context of place, time, and circumstance. Different cultural and ethnic groups learn to work cooperatively and contribute to a democratic society. The ultimate purpose is the creation of a new social order. Character development is based on making group decisions in light of consequences. For Pragmatists, teaching methods focus on hands-on problem solving, experimenting, and projects, often having students work in groups. Curriculum should bring the disciplines together to focus on solving problems in an interdisciplinary way. Rather than passing down organized bodies of knowledge to new learners, Pragmatists believe that learners should apply their knowledge to real situations through experimental inquiry. This prepares students for citizenship, daily living, and future careers [19].

The nature of reality for Existentialists is subjective, and lies within the individual. The physical world has no inherent meaning outside of human existence. Individual choice and individual standards rather than external standards are central. Existence comes before any definition of what we are. We define ourselves in relationship to that existence by the choices we make. We should not accept anyone else's predetermined philosophical system; rather, we must take responsibility for deciding who we are. The focus is on freedom, the development of authentic individuals, as we make meaning of our lives. There are several different orientations within the existentialist philosophy. Soren Kierkegaard (1813-1855), a Danish minister and philosopher, is considered to be the founder of existentialism. His was a Christian orientation. Another group of existentialists, largely European, believes that we must recognize the finiteness of our lives on this small and fragile planet, rather than believing in salvation through God. Our existence is not guaranteed in an afterlife, so there is tension about life and the certainty of death, of hope or despair. Unlike the more austere European approaches where the universe is seen as meaningless when faced with the certainty of the end of existence, American existentialists have focused more on human potential and the quest for personal meaning. Values clarification is an outgrowth of this movement. Following the bleak period of World War II, the French philosopher, Jean Paul Sartre, suggested that for youth, the existential moment arises when young person realize for the first time that choice is theirs, that they are responsible for themselves. Their question becomes "Who am I and what should I do? Related to education, the subject matter of existentialist classrooms should be a matter of personal choice. Teachers view the individual as an entity within a social context in which the learner must confront others' views to clarify his or her own. Character development emphasizes individual responsibility for decisions. Real answers come from within the individual, not from outside authority. Examining life through authentic thinking involves students in genuine learning experiences. Existentialists are opposed to thinking about students as objects to be measured, tracked, or standardized. Such educators want the educational experience to focus on creating opportunities for self-direction and self-actualization. They start with the student, rather than on curriculum content [19].

2.2 Teaching and Learning

Learning is the act of acquiring new, or modifying and reinforcing existing, knowledge, behaviors, skills, values, or preferences and may involve synthesizing different types of information. The ability to learn is possessed by humans. Progress over time tends to follow a learning curve. It does not happen all at once, but builds upon and is shaped by previous knowledge. To that end, learning may be viewed as a process, rather than a collection of factual and procedural knowledge [1,33].

A teaching method comprises the principles and methods used for instruction to be implemented by teachers to achieve the desired learning or memorization by students. These strategies are determined partly on subject matter to be taught and partly by the nature of the learner. For a particular teaching method to be appropriate and efficient it has to be in relation with the characteristic of the learner and the type of learning it is supposed to bring about [33].

The design and selection of teaching methods must take into account not only the nature of the subject matter but also how students learn [1,33]. In today's school the trend is that it encourages a lot of creativity. It is a known fact that human advancement comes through reasoning. This reasoning and original thought enhances creativity [4]. Scholarly interest in creativity involves many definitions and concepts pertaining to a number of disciplines: psychology, cognitive science, education, philosophy (particularly philosophy of science), technology, sociology, linguistics, business studies, songwriting, and economics, covering the relations between creativity and general intelligence, mental and

neurological processes, personality type and creative ability, creativity and mental health; the potential for fostering creativity through education and training, especially as augmented by technology; and the application of creative resources to improve the effectiveness of teaching and learning [22].

The approaches for teaching can be broadly classified into teacher centered and student centered. In Teacher Centered Approach to Learning, teachers are the main authority figure in this model. Students are viewed as “empty vessels” whose primary role is to passively receive information (via lectures and direct instruction) with an end goal of testing and assessment. It is the primary role of teachers to pass knowledge and information onto their students. In this model, teaching and assessment are viewed as two separate entities. Student learning is measured through objectively scored tests and assessments. In Student-Centered Approach to Learning, while teachers are an authority figure in this model, teachers and students play an equally active role in the learning process. The teacher’s primary role is to coach and facilitate student learning and overall comprehension of material. Student learning is measured through both formal and informal forms of assessment, including group projects, student portfolios, and class participation. Teaching and assessments are connected; student learning is continuously measured during teacher instruction. Commonly used teaching methods may include class participation, demonstration, recitation, memorization, or combinations of these. Newer teaching methods may incorporate television, radio, internet, multimedia and other modern devices. Some educators believe that the use of technology, while facilitating learning to some degree, is not a substitute for educational methods that encourage critical thinking and a desire to learn. Inquiry learning is another modern teaching method. A popular teaching method that is being used by a vast majority of teachers is hands on activities. Hands-on activities are activities that require movement, talking, and listening, it activates multiple areas of the brain [3,5].

2.3 Educational Philosophies

Within the epistemological frame that focuses on the nature of knowledge and how we come to know, there are four major educational philosophies, each related to one or more of the general or world philosophies just discussed. These educational philosophical approaches are currently used in classrooms the world over. They are Perennialism, Essentialism, Progressivism, and Reconstructionism. These educational philosophies focus heavily on what we should teach, the curriculum aspect [19,32].

For Perennialists, the aim of education is to ensure that students acquire understandings about the great ideas of Western civilization. These ideas have the potential for solving problems in any era. The focus is to teach ideas that are everlasting, to seek enduring truths which are constant, not changing, as the natural and human worlds at their most essential level, do not change. Teaching these unchanging principles is critical. Humans are rational beings, and their minds need to be developed. Thus, cultivation of the intellect is the highest priority in a worthwhile education. The demanding curriculum focuses on attaining cultural literacy, stressing students' growth in enduring disciplines. The loftiest accomplishments of human kind are emphasized– the great works of literature and art, the laws or principles of science. Advocates of this educational philosophy are Robert Maynard Hutchins who developed a Great Books program in 1963 and Mortimer Adler, who further developed this curriculum based on 100 great books of western civilization [19].

Essentialists believe that there is a common core of knowledge that needs to be transmitted to students in a systematic, disciplined way. The emphasis in this conservative perspective is on intellectual and moral standards that schools should teach. The core of the curriculum is essential knowledge and skills and academic rigor. Although this educational philosophy is similar in some ways to Perennialism, Essentialists accept the idea that this core curriculum may change [19].

Schooling should be practical, preparing students to become valuable members of society. It should focus on facts the objective reality out there and "the basics," training students to read, write, speak, and compute clearly and logically. Schools should not try to set or influence policies. Students should be taught hard work, respect for authority, and discipline. Teachers are to help students keep their non-productive instincts in check, such as aggression or mindlessness. This approach was in reaction to progressivist approaches prevalent in the 1920s and 30s. William Bagley, took progressivist approaches to task in the journal he formed in 1934. Other proponents of Essentialism are: James D. Koerner in 1959, H. G. Rickover in 1959, Paul Copperman in 1978, and TheodoreSizer in 1985 [19].

Progressivists believe that education should focus on the whole child, rather than on the content or the teacher. This educational philosophy stresses that students should test ideas by active experimentation. Learning is rooted in the questions of learners that arise through experiencing the world. It is active, not passive. The learner is a problem solver and thinker who makes meaning through his or her individual experience in the physical and cultural context. Effective teachers provide experiences so that students can learn by doing. Curriculum content is derived from student interests and questions. The scientific method is used by progressivist educators so that students can study matter and events systematically and first hand. The emphasis is on process-how one comes to know. The Progressive education philosophy was established in America from the mid1920s through the mid1950s. John Dewey was its foremost proponent. One of his tenets was that the school should improve the way of life of our citizens through experiencing freedom and democracy in schools. Shared decision making, planning of teachers with students, student-selected topics are all aspects. Books are tools, rather than authority [19].

Social reconstructionism is a philosophy that emphasizes the addressing of social questions and a quest to create a better society and worldwide democracy. Reconstructionist educators focus on a curriculum that highlights social reform as the aim of education. Theodore Brameld (1904-1987) was the founder of social reconstructionism, in reaction against the realities of World War II. He recognized the potential for either human annihilation through technology and human cruelty or the capacity to create a beneficent society using technology and human compassion. George Counts (1889-1974) recognized that education was the means of preparing people for creating this new social order. Critical theorists, like social reconstructionists, believe that systems must be changed to overcome oppression and improve human conditions. Paulo Freire (1921-1997) was a Brazilian whose experiences living in poverty led him to champion education and literacy as the vehicle for social change. In his view, humans must learn to resist oppression and not become its victims, nor oppress others. To do so requires dialog and critical consciousness, the development of awareness to overcome domination and oppression. Rather than "teaching as banking," in which the educator deposits information into students' heads, Freire saw teaching and learning as a process of inquiry in which the child must invent and reinvent the world. For social reconstructionists and critical theorists, curriculum focuses on student experience and taking social action on real problems, such as violence, hunger, international terrorism, inflation, and inequality. Strategies for dealing with controversial issues (particularly in social studies and literature), inquiry, dialogue, and multiple perspectives are the focus. Community-based learning and bringing the world into the classroom are also strategies [19,32].

Related to both the metaphysical world view philosophies and the educational philosophies are theories of learning that focus on how learning occurs, the psychological orientations. They provide structures for the instructional aspects of teaching, suggesting methods that are related to their perspective on learning. These theoretical beliefs about learning are also at the epistemic level of philosophy, as they are concerned with the nature of learning. Each psychological orientation is most directly related to a particular educational philosophy, but may have other influences as well. The first two theoretical approaches can be thought of as transmissive, in that information is given to learners. The second two approaches are constructivist, in that the learner has to make meaning from experiences in the world [19].

Information Processing theorists focus on the mind and how it works to explain how learning occurs. The focus is on the processing of a relatively fixed body of knowledge and how it is attended to, received in the mind, processed, stored, and retrieved from memory. This model is derived from analogies between how the brain works and computer processing. Information processing theorists focus on the individual rather than the social aspects of thinking and learning. The mind is a symbolic processor that stores information in schemas or hierarchically arranged structures [19].

Knowledge may be general, applicable to many situations; for example, knowing how to type or spell. Other knowledge is domain specific, applicable to a specific subject or task, such as vowel sounds in Spanish. Knowledge is also *declarative* (content, or knowing *that*; for example, schools have students, teachers, and administrators), *procedural* (knowing *how* to do things the steps or strategies; for example, to multiply mixed number, change both sides to improper fractions, then multiply numerators and denominators), or *conditional* (knowing *when* and *why* to apply the other two types of knowledge; for example, when taking a standardized multiple choice test, keep track of time, be strategic, and don't get bogged down on hard problems) [19].

The intake and representation of information is called encoding. It is sent to the short term or working memory, acted upon, and those pieces determined as important are sent to long term memory storage, where they must be retrieved and sent back to the working or short-term memory for use. Short term memory has very limited capacity, so it must be kept active to be retained. Long term memory is organized in structures, called schemas, scripts, or propositional or hierarchical networks. Something learned can be retrieved by relating it to other aspects, procedures, or episodes. There are many strategies that can help in both getting information into long term memory and retrieving it from memory. The teacher's job is to help students to develop strategies for thinking and remembering [19].

Behaviorist theorists believe that behavior is shaped deliberately by forces in the environment and that the type of person and actions desired can be the product of design. In other words, behavior is determined by others, rather than by our own free will. By carefully shaping desirable behavior, morality and information is learned. Learners will acquire and remember responses that lead to satisfying aftereffects. Repetition of a meaningful connection results in learning. If the student is ready for the connection, learning is enhanced; if not, learning is inhibited. Motivation to learn is the satisfying aftereffect, or reinforcement. Behaviorism is linked with empiricism, which stresses scientific information and observation, rather than subjective or metaphysical realities. Behaviorists search for laws that govern human behavior, like scientists who look for patterns in empirical events. Change in behavior must be observable; internal thought processes are not considered [19].

Ivan Pavlov's research on using the reinforcement of a bell sound when food was presented to a dog and finding the sound alone would make a dog salivate after several presentations of the conditioned stimulus, was the beginning of behaviorist approaches. Learning occurs as a result of responses to stimuli in the environment that are reinforced by adults and others, as well as from feedback from actions on objects. The teacher can help students learn by conditioning them through identifying the desired behaviors in measurable, observable terms, recording these behaviors and their frequencies, identifying appropriate reinforcers for each desired behavior, and providing the reinforcer as soon as the student displays the behavior. For example, if children are supposed to raise hands to get called on, we might reinforce a child who raises his hand by using praise, "Thank you for raising your hand." Other influential behaviorists include B.F. Skinner (1904-1990) and James B. Watson (1878-1958) [19].

Cognitivists or Constructivists believe that the learner actively constructs his or her own understandings of reality through interaction with objects, events, and people in the environment, and reflecting on these interactions. Early perceptual psychologists (Gestalt psychology) focused on the making of wholes from bits and pieces of objects and events in the world, believing that meaning was the construction in the brain of patterns from these pieces [19].

For learning to occur, an event, object, or experience must conflict with what the learner already knows. Therefore, the learner's previous experiences determine what can be learned. Motivation to learn is experiencing conflict with what one knows, which causes an imbalance, which triggers a quest to restore the equilibrium. Piaget described intelligent behavior as adaptation. The learner organizes his or her understanding in organized structures. At the simplest level, these are called schemes. When something new is presented, the learner must modify these structures in order to deal with the new information. This process, called equilibration, is the balancing between what is assimilated (the new) and accommodation, the change in structure. The child goes through four distinct stages or levels in his or her understandings of the world. Some constructivists (particularly Vygotsky) emphasize the shared, social construction of knowledge, believing that the particular social and cultural context and the interactions of novices with more expert thinkers (usually adult) facilitate or scaffold the learning process. The teacher mediates between the new material to be learned and the learner's level of readiness, supporting the child's growth through his or her "zone of proximal development." [19].

The roots of humanism are found in the thinking of Erasmus (1466-1536), who attacked the religious teaching and thought prevalent in his time to focus on free inquiry and rediscovery of the classical roots from Greece and Rome. Erasmus believed in the essential goodness of children, that humans have free will, moral conscience, the ability to reason, aesthetic sensibility, and religious instinct. He advocated that the young should be treated kindly and that learning should not be forced or rushed, as it proceeds in stages. Humanism was developed as an educational philosophy by Rousseau (1712-1778) and Pestalozzi, who emphasized nature and the basic goodness of humans, understanding through the senses, and education as a gradual and unhurried process in which the development of human character follows the unfolding of nature. Humanists believe that the learner

should be in control of his or her own destiny. Since the learner should become a fully autonomous person, personal freedom, choice, and responsibility are the focus. The learner is self-motivated to achieve towards the highest level possible. Motivation to learn is intrinsic in humanism. Recent applications of humanist philosophy focus on the social and emotional well-being of the child, as well as the cognitive. Development of a healthy self-concept, awareness of the psychological needs, helping students to strive to be all that they can are important concepts, espoused in theories of Abraham Maslow, Carl Rogers, and Alfred Adler that are found in classrooms today. Teachers emphasize freedom from threat, emotional well-being, learning processes, and self-fulfillment [19].

Conclusion based the review of literature above is “our educational philosophy is our belief about why, what and how we teach, whom we teach, and about the nature of learning”. It is a set of principles that guides professional action through the events and issues teachers face daily. Sources for our educational philosophy are our life experiences, our values, the environment in which we live, interactions with others and awareness of philosophical approaches. Learning about the branches of philosophy, philosophical world views, and different educational philosophies and theories will help us to determine and shape our own educational philosophy, combined with these other aspects.

2.4 Chemistry and Philosophical Perspectives in Chemical Education

Chemistry (chemical) education is a comprehensive term that refers to the study of the teaching and learning of chemistry in all schools, colleges and universities. The relationship between chemical education and the history and philosophy of science has a long history [28]. A new edition of *Introduction to Concepts and Theories in Physical Science* has presented science as a human adventure, from Copernicus to Einstein and beyond [16]. This book provided a glimpse for students and teachers as to how science evolves through the interactions of theories, experiments, and the work of actual scientists within a history and philosophy of science perspective [6,26,27,18]. According to [9], *Science & Education* was one of first journals to dedicate space to the work of educators preoccupied with the synthesis of perspectives from philosophy of chemistry in chemical education. This special edition is testament to the journal’s vision in pushing boundaries for innovative scholarship, and it illustrates the small but growing interest of philosophers, educators and chemists alike in “capitalizing” on the philosophical aspects of chemistry for the improvement of chemical education. The volume consists of papers that deal with a range of issues raised in philosophy of chemistry in application to chemical education. One set of papers focus on the nature of chemical knowledge, particularly in relation to models, explanations and laws. Andrea Woody uses the ideal gas law as an example in reviewing contemporary research in philosophy of science concerning scientific explanation. She clarifies the inferential, causal, unification, and erotetic conceptions of explanation. Chemical laws is the primary focus of Emma Tobin’s work. She provides an overview of the laws in chemistry, and reflects on the recent debates on the particular and universal nature of laws, concluding that while generalisations in chemistry are diverse and heterogeneous, a distinction between idealizations and approximations can nevertheless be used to successfully taxonomise them. Agustin Aduriz-Bravo challenges the received, syntactic conception of scientific theories and argues for a model-based account of the nature of science. The significance of models and modeling in chemistry is further highlighted by Jose A. Chamizo who presents a typology of models and their relation to modeling. Merce Izquierdo-Aymerich argues for the generation of chemical criteria from the history and philosophy of chemistry for informing the design of chemistry curriculum.

Furthermore, according to [9], a second set of papers focus on particular epistemological themes that have generated a great deal of debate in philosophy of chemistry in recent years. The authors extend these debates to the curricular, textbook and teaching contexts, and in so doing, elaborate on their potential instantiation in education. Micah Newman targets emergence and supervenience, key concepts related to the micro–macro relationships in chemistry. He provides a model for teaching chemistry with the potential to enhance fundamental understanding of chemistry. Pierre Lazslo argues that chemistry ought to be taught in like manner to a language, on the dual evidence of the existence of an iconic chemical language, of formulas and equations; and of chemical science being language like and a combinatorial art. Universality and specificity of chemistry are interrogated by Mariam Thalos who argues that chemistry possesses a distinctive theoretical lens a distinctive set of theoretical concerns regarding the dynamics and transformations of a variety of organic and nonorganic substances. While she agrees that chemical facts bear a reductive relationship to physical facts, she argues that theoretical lenses of physics and chemistry are distinct. Manuel Fernandez-Gonzalez

discusses the concept of pure substance, an idealized entity whose empirical correlate is the laboratory product. A common structure for knowledge construction is proposed for both physics and chemistry with particular emphasis on the relations between two of the levels: the ideal level and the quasi-ideal level. Ebru Kaya and Sibel Erduran focus on concept duality, chemical language and structural explanations, to illustrate how chemistry textbooks could be improved with insights from philosophy of chemistry. They provide some example scenarios of how these ideas could be implemented at the level of the chemistry classroom. Vicente Talanquer presents a case that dominant universal characterizations of the nature of science fails to capture the essence of the particular disciplines. The central goal of this position paper is to encourage reflection about the extent to which dominant views about quality science education based on universal views of scientific practices may constrain school chemistry. Activities, practices and values of chemistry are interrogated in a third set of papers. Earley recommends that chemistry educators shift to a different 'idea of nature', an alternative 'worldview.' Andoni Garritz illustrates how teaching history and philosophy of physical sciences can illustrate that controversies and rivalries among scientists play a key role in the progress of science and why scientific development is not only founded on the accumulation of experimental data. The case of quantum mechanics and quantum chemistry is used as an example because it is historically full of controversies. Marcos Antonio Pinto Ribeiro and Duarte Costa Pereira illustrate how pluralism in philosophical perspectives can result in different cognitive, learning and teaching styles in chemical education. Their paper reports on the authors' experiences in Portugal in drafting structural ideas and planning for the subject "didactic of chemistry" based on the philosophy of chemistry. Veli-Matti Vesterinen, Maija Aksela and Jari Lavonen assess how the different aspects of nature of science were represented in Finnish and Swedish upper secondary school chemistry textbooks. They present an empirical study where dimensions of nature of science were analyzed from five popular chemistry textbook series. Joseph Amparo Vilches and Daniel Gil-Perez reflect on the Decade of Education for Sustainable Development and how chemical education for sustainability remains practically absent nowadays in many high school and university chemistry curricula all over the world. They explore the belief that genuine scientific activity lies beyond the reach of moral judgment is logically. They propose possible contributions of chemistry and chemical education to the construction of a sustainable future. Jesper Sjoström is concerned with Bildung-oriented chemistry education, based on a reflective and critical discourse of chemistry. This orientation is contrasted with the dominant type of chemistry education, based on the mainstream discourse of chemistry. Bildung-oriented chemistry education includes not only content knowledge in chemistry, but also knowledge about chemistry, both about the nature of chemistry and about its role in society [10].

Over all the set of papers illustrate the relevance of philosophy of chemistry for chemical education. We witness examples of relevance in the curriculum, textbooks, teaching and learning. The scholarship in the area is ripe for further studies. The fundamental questions such as "What is chemical knowledge and how does it develop? What criteria, standards and heuristics shape its development?" are directly relevant for ensuring that teaching and learning environments are effectively structured and resourced for sound and deep understanding of chemistry. While theoretical investigations can help orient the design of curriculum content informed by significant philosophical issues in chemistry, the genuine implementation of such curricula will demand more than rhetoric. Teachers' role in the implementation of meta-perspectives on chemistry is crucial. In this sense, a great responsibility rests on teacher educators in developing teachers' understanding of the nature of chemistry. At this juncture science educators are faced with the following scenario: from empiricism to historicism, we learned many things and it is time to move on and embrace naturalism. If we accept this, then there would be immediate consequences for the status and the extent to which historical aspects of science content would continue to play an important role in our classrooms [10,17].

Chemistry and Chemical Education are as a Bridge to Peace. According to [20], It can be important tools to advance the peace process, for example in the Middle East. The Middle East is a region in conflict for many years. This part of the world is of particular importance because it has a source of energy that is a strategic resource: fossil fuel. This nonrenewable source of energy not only fuels economic and political conflicts, but its worldwide use also places at risk the sustainability of life on Planet Earth, by polluting the environment and contributing to climate change. The Middle East also has major problems of air and water quality, which will require regional cooperation to solve. Geopolitical borders are only lines on a map; air and water do not recognize these lines. Therefore, any work concerning the environment - especially air and water quality - must be done in collaboration

between nations. Chemistry is an international language. A chemist from Bethlehem, Pennsylvania in the USA, and a chemist from Bethlehem, Palestine, use the same chemical notations, and can communicate scientifically to one another without understanding each other's spoken language. Building on the international language of chemistry, three major international conferences called the "Malta Conferences" and formally titled "Frontiers of Chemical Science: Research and Education in the Middle East" were held in 2003 [14,18,20,23], in 2005 [20,21,24,29], and in 2007 [12,13,20]. In these conferences, chemists from 14 Middle East nations gathered to discuss solutions to the problems of air and water quality, energy resources, and chemical education in the Middle East. These collaborations between the chemists have yielded results that are a cornerstone for a bridge to peace.

3. CONCLUSIONS

1. Chemistry (chemical) education is a comprehensive term that refers to the study of the teaching and learning of chemistry in all schools, colleges and universities.
2. Our educational philosophy is our belief about "why, what and how we teach, whom we teach, and about the nature of learning". It is a set of principles that guides professional action through the events and issues teachers face daily. Sources for our educational philosophy are our life experiences, our values, the environment in which we live, interactions with others and awareness of philosophical approaches. Learning about the branches of philosophy, philosophical world views, and different educational philosophies and theories will help us to determine and shape our own educational philosophy, combined with these other aspects.
3. Chemistry and Chemical Education are as a Bridge to Peace. It can be important tools to advance the peace process.
4. There are at least two different philosophical perspectives that describe how the work in chemistry education is carried out. The first is what one might call a practitioner's perspective, where in the individuals who are responsible for teaching chemistry (teachers, instructors, professors) are the ones who ultimately define chemistry education by their actions. A second perspective is defined by a self-identified group of chemical educators and instructors who as opposed to declaring their primary interest in a typical area of laboratory research, take on an interest in contributing suggestions, essays, observations, and other descriptive reports of practice into the public domain, through journal publications, books, and presentations.

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