ISBN: 978-93-90847-60-0

10. Impact of ICT tools in Chemistry Education

Prof. Dilip Kumar Choudhary

Professor,
Department of Chemistry,
C. M. Science College, Darbhanga.

Abstract:

The use of ICT can improve both the learner's and the facilitator's capacity for learning. Several areas in chemistry require computational techniques to master. The application of ICT in some chemistry-related topics is the topic of this article. In order to grasp the many concepts, such as stereochemistry, IUPAC nomenclature, and other organic chemistry topics, we attempted to get past the traditional chalk and talk method. This study examines how students' academic achievement is affected by teachers who use both traditional methods and ICT tools. It also looks at how students feel about the subject of chemistry, how they feel about using ICT tools to teach and learn the subject, and how ICT tools affect students' written communication skills. In this study, ICT tools refer to the use of digital devices for all facets of instruction and learning. Video tapes, audio tapes, CDs, DVDs, television broadcasts, video cassettes, computer-based learning materials, teleconferencing, video conferencing, the internet, web conferencing, etc. would therefore be the components of ICT. We will talk about in this essay. ICT tools' effects on chemistry education.

Keywords:

Education, Chemistry, Computational Technique, Skills, Digital Equipment, E-Learning, Molecular Structures, Information and Communication Technologies, Animation, Videos, Stereochemistry

10.1 Introduction:

The foundation of all other scientific fields is thought to be chemistry. It is a creative science that is necessary for enhancing our way of life and sustainability. The goal is to describe the goals and associated ICT activities, such m- and e-learning, which enhance education.

To help students understand and for their own benefit, chemistry professors must be well aware of the ways in which ICT is employed as a teaching and learning tool. Using ICT to help students visualize spatial three-dimensional (3D) elemental and molecular structures is one of the opportunities for teaching and learning chemistry. It also enables collaborative, synchronous and asynchronous interactions between students and teachers. ICT is regarded as a reliable source of theoretical knowledge and scientific data, and it provides a workable way to assist real-world chemistry learning.

In order to enhance students' comprehension of chemistry concepts and theories in a variety of contexts, the breadth of knowledge available on the Web and in other ICT-based cognitive tools, together with virtual labs and simulations, should be included into chemistry education nationwide. [1]

ICT can answer issues from everyday life in the classroom that were previously unsolvable in a traditional classroom setting. Students have more options for research, interaction, cooperation, and collaboration thanks to the adaptability of ICT and the internet in particular.

Thanks to the placement of interactive educational resources that boost student motivation and facilitate the acquisition of basic skills, ICT improves education. For students of all ages, using various multimedia resources including TV, records, films, and computer programs creates a more engaging and demanding atmosphere for learning.

We will be greatly impacted by the recent and rapid improvements in ICT, especially on the Internet. It is nearly difficult to envision information and communication technology (ICT) at the close of the 20th century, let alone as we begin the 21st.

We are already beginning to see how these developments are transforming our perceptions of just-in-time learning, remote learning, traditional schooling, and the value of lifelong learning. The amount of knowledge available to our students as they study for their classes and enter the workforce will greatly rise thanks to advances in ICT, but this shouldn't be the upper bound on what we expect.

We need to think beyond just imparting facts and information to our pupils if we want to give them a top-notch education. We need to consider the findings of educational research, which indicate that students learn best when they build on prior knowledge and engage in active learning while comprehending and utilizing a metacognitive approach. [2]

Idea of ICT Information and communication technologies are defined for the purposes of this study as any digital tools, resources, information, and devices that can be used to achieve the objectives of teaching and learning as well as system administration.

The application of digital devices to all facets of teaching and learning might be interpreted as the study's use of ICT tools. Consequently, the following would be considered ICT components: computer-based learning materials, teleconferencing, video conferencing, the internet, web conferencing, audio and video tapes, CDs, DVDs, television broadcasts, and video cassettes. The following ICT tools were employed in this study:

- Internet
- Power point Presentations
- MS word
- MS Paint
- CD ROM

ICT has a broad and evolving potential application in science education. This is shown by the possibility that different ICT technologies offer to supply an enormous array of excellent resources that are pertinent to science education.

A large body of research suggests that when learning is assisted by ICT, students are more highly motivated, and ICT also gives teachers the chance to be innovative in their approach to teaching. [3]

10.2 Review of Literature:

A key component of the Indian government's emphasis on ICT-enabled teaching and learning is the use of virtual labs, which offer lab experiences in online learning environments to individuals unable to perform their lab experiments in person.

In addition, the government has implemented many measures to enhance the quality and efficacy of education, such as the e-PG Pathshala platform, which includes multimedia self-learning modules that provide students with access to valuable and high-quality resources (Osborne, 2003). [4]

Presenting different kinds of courses is now possible for teachers thanks to the development of interactive technology and other free web-based applications. Computers have shown to be the most effective tools for fostering students' curiosity and bolstering science education as information technologies have advanced.

Computerized modeling and animations are used in science education to describe, clarify, and forecast scientific processes. The ability to reason, explain, and engage in higher level thinking are critical for learning science, and these transitions may foster these abilities (Barak, 2009). [5]

10.3 Objectives:

- To examine the extent of ICT tool utilization in supplementing chemistry learning among students.
- To assess the frequency and patterns of ICT tool usage in accessing resources and information for chemistry studies.
- To explore the engagement and collaboration facilitated by ICT tools in chemistry education.
- To evaluate the perceived effectiveness of ICT tools in aiding comprehension and understanding of chemistry concepts

10.4 Research Methodology:

The overall design of this study was exploratory. The research paper is an effort that is based on secondary data that was gathered from credible publications, the internet, articles, textbooks, and newspapers. The study's research design is primarily descriptive in nature.

10.5 Result and Discussion:

Elucidation of chemistry with the help of Information and communications technology:

The idea that chemistry is a challenging subject in part due to the fact that a single piece of information can be viewed from multiple perspectives at once is one of the main guiding concepts in research on chemistry education. There are three levels of information analysis in chemistry: macroscopic (visible), submicroscopic (invisible), and symbolic (structural formula).

The term "three levels of chemistry" is commonly used to refer to these three stages. It is relatively simple for an expert (a chemist, a teacher) to think of the visible world in terms of structural formulas and dynamic processes occurring at the microscopic level, but modeling is challenging for a beginner (a student, a pupil).

We therefore require methods for concretizing the links between various levels of information and for visualizing it. ICT provides the required visual aids for this task. Animations, simulations, videos, and molecular modeling in chemistry are the most often utilized tools for visualizing various levels. [6]

An animation is a collection of images that can be used to produce moving images. Animations are a great tool for explaining chemistry phenomena and processes. In terms of pedagogy, they are a flexible kind of media. In addition to having students produce their own animation, teachers can also utilize animation to communicate information.

Like animation, videos are digital files, but they are not the same when it comes to the chemical information they contain. While the macroscopic level of phenomena can be presented on the movies, the microscopic level of phenomena is investigated in chemistry animation.

Video processing allows for the editing of video recordings, which in turn links macro-level videos and micro-level animations. Multiple movies and animations can be studied simultaneously in a single video presentation by connecting video documents in a leveled manner.

While simulations can handle bigger systems, molecular modeling is limited to the modeling of single molecules or small static systems. Molecular modeling differs from simulations in that simulations study dynamic processes.

In molecular modeling, the user takes an active part and is given the freedom to construct, compute, and visualize the system anyway they see fit thanks to the software. Users' rights are restricted considerably in simulations. Since the simulation is dependent on data that has been generated in advance, the user frequently does not execute the calculation. The essay has up to this point discussed how various ICT tools can be used to visualize the three levels of chemistry.

We then need to consider how ICT may be used to concretize links between various levels. For example, concept maps work well in this type of task (Novak & Cañas, 2008). Using a linking word to illustrate how concepts relate to one another, a concept map is a method for outlining information.

Although idea maps can be created by hand, it is simple to add other types of information to electrical concept maps, such as links to other documents and pictures, sounds, videos, and animations. A straightforward concept map on isomerism is shown in the accompanying image (Figure 10.1), which provides an example of each isomerism category on a submicroscopic level.

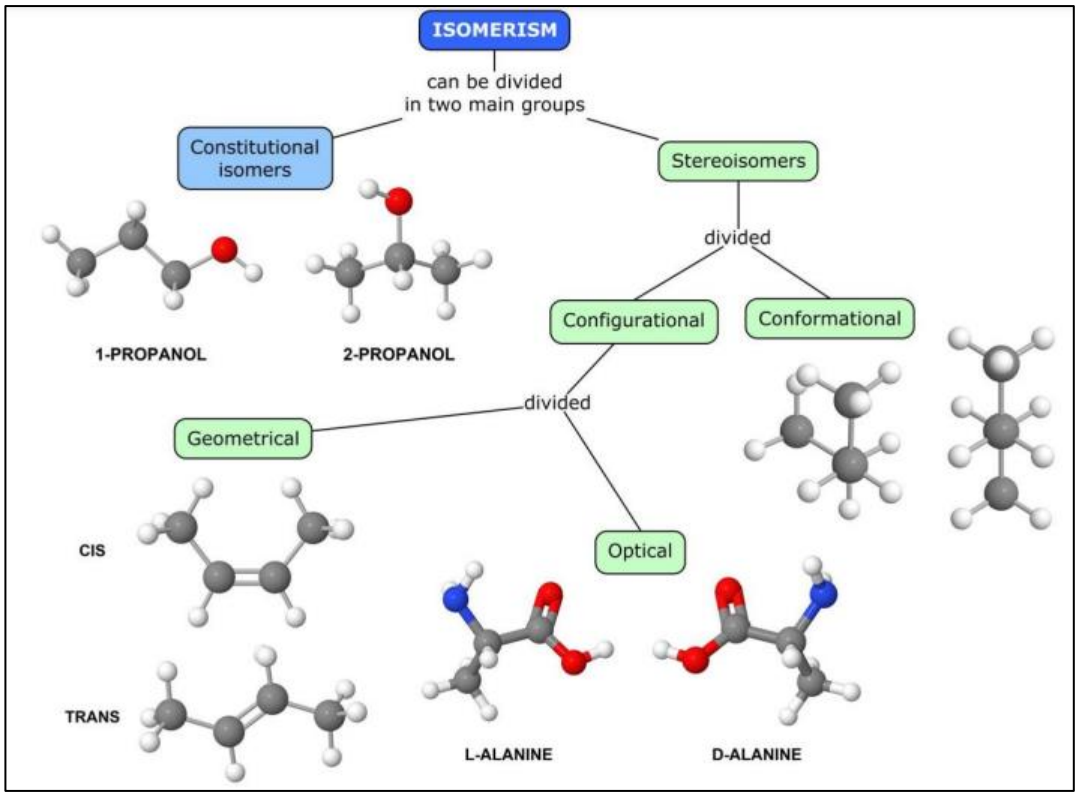

Figure 10.1: A simple concept map of isomerism. This map has been made with the CmapTools software.

Concept maps are designed to be cognitive aids. Constructing idea maps makes it easier for students to present, critique, and expand on their understanding of a subject by visualizing their knowledge structure. Additionally, creating concept maps engages a variety of higher order cognitive abilities.

ICT in Chemistry ICT in chemistry education has the potential to improve the quality of chemistry education by offering answers to many of the issues that the field faces. As everyone knows, traditional classroom instruction essentially uses the talk-and-chalk approach.

Additionally, even while a teacher wants his students to have a thorough comprehension of the subject, there is pressure on them to complete the syllabus on time. [7]

There are so many topics which can be covered with the help of chemsketch.

1. Aromaticity
2. 3D structure optimization
3. Tautomeric forms
4. Auto renumbering
5. Calculation of Molar Refractivity, Surface tension, Parachor, Index of refraction, Density, Polarizability and dielectric constant.
6. IUPAC Nomenclature
7. Import and export of molecule
8. Conversion of 2D into 3D
9. Advance form of periodic table
10. Structure of Carbohydrate
11. Structure of Fullerene and other bigger molecule
12. Editing of molecule structure

Stereochemistry:

The study of chiral compounds is a key area of stereochemistry research. March of 1985 As "three dimensionality" is implied by the word "stereo-," stereochemistry is often referred to as 3D chemistry. Teaching stereochemistry using the chalk-and-talk approach is always an exhausting endeavor for teachers because it necessitates a lot of three-dimensional structures for molecules, which cannot be drawn on a black board. Several free sketching tools are accessible online that make it simple to draw three-dimensional objects and determine several additional types of information, such as bond angle, angle strain, chiral carbon, etc.

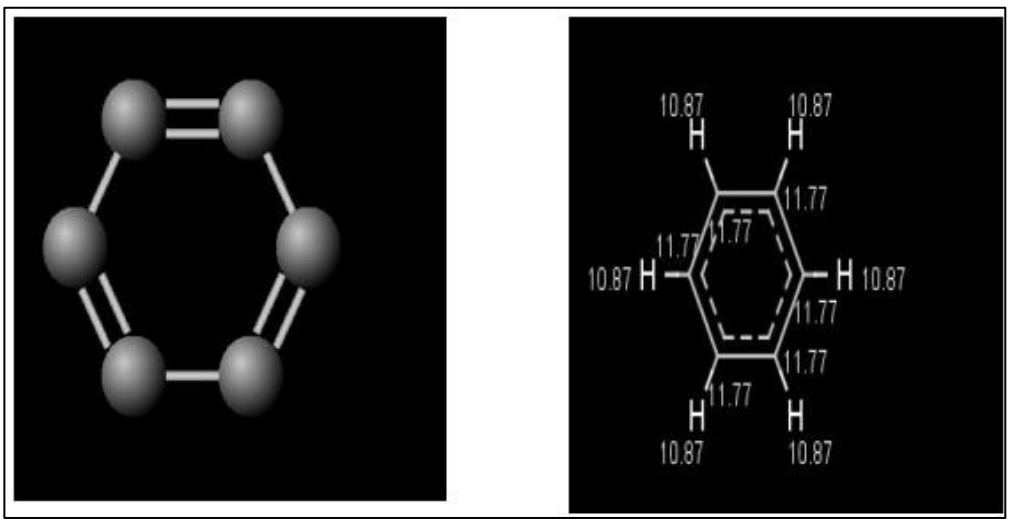

Figure 10.2: Stereochemistry of benzene [8]

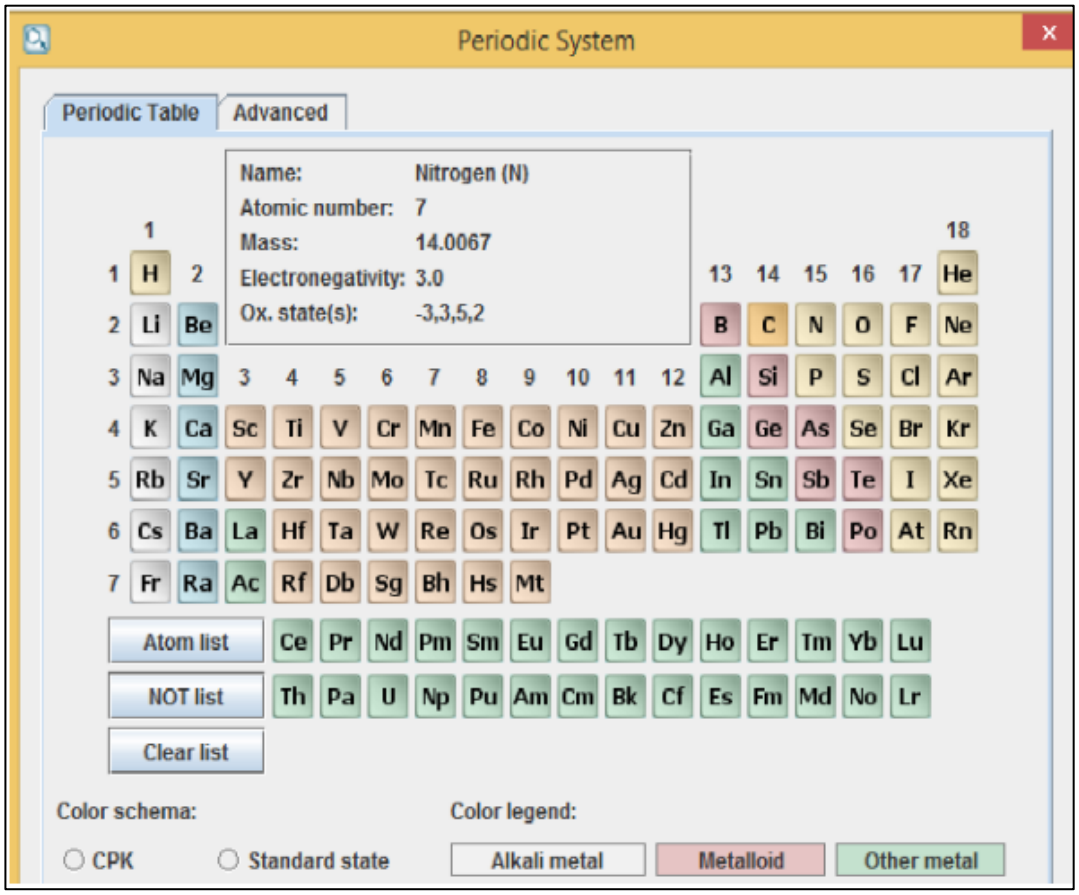

Figure 10.3: Snapshot of Periodic Table

Periodic Table

Every facet of chemistry makes use of the periodic table concept. Whether it is pharmaceutical, drug, or medical chemistry, or organic, inorganic, and physical chemistry. But remembering every property in the periodic table is a constant struggle. We can teach the periodic table more effectively with the use of this tool.

Every element from atomic number 1 (hydrogen) to 118 (ununnoctium) has been found or created; on December 30, 2015, the IUPAC certified the existence of elements 113, 115, 117, and 118 (Chemistry: Four elements added to periodic table". BBC News) The periodic table is set up in the form of a large grid. Because of its atomic structure, each element is positioned in a particular way.

The periodic table has rows (from left to right) and columns (from up and down), much like any other grid. Every column and row has distinct properties. For instance, whereas potassium (K) and calcium (Ca) from row four have different properties, beryllium (Be) and magnesium (Mg), which are found in column two, have some similarities.

IUPAC Naming:

The International Union of Pure and Applied Chemistry (IUPAC) recommended the nomenclature of organic chemical compounds in 1971 through The Commission on the Nomenclature of Organic Chemistry, which is a systematic approach to identifying organic chemical compounds in chemical nomenclature [9].

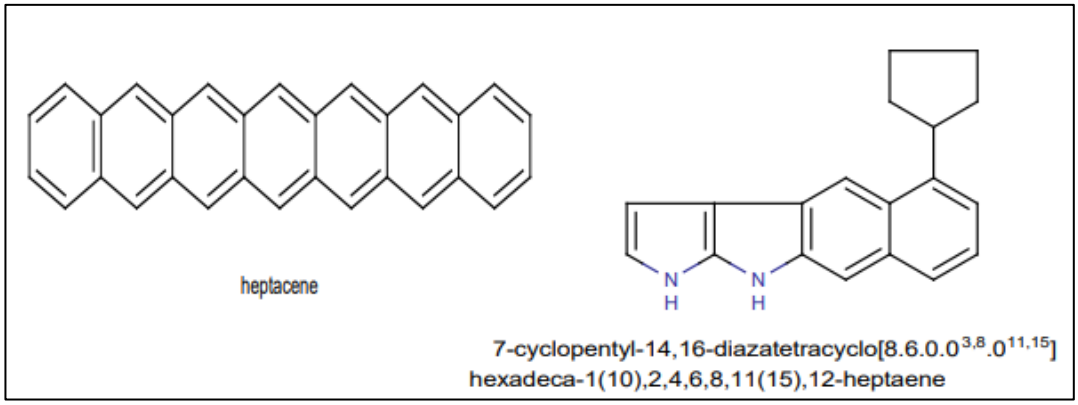

Figure 10.4: IUPAC Nomenclature

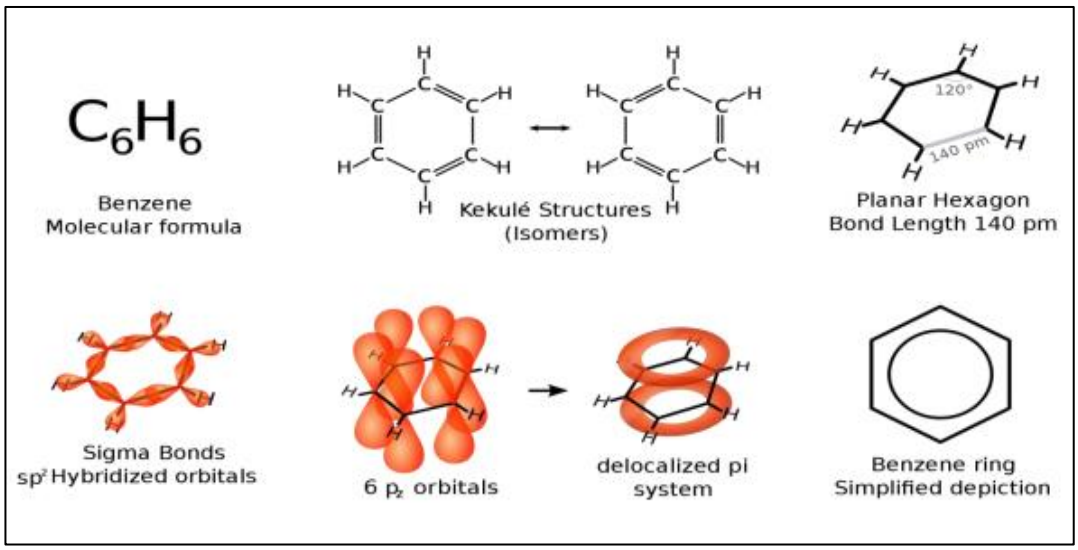

Figure 10.5: Various Possible Structure of Benzene

Various Chemist Software tools and programs for chemistry researchers and teachers are being designed with the aid of information technology. This section discusses a small number of them.

A. Chem Draw: This drawing tool is the most commonly used for research in chemistry. It is a part of the ChemOffice family and is available on Windows and Mac. With the

help of this tool, we may sketch chemical structures and see 3-D structures in addition to learning about the properties of chemicals. It provides precise IUPAC names for the chemical structures and creates accurate structures based on the chemical names.

B. Chem Doodle: This tool offers sophisticated mechanism sketching capabilities to illustrate bond arrow notation, a single electron, and two electrons. It is the only ICT tool for chemical drawings that can easily create chemical text and atomic notations through the use of subscript and superscript merge formatting in text.

C. Chem Sketch: This tool aids in the illustration of polymer, organometallic, and organic chemistry chemical structures. For example, it can calculate molar refractivity, density, and molecular weight. It is employed for both 2D and 3D structural viewing. This molecular editing tool is used to create and edit chemical structure images. ChemSketch is a readily understood chemical structure drawing tool with over 20 lakh users worldwide.

D. Chem Window: John Wiley & Sons publishes this chemical structure sketching molecule editor. It is utilized for bond length, angle, and other computations as well as 2D and 3D visualization of structures. Chemists utilize it to create accurate process flow diagrams.

E. Chem3D Pro: This part of the ChemOffice package is also available. It enables the analysis of molecular attributes, such as name and molecular weight, and the drawing of chemical structures as well as the visualization of 3D structures. Windows OS is used to execute it.

F. Marvinsketch: It is a desktop toolkit that may be used to import, export, publish, and draw molecular structures. Additionally, it allows conversion between several graphical and chemical file types. It is a molecular editor designed to enable research to be accessed on all platforms. It supports practically all common chemical file types and translates chemistry into a digital environment.

G. BK Chem: This Python-based sketching use for chemists is free. It can just establish each element's fundamental structure and relationship to its associated symbols. This cross-platform program allows you to sketch molecular structures and chemical compounds. It is used to create ready-to-use templates for molecular charts and graphs, bond by bond drawing. Chemical researchers can utilize BKChem to show complex diagrams with usefulness.

H. J Chem Paint: Chemistry Development Kit created this molecule editing tool for 2D chemical structures. It is open-source Java software that works with Windows, Mac OS, Linux, and UNIX. It can be used to import and export data in plain-text forms in addition to drawing chemical structures. J Chem paint makes it simple to draw and remove different types of chemical bonds. It can be downloaded for free. There are ring templates that range in size from three to eight atoms.

ICT Tools for Chemistry A wide range of chemical software is widely available and can be utilized as an ICT tool to help improve chemistry learning.

While some of them have economic value, others are freely available. You may use Chemsketch and Marvin Sketch to draw molecules. Along with the object, these tools offer a variety of other details. [10]

10.6 Conclusion:

In order to recruit and keep the greatest talent and support their professional development, the current paradigm for chemistry education in our nation needs to be changed at all levels. The teaching profession needs to be made more appealing in order to achieve this goal. In the form of fellowship and awards, educators and researchers alike ought to be appropriately acknowledged for their achievements. The goal is to present teachers' perspectives on ICT integration into the teaching-learning process and their experiences with it, as well as to identify any perceived barriers to such integration. It is imperative that the current paradigm of chemistry education in this nation be changed to attract and retain top talent while also fostering their professional growth at all educational levels. The teaching profession needs to be made more appealing in order to achieve this goal.

10.7 References:

1. Reid, S., 2002. The integration of ICT into classroom teaching. Alberta Journal of Educational Research, vol. 48, pp.30-46
2. Kukulska-Hulme, A., Traxler, J. (2005). Mobile learning: A handbook for educators and trainers, London: Routledge.
3. Dillenbourg, P. (1999). What do you mean by collaborative learning? In P. Dillenbourg (Ed.), Collaborative-learning: Cognitive and Computational Approaches. (pp.1-19). Oxford: Elsevier.
4. Osborne, J. F., & Hennessy, S. (2003). Literature review in science education and the role of ICT: Promise, problems and future directions. A NESTA Futurelab Research report – report 6. 2003.
5. Barak, M., Dori, Y.J. (2009). Enhancing higher order thinking skills among in-service science education teachers via embedded assessment. Journal of Science Teacher Education, 20 (5), pp. 459-474.
6. Ferdig, R. (2007). Editorial: Examining social software in Teacher education. Journal Of Technology and Teacher Education, 15(1), 5-10.
7. Trindade, J., et al., 2002. 'Science learning in virtual environments: a descriptive study.' British Journal of Educational Technolog,33(4), pp.471-488
8. Heeren, T., & D'Agostino, R. (1987). Robustness of the two independent samples t-test when applied to ordinal scaled data. Statistics in Medicine, 6 (1), 79–90.
9. Král, L., & Řezníčková, D. (2013). The proliferation and implementation of GIS as an educational tool at gymnasiums/grammar schools in Czechia. Geografie, 118 (3), 265-283.
10. Sadykov, T., Čtrnáctová, H. (2017). Současné interaktivní metody výuky chemie na úrovni ISED 2. Aktuálne problémy dizertačných prác v teórii prirodoveného vzdelávania. Trnava: Trnavská univerzita v Trnave, Pedagogická fakulta, 2017, pp. 53–60. ISBN 978-80-568- 0107-9.