

NEW HORIZONS OF MOBILE CHEMISTRY APPS USEFUL IN TEACHING LEARNING PROCESS

Useful mobile chemistry apps

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Abstract : Electronic devices such as Cellphones, Smartphones, Android, and Tabs are the valuable tools in teaching and learning process. The Android mobiles are the daily needs in the life of educations, teachers and students. In the academic spectrum of chemistry, Chemistry apps are powerful techniques used today in the teaching learning process. According to survey dating of 2017 use of chemistry apps in the teaching learning process helps both teachers and students to meet curriculum objectives and learning outcomes more meritoriously. The Mobile apps in smartphones enhance student learning in and out of classrooms and laboratory. The accessibility of Chemistry apps on smartphones and other portable electronic devices affords chemical experts and chemistry student's powerful and compact tools to solve problems.

Keywords : *m-learning, m-classrooms Technology, m-Chemistry Apps, m-learning, m-Effective teaching.*

I. INTRODUCTION

The incorporation of technology in our chemistry teaching is now ubiquitous but such is the amount of possibilities that it can be overwhelming for those new to the field to focus on areas of use to their teaching.¹⁻³ Mobile chemistry apps technology has the potential to assist us in our role as teachers for teaching learning process. One of such technology to study effective chemistry through smartphones mobile apps learning.⁴⁻¹¹ The chemistry "apps", on hand-held and portable touch-controlled computers such as smartphones and iPods are seeing dramatic growth with increasing adoption rates. In India 60 per cent of peoples use androids, iOS, Smartphones, tabs and other devices. The younger students are more likely to own androids. The potential of mobile learning to provide education flexibly, most balk at the cost of providing students with mobile hardware. The habit of 'bring your own device' (BYOD) is often mooted as a cost-effective alternative. The students were enthusiastically using mobile technologies such as androids, tablet computers and smartphones to support their learning.¹²⁻¹⁵ The Indian government also promote e-learning education like NPTEL, Swayam, Swayam Prabha and e-PG Pathshala. The goal of mobile chemistry Apps useful in Teaching Learning Process is to offer the project team with insights into how university students perceive mobile learning, the mobile technologies they own or access, the types of informal mobile learning they undertake and their mobile learning preferences. The teaching learning process on mobile chemistry apps mostly depends on 1) Student demographics, 2) Practice of mobile devices by students to support learning or study 3) Technological resources such as internet access, Wi-Fi facility 4) The accessibility and superiority of internet access, 5) Ownership and access to mobile devices 6) Teacher attitudes and beliefs 7) Knowledge and skills 8) Classroom management 9) Adapt technology and planning.

RESEARCH EXPERIMENTAL

All chemistry apps undergo support different operating system do you have on your smartphones.

1. Samsung
2. Redmi Mi
3. Apple iOS
4. Window Phone
5. Google android
6. Sony
7. Honers
8. Others

These are the some Smartphone and operating system used by student user, Desktop and Tablets computers at different college and university. The access chemistry apps in Androids, smartphone and tablets used in large group of students. One of the simplest and most effective ways of incorporating technology into our teaching is to create podcasts and screencasts. A podcast (audio only) and screencast (audio with video or screen capture) allows students to recover material in their own time at their own pace. There are some useful resources for how these can be created in a chemistry context.

RESULT AND DISCUSSION

Chemistry is a complex topic involving a lot of terminology, different vocabulary and difficult to visualize molecule and dynamic of chemical bondings. The chemistry teacher recognize these difficulties and use various techniques to enhance the students. One such techniques use of mobile chemistry apps into teaching classrooms, laboratory practical and curriculum. Smartphones can aid as effective and suitable informative tools, with actually inspires learning. The Android Smartphones provide a crowd of applications

that can be downloaded directly onto the cell phone. These mobile applications, or “apps”, have an extensive array of functionalities and cover several disciplines. We have tested and use many of chemistry apps discussed here to give the students an objective outlook on the performance of each.

Utilization of mobile chemistry apps in teaching and learning chemistry

1.1 3D Chemistry Apps

The 3D viewer apps can be a beneficial device in the chemistry classroom. The 3D VSEPR app helps you to visualize the shapes of the VSEPR models in 3D such that you can understand more and you can sort out your confusions. This education app help the students to learn chemistry in a smarter way. Students can see the every parts of models by swiping their fingers to screen. This apps provide information of Orbital, Shape of orbitals, Atom, orbitals of all atoms, S Orbital, P Orbital, D Orbital, F Orbital, How orbitals looks, atomic orbitals, Shapes of atomic orbitals, theory of orbitals, structure of atom, sub-shell, sub shells, Filling of orbitals in atom, electronic density, arrangement of electrons in atoms, arrangements of orbitals, where are electrons, electron, electronic configuration of atoms, see orbitals, observe orbitals, what are the shapes of orbitals, understanding orbitals, chemistry lovers, micro world, microscopic world, microscopic education, futuristic education, where electrons exists, molecular orbital theory, quantum physics, quantum numbers, molecular orbital diagrams, orbital diagrams(**Figure 1**).

The other “ChemEx 3D” apps is a chemistry lab app. ChemEx 3D is all about adapting new ideas and creating new methods of learning chemistry. ChemEx 3D is a simplest and easiest way to learn chemistry. This allows for free check on periodic table and a lot information about 103 different atoms, such as atomic number, atomic name, atomic mass, atomic phase, electronic configuration, electron per cell, crystal structure, atomic density, melting and boiling point, critical point, electronegativity, covalent radius, vander waals radius, discovery also allows to check their 3D structure(**Figure 2**).

The “Organic Chemistry Visualized” app provides a visual approach to organic chemistry. It is not meant to replace a textbook - it should be seen as a visual aid. The molecules and reactions are just briefly described. The main focus are the numerous animations of the molecules and reactions. Currently alkanes, alkenes and alkynes are described. You can test your knowledge through a quiz of 50 questions. The Hardware requirements - SCREEN SIZE > 3.7 inches and DUAL-CORE CPU! The animations are strongly compressed in order to keep the app size small. This is why the animations only run on newer smartphones. The Organic Chemistry Visualized is a free software application from the Teaching and Training Tools subcategory, part of the Education category. The app is currently available in English. The program can be installed on Android(**Figure 3**).

The Virtual Orbitals 3D Chemistry apps helps you to visualize the shapes of the orbitals in 3D such that you can understand more and you can sort out your confusions. This education app help the students to learn chemistry in a smarter way. Students can see the every parts of orbitals by rotating their fingers to screen. It is useful app for chemistry students to understand some complex parts of orbitals and help to feel them(**Figure 4**).

1.2 Classic Periodic Table Apps

The “Periodic Table” app useful toward learning general chemistry and supporting several aspects of elemental periodicity. In the Periodic Table application you will find a huge amount of data about chemical elements for free. The chemistry falls into to the number of the most important sciences and is one of the main school objects. Its studying begins with the Periodic Table. Interactive approach to a training material is more effective than classical. As in it technologies which became the family for the modern pupils are used(**Figure 5**).

Periodic Table - is a free application for Android which displays the entire periodic table at startup interface. The table has a long-form approved by the International Union of Pure and Applied Chemistry (IUPAC) as the core. Besides the Periodic Table of chemical elements, you can use the Table of solubility. Did you know that neodymium is used in microphones? Or europium in Euro bank notes to help stop counterfeiting? These are just two of the absorbing facts in our customizable app, based on our popular and well-respected Royal Society of Chemistry Periodic Table website(**Figure 6**).

The “Merck PTE” App is the ultimate tool for every friend of chemistry - whether pupil or teacher, student or professor, amateur or expert, hobbyist or technician. Our app is a must-have of digital periodic tables. Get informed with our mobile reference work, any time, with ease, offline and in detail. (with 1 million downloads). Even more features. Even more improvements. Even more user friendliness. Student can download apps free of charge and start experimenting.

Features:

★ All important information about the elements like atomic number, valence electrons, oxidation state, electronegativity according to Allred-Rochow and Pauling, atomic mass, boiling point, melting point, atomic radius, density, history, discoverer, classification, crystalline structure type, electron configuration, basic state, ionization energy, isotopic composition, state of matter, hardness according to Mohs, oxidation numbers, percentage of mass in Earth's crust, year of discovery.

★ Visualized element properties Atomic radius, atomic radius graphic, electronegativity (according to Allred-Rochow and Pauling), ionization energy, relative atomic mass, state of matter, ranking list of properties, discovery, classifications.

★ Molar mass calculator, Simple entry field for chemical formulas. Calculate molar mass simply and quickly(**Figure 7**).

Chemistry Notes apps

The apoc - Advanced Problems in Organic Chemistry - is your fully interactive virtual set of enhanced flashcards. The app allows students of university level organic chemistry classes to test their proficiency with chemical mechanisms and transformations taught in advanced chemistry courses. For students of organic chemistry around the world, the Evans database of organic chemistry problems has become an extremely useful learning resource. Hundreds of unique questions focusing on organic synthesis, conformational analysis, and many other categories can be browsed. Additionally, more than a hundred sub categories help refine the browsing

process and tailor the results. The work done in this mobile project transforms this rich database into an easy-to-use and free mobile app, putting hundreds of organic chemistry problems at your fingertips. Additional features like shake for random questions, direct access to suggested solutions and the primary literature, and being able to keep track of your learning process and favorite exercises by bookmarking make apoc (Figure 8).

The “Chemical Reaction apps” describes the chemical reactions. The application includes a handy search and the ability to reproduce the text aloud (Figure 9). This application provides an information about important Inorganic Chemistry reactions, helps to balance chemical reactions and to calculate molecular masses of chemical compounds. The application is free and works in offline mode. However, the database of chemical reactions will be updated periodically. The key features of this apps are searching for chemical reactions by reagents and by products, search functionality comes together with the autocomplete functionality, Balancing chemical reactions, calculation of molecular masses of chemical compounds and convenient mechanism for input of chemical compound formulas (Figure 10).

This app allows to discover chemical reactions and to solve the chemical equations with one and or unknown variables. You'll always have Mendeleev's Periodic Table and Solubility table handy. And even the calculator of molar masses. The app discovers the equations of chemical reactions even if the right or left part is unknown, helps you with organic and inorganic chemistry. The discovered reactions in a usual and ionic aspect will be mapped and formulas of organic chemistry are drawn for you. Mendeleev's periodic convenient interactive table. Press a chemical element in the table to look the information. The calculator of molar masses. Enter correctly a chemical compound and it will show molar masses and percentage of elements. The table of solubility of substances is added in the app. Now your textbooks become waste! The best solver of chemical equations for iPhone and iPad (Figure 11). You are downloading the “Organic Chemistry Nomenclature” apk file for Android: Organic Chemistry Nomenclature is the ultimate way for Chemistry students to study and memorize the names and structures of all the important chemical function (Figure 12).

The “Chemistry Cheat Sheets Free” apk covers the important topics in general chemistry and organic chemistry in a brief mode with several summary tables and figures. It cover maximum entry-level knowledge in all branches of chemistry. For example, Organic compounds, salts, inorganic acids, gases, and biomolecules under “chemicals”. Study of various Chemical, physical, and other properties (Figure 13).

1.3 Chemistry Design apk

ChemDoodle Mobile content rating is everyone. This app is listed in Education category of app store and has been developed by <http://www.chemdoodle.com>. You could visit iChemLabs, LLC.'s website to know more about the company/developer who developed this. ChemDoodle Mobile can be downloaded and installed on android devices supporting 10 api and above. Download the app using your favorite browser and click on install to install the app. Please note that we provide original and pure apk file and provide faster download speed than ChemDoodle Mobile apk mirrors. You could also download apk of ChemDoodle Mobile and run it using popular android emulators (Figure 15).

The “Chemistry By Design” (iPhones, iPads, Android & iOS) précises the entire synthesis paths of the pharmaceutical compounds. The paths are branded by name, author, year, and drugs can be searched within the app. This apk allows students to test their skills using known synthetic sequences. The goal is to display the reagents, starting materials and products for every single step used in constructing a natural product or pharmaceutical.

A continuously growing database, currently featuring hundreds of syntheses of natural products and pharmaceuticals, is now available for browsing and testing your organic chemistry skills. You can choose to start your browsing by selecting from various lists or using the search box. Chemistry By Design is a free software application from the Teaching and Training Tools subcategory, part of the Education category (Figure 16).

The ChemSpider Mobile allows you to search the Chem Spider chemical database, provided by the Royal Society of Chemistry. Compounds can be searched by structure or by name, and browsed within the app. Results can be examined by jumping to the web page (Figure 17). Draw complex molecular structures and reaction schemes using your fingertips. An easy circle gesture (U.S. Patent No. 9754085) makes even complicated polycyclic rings easy and fun to draw. Multiple double bonds or multiple functional groups are simple to add all at one time. Annotation and reaction condition text is chemically aware and properly subscripts numbers. With over 175k downloads, Chirys Draw is speeding the way scientists draw and communicate. Imagine what you will create (Figure 18).

1.4 Chemistry Laboratory APK

The Molarity App from Sigma-Aldrich(R) is a chemistry calculator tool that generates lab-ready directions describing how to prepare an acid or base solution of a specified molarity or normality from a concentrated acid or base solution. A second tab includes a general molarity function that calculates the mass of any reagent needed to prepare a given volume of solution of desired molarity. A third tab features a stock dilution function that calculates how to dilute a stock solution of any known molarity to your desired volume and molarity (Figure 19).

The Solution Calculator” is a handy tool for students taking chemistry classes, or researchers/scientists working in a biology, chemistry or biochemistry laboratory. It has a convenient calculator for making chemical solutions and for diluting solutions using a stock solution. It helps you to quickly determine how much chemical/stock solution you need. You do not need to mess around with your calculator and can spend more time in your study or research. It contains a handy tool to calculate molecular weight (M.W.) of commonly used chemicals in the lab. You do not need to enter the name or molecular formula of the chemical, you just need to press a few buttons to get the MW of the chemical instantaneously (Figure 20).

1.5 Research apps

A simple app designed as a quick reference for chemistry students. Includes a periodic table with links to wikipedia, a tool to calculate molecular masses of compounds (with a button at the top to perform simple grams/moles calculations, calculate mass percent and do stoichiometry with that compound), a table of polyatomic ions, constants, solubility rules, tools for calculating molarity and volume of solutions, tools for converting between units commonly used in chemistry, compound lookup that links to major chemical search engines (and wikipedia, of course), a table of reduction potentials, organic chemistry functional groups, IR, H1 NMR and C13NMR spectroscopy tables and a table with common ligands(**Figure 21**).

In Researcher app, you can find all the top impact factor journals and papers from Nature Springer, ACS, Elsevier, Wiley, Taylor and Francis, RSC, BMJ, IEEE, arXiv, PubMed, PLOS, PNAS, PubMed, F1000, Cell, Science AAAS and more. The university students and researchers find the app invaluable when writing literature reviews, composing their thesis, and learning what's new in the world of science. It's free and easy to use, allowing you stay on top of your academic research by enabling you to follow, filter and save papers from all journals relevant to your research, and then sync them with your reference manager(**Figure 22**).

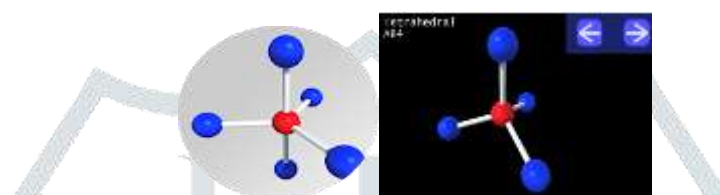


Figure 1: 3D VSPER Screenshot of 3D VSPER



Figure 2: ChemEx 3D Screenshot of ChemEx 3D



Figure 3: Organic Chemistry Visualized Screenshot of OCV

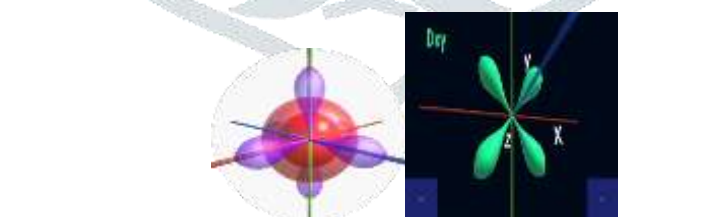


Figure 4: Virtual Orbitals 3D Chemistry Screenshot of Virtual d_{xy} Orbitals



Figure 5: Periodic Table RCS Screenshot of Periodic Table



Figure 6: Screenshot of Periodic Table



Figure 7: Merck PTE” App Screenshot images of Merck PTE” App

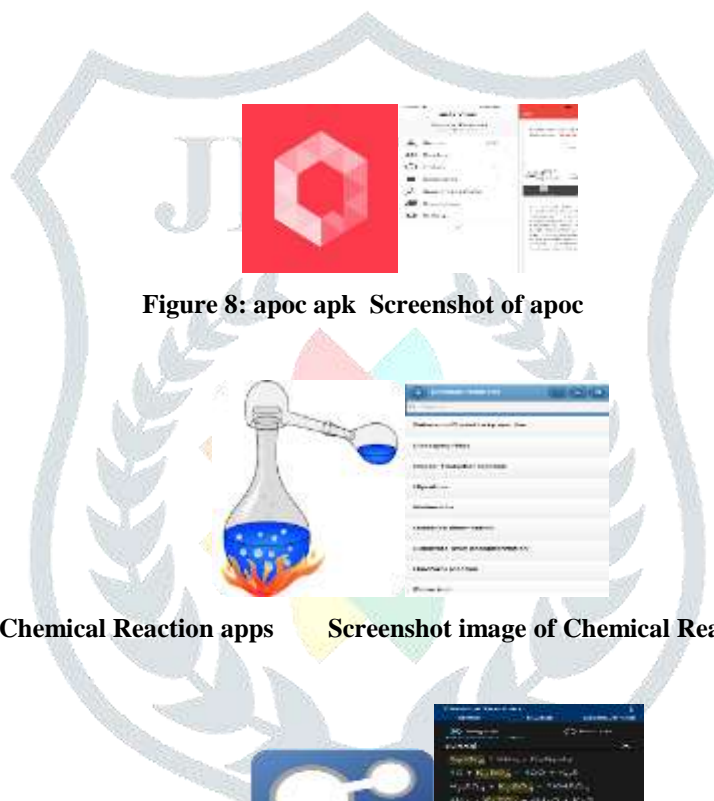


Figure 8: apoc apk Screenshot of apoc

Figure 9: Chemical Reaction apps Screenshot image of Chemical Reaction apps



Figure 10: Chemical Reaction apps Screenshot image of Chemical Reaction



Figure 11: Chem./Homework apps Screenshot of Chemistry & Homework apple

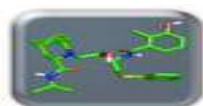


Figure 12: Organic Chemistry Nomenclature Apps



Figure 13: Chemistry Cheat Sheets apk

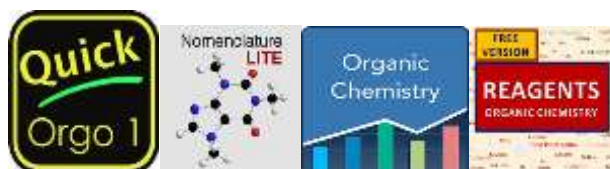


Figure 14: APKs for more study in teaching learning process for Students and Teachers

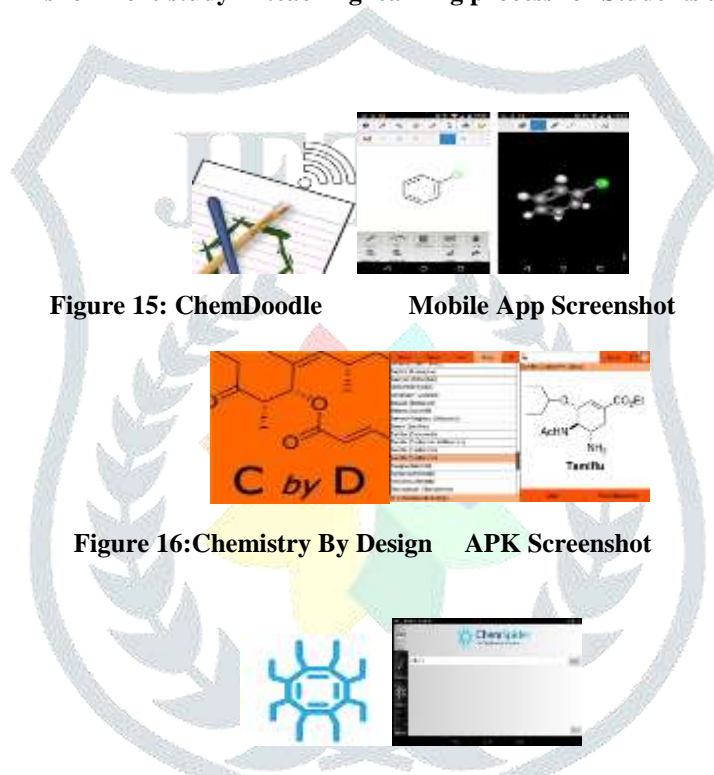


Figure 15: ChemDoodle Mobile App Screenshot

Figure 16: Chemistry By Design APK Screenshot

Figure 17: Chem Spider Screenshot image of Chem Spider



Figure 18: Chirys Draw APK



Figure 19: Molarity App Screenshot of Molarity App



Figure 20: Solution Calculator Screenshot image of Solution Calculator



Figure 21: Chemistry APK



Figure 22: Researcher PAK Screenshot image of Researcher APK

CONCLUSIONS

The mobile apps are the beautiful technology for increasing student's engagement in chemistry. The mobile apps along with the multimedia features introduced in this paper will potentially attract students to obtain effective and interactive learning experience in the fields of chemical science, chemical technology, chemical engineering, and other subjects. The apps create opportunities for collaborative activities among students. The mobile chemistry apps on androids and other portable electronic devices gives chemistry students and chemical professionals effective and chemical tools to solve problems appropriately with no tension and good interest from electronic media, high price heavy books, and large PCs.

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CONFLICT OF INTEREST

The authors declare no conflict of interest

REFERENCES

1. Bennett, J. and Pence, H. E. 2011. Managing Laboratory Data Using Cloud Computing as an Organizational Tool. *Journal of Chemical Education*, 88:761–763.
2. Alrasheedi, M. and Capretz, L. F. 2015. Determination of Critical Success Factors Affecting Mobile Learning: A Meta-Analysis Approach. *The Turkish Online Journal of Educational Technology*, 14: 41–51.
3. Clark, A. M. Ekins, S. and Williams, A. J. 2012. Open drug discovery teams: a chemistry mobile app for collaboration. *Molecular Informatics*, 31: 585–597.
4. Williams, A. J. and Pence, H. E. 2011. Smart Phones, a Powerful Tool in the Chemistry Classroom. *Journal of Chemical Education*, 88: 683–688.
5. Williams, A. J. Ekins, S. Clark, A. M. Jack, J. J. and Apodaca, R. L. 2011. Mobile apps for chemistry in the world of drug discovery. *Drug Discovery Today*, 16, 928–939.
6. Evans-Cowley, J. 2010. Planning in the Real-Time City: The Future of Mobile Technology. *Journal of Planning Literature*, 25:136–149.
7. Ismail, I. Azizan, S. N. and Azman, N. 2013. Mobile Phone as Pedagogical Tools: Are Teachers Ready. *International Education Studies*, 6: 36–47.
8. Murphy, A. Farley, H. Lane, M. Hafeez, B. Abdul and Carter, B. 2014. Mobile Learning Anytime, Anywhere: What are our students doing. *Australasian Journal Information Systems*, 18: 331–345.
9. Lampe, C. Wohn, D. Y. Vitak, J. Ellison, N. B. and Wash, R. 2011. Student use of Facebook for organizing collaborative classroom activities. *International journal of Computer-Supported Collaborative Learning*, 6: 329–347.
10. Clark, A. M. Ekins, S. & Williams, A. J. 2012. Redefining cheminformatics with intuitive collaborative mobile apps, *Molecular Informatics*, 31: 569–584.
11. Kobus, M. Rietveld, P. van Ommeren, J. N. 2013. Ownership versus on-campus use of mobile IT devices by university students. *Computers & Education*, 68: 29–41.
12. Mobile Reagents, <http://itunes.apple.com/us/app/mobilereagents/id395953310> (accessed November 3, 2018).
13. ChemSpider Mobile, <http://itunes.apple.com/us/app/chemspider/id458878661> (accessed November 3, 2018).
14. Android, <http://www.android.com/> (accessed November 3, 2018).

15. Ekins, S. Clark, A. M. Williams, A. J. 2013. Incorporating Green Chemistry Concepts into Mobile Chemistry Applications and Their Potential Uses. *ACS Sustainable Chemistry & Engineering*, 1: 8–13.

