Chemistry Acoustic (Chemcoustic): Android Based Application for Fun Chemistry Learning

A Mugitsah¹, F S Irwansyah¹* and C Z Subarkah¹
¹Department of Chemistry Education, UIN Sunan Gunung Djati Bandung, Indonesia

*ferli@uinsgd.ac.id

Abstract. Learning media are used to facilitate educational practices, both in terms of administration and as a tool in teaching and learning activities. Music and dynamic images are effective stimulants of the brain's work in developing eidetic intelligence, remembering visual information with high-level photographic accuracy. Making Chemcoustic application as audio visual media aims to develop students' learning abilities in understanding chemical concepts based on chemistry representations, by utilizing Android-based technology. The making of the application is carried out with the design stages of the application design in terms of the display, content, and lyrics of chemical songs, making music arrangements, song validation, application making, testing, and evaluation. The trial was conducted on 40 fresh graduated high school students using C1-C4 type test instruments in the form of pre-test and post-test. Based on the t-test quantitative analysis, the calculated t value is greater than the t table value, and the average gain score of the post-test (52.8975) is much greater than the average gain score pretest (15.68). Qualitative observation shows that learning using Chemcoustic applications is conducive, enthusiasm and activeness of students increases significantly. Chemcoutic application is effective as a medium of chemistry learning, as well as science learning that demands complex concepts with macroscopic, sub-microscopic, and symbolic representations.

1. Introduction
In the life of modern society, technological innovation is very influential in every aspect of life including the world of education. Education needs to be transformed in order to meet the demands of rapidly changing technologies, new skill demands in the workplace, and to foster equity, social cohesion and global citizenship. One example of media that can be used in learning activities is audio visual media. This media can facilitate the understanding of concepts and student absorption, helping teachers to present material in a directed, systematic, and interesting manner so that learning objectives can be achieved [1]. Through exciting learning media, motivation and learning outcomes increase, and encourage students to be more active in writing, speaking, strengthening memory and imagination increasingly stimulated. Thus, audio-visual learning media can make the teaching and learning process more effective, efficient, and enjoyable [2].

Complicated and abstract concepts often make the students difficult to understand science, especially chemical concepts which include macroscopic, submicroscopic and symbolic representations. Submission of material verbally is not enough in chemical learning. Hence it must be supported by the use of media that serves as a teaching aid in learning. One of difficult concept which causes misconceptions is chemical bonding. Chemical bonding explains how atoms form bonds, both with the same atom and with different atoms. The concepts in chemical bonds are abstract so that they are difficult to apply contextually [3].
As written in Quran, An-Nahl verse 78, it is known that the key to the entry of knowledge starting from the sense of hearing (as-sam'a) through the audio receptors, then vision (al-abshaar) through visual receptors, as well as storage in the brain in the form of long-term memory internally internalized profound (afidah) [4]. Based on the theory of neurons according to Roger Sperry, separate nerve cells (neurons) will mesh and integrate with new neurons to form a circuit that bridges access between the right brain and the left brain. Integration between neurons can occur with the condition that there is a stimulant, in the form of audio in harmony with the rhythm of brain waves or Brain Wave Rhythm (BWR) [5]. Audio (sound) is a longitudinal wave that can be quickly received by the human brain, and stored in the long-term memory.

Archiving learning outcomes will be more effective when modified in the form of music that has brainwave beats such as acoustic music [6]. Eric Wright’s research shows that in addition to producing rhythms such as acoustic music blocks, human brain activity has eidetic intelligence or memory since birth. Eidetic intelligence is the ability to remember visual information with high photographic accuracy. Like the absolute pitch that requires treatment, eidetic intelligence must be maintained and trained [7].

Various applications can be easily accessed via smartphone based on Android, not limited to urban areas but has penetrated to remote villages. Utilization of technology as the basis of audio-visual media becomes a means of interactive learning optimization, thus enabling two-way communication (two-way traffic) in the learning process [8]. This article carries the research study and the development aiming to create an application called Chemcoustic. The application of simplified chemical bonding concept by considering chemistry representative and complimented by Chemcoustic song that consist the keywords of chemical concept, in order to make students easier in remembering the concepts they have learned.

2. Method
The making process of Chemcoustic application uses design-based research (DBR) method [10]. Generally, this research undertakes three main stages, such as preparation; making song lyrics and music arrangement, design; making the ppt form, generate to android application, validation, and development; limited trial and evaluation. The instruments used in this research are storyboard, flowchart, and the questions of pre-test and post-test. Designing content and watermarks of the application display images / animations in the application uses the storyboard and flowchart, to make it easy to understand and follow by user thoroughly and significantly. Validation of Chemcoustic applications is done by presenting experts who are experienced in the field of chemistry, namely lecturer capita of chemistry at UIN Sunan Gunung Djati Bandung. This validation stage aims to test the suitability of song lyrics and application content with the concept of chemistry, so that misconceptions do not occur. The limited trial of Chemcoustic applications holding on 40 fresh graduated high school students. Respondents were asked to fill in the pretest questions, then using the Chemcoustic application, and finally they were asked to fill in the post-test questions. The result of the test is processed through quantitative analysis of t-test, so that the effectiveness of the use of Chemcoustic applications as learning media can be known.

3. Result and Discussion
Chemcoustic as the audio visual learning media contains a discussion of chemical concepts with visualization in the form of three-dimensional (3D) images that are attractive and dynamic, complemented by audio in the form of songs about chemical concepts. The material presented in the application is a form of simplification of chemical concepts by prioritizing macroscopic, submicroscopic, and symbolic concept accuracy. The macro, which refers to what is observable; the submicro, which refers to what happens at molecular level; and the symbolic aspect, which refers to how a phenomenon is symbolized [11]. The songs provided also contain keywords from chemical concepts, so that it can make it easier for students to remember concepts that they have learned at the material presentation stage. In the Chemcoustic application there is also an evaluation option that contains questions to assess the level of cognitive skills, such as remembering, understanding, applying, and analysing (C1-C4 type) which are related to chemical material / concepts along with the discussion stage.

The topic ‘chemical bonding’ was taught to senior high school students. They were expected to compare the process of forming ionic bonds, covalent bonds, coordination bonds, metal bonds and their
relationship with the physical properties of the compounds. The following is the indicators with chemistry representation describes the competencies.

**Table 1. Indicators and representations of chemical bonding.**

| Indicators                                                                 | Representations                                    |
|---------------------------------------------------------------------------|----------------------------------------------------|
| Explain the tendency of an element to achieve stability                   | Multiple: maro, submicro, and symbolic              |
| Explain the process of ionic bond formation                                | Hybrid: submicro and symbolic                       |
| Explain the process of forming single, double, and triple covalent bonds   | Hybrid: submicro and symbolic                       |
| Explain the process of forming coordination bonds on several compounds    | Hybrid: submicro and symbolic                       |
| Describe the process of forming metallic bonds                             | Multiple: maro, submicro, and symbolic              |
| Link the physical properties of matter with the type of each chemical bonding | Multiple: maro, submicro, and symbolic              |

The utilizing *Chemcoustic* can be operated after the application is installed completely on the smartphone. There are seven tools in the application, with the descriptions below:

a. The main: menu to display all menus contained in the application, containing links and materials profiles listed in the electronic module, which user can choose to learn. This display is similar to the table of contents of books.

b. Instructions: contain direction for students in using the application.

c. Basic competence: as a basis for learning and assessment of students.

d. Learning indicators: as targets for achieving learning outcomes.

e. The material: contains learning material with descriptive explanations and dynamic 3D images.

f. Chemcoustic: to show a video about the chemical bonds that are delivered with acoustic songs,
   to help student easier in remembering the topics.

g. Evaluation: contains questions to practice the ability of students, accompanied by confirmation of the accuracy of the answers and discussion of questions.

The materials of chemical bonding consist of ionic bond, covalent bond, and metallic bond. Chemical bonding could be categorized as abstract concept in the concret phenomenon, which has a multiple representation. Each type of the bond has own mechanism of stabilizing process, so that the explanations are served separately in different menu. Considering the chemistry representations, the contents are described in the text, then be visualized by the factual phenomenon images as macroscopic representation, three dimensionnal and dynamic animation as submicroscopic representation, and symbolized by the invented chemistry symbols as symbolic representation.

**Figure 1.** The first display contains menus in the application: instructions, basic competency, learning indicators, materials, *Chemcoustic*, and evaluation.
Chemcoustic application trials for 40 students with chemical bonding material were evaluated through ten questions in the form of descriptions given before and after using Chemcoustic applications. The value obtained from the test is processed by quantitative analysis of the t-test, through tests of normality, homogeneity, with data trends listed in the following graph:

![Graph of the results of the Chemcoustic application trial](image)

**Figure 4.** Graph of the results of the Chemcoustic application trial

### 3.1 Quantitative results
Based on the results of the normality test, the data obtained from the application test results are normally distributed. After that a homogeneity test is performed to determine differences in the values of pre-test and post-test. Homogeneity test data shows the value of $F$ count is smaller than $F$ table, which means there is a difference between the pre-test and post-test values. To find out the significance of the effect of Chemcoustic application on gain score, an independent $t$ test was performed. The trial results show an increase in students' cognitive abilities as evidenced by the acquisition of the gain score after the use of the Chemcoustic application (pre-test) is greater than the gain score before the use of the chemcoustic application (post-test). The significant increase in value is seen from the average pretest value of 15.68 and the post-test average value of 52.8975. In the $t$ test, the calculated $t$ value is greater than the $t$ table value. This shows that the use of Chemcoustic applications as a learning media is effective in helping chemistry learning.
3.2 Qualitative results
Qualitative analysis is done through direct observation on the implementation of tests and learning to use media in the form of Chemcoustic applications. When facing pre-test questions students look tense and confused in answering the questions given. The students forgot the concept even they have learnt the topic. This is also evident from the number of incorrect answers and unanswered questions, which has an impact on the acquisition of low pre-test scores. After working on the pre-test questions, students are directed to take part in learning about chemical bonds using the Chemcoustic application. Learning takes place conducive. All students are actively involved and enthusiastic about learning, especially when using attractive Chemcoustic applications, easy to understand, and not boring. Learning media based on audio visual can generate new interests and desires, provide stimulants and motivate learning, to create effective learning and facilitate teachers in delivering learning material in accordance with curriculum requirements and create learning becomes more alive.

The final stage in the trial process of Chemcoustic application is evaluation through the provision of post-test questions about the material that has been studied. The look on students' faces when working on post-test questions was much calmer and more focused compared to the conditions when working on pretest questions. In addition, seen from the student answer sheets at the post-test stage, the answers given were relatively appropriate and almost every student answered all the questions given. Audio visual based media like Chemcoustic help overcome the limitations of space and time of learning, because students can access back learning material anytime and anywhere. In harmony with Jerome Bruner's learning theory of the learning process through enactive, iconic, and symbolic stages, which rely on manipulation of real objects, through visualization, and symbols that take place gradually and continuously.

4. Conclusion
Chemcoustic is an audio-visual learning media, designed interestingly through dynamic 3D visualization of chemical concepts. It can be used practically through computers or Android-based smartphone. Based on trials, the Chemcoustic application is effective in helping students understand and remember the chemistry taught. Statistical processing of pre-test and post-test scores showed a significant increase, the average pretest value of 15.68 and the post-test average value of 52.8975. Thus, this application can be used in schools as a medium for learning chemistry, as well as science learning that demands complex concepts with macroscopic, sub-microscopic, and symbolic representatives.

References
[1] Miarso, Menyemai Benih Teknologi Pendidikan. Jakarta: , Jakarta: Pustekom DIKNAS, 2006.
[2] Asmara, "Pengembangan Media Audio Visual Tentang Praktikum Reaksi Reduksi Oksidasi dan Elektrokimia,," Lantanida Journal, vol. 2, no. 2, p. 22, 2014.
[3] Adistya, "Identifikasi Konsep Ikatan Kimia," Pembelajaran Kimia, vol. 3, no. 2, pp. 41-50, 2018.
[4] S. b. A. dkk, Tasfseer Al-Mukhtashar, Riyadh: Markaz Tafsir Lid Diraasatil Qur’aniyah, 2005.
[5] R. M. Ruth Clark, E-learning and The Science of Instruction, New York: John Wiley & Sons, 2016.
[6] Sharon, Instructional Technology And Media For Learning, New York: Pearson Education, 2008.
[7] Sheppard, Music Makes Your Child Smarter, Jakarta: Gramedia Pustaka, 2005.
[8] Haryoko, "Efektifitas Media Audio Visual," Jurnal Elektro, vol. 2, no. 4, pp. 1-10, 2009.
[9] J. P. G. a. W. R. B. M. D. Gall, M. D. Gall, J. P. Gall and W. R. BorgEducational Research: An Introduction, nnnnew York: Longman, 2003.
[10] S. B. a. K. Squire, "Design-Based Research: Putting a Stake in the ground," J. Learn. Sci, vol. 13, no. 1, pp. 1-4, 2004.
[11] T. D. Gilbert J. K., "Introduction: macro, submicro and symbolic representations and the relationship between them: key models in chemical education, in J. K. Gilbert, D. TreagustMultiple representations in chemical education," Dordrecht, Springer., vol. 11, no. 1, pp. 1-8, 2009.

[12] S. B. a. K. Squire, "Design-Based Research: Putting a Stake in the ground," J. Learn. Sci, vol. 13, no. 1, pp. 1-4, 2004.