Combined Multimedia and e-learning Media: Enhancing Conceptual Comprehension in Physical Chemistry Teaching

Is Fatimah

[1]Chemistry Department, Islamic University of Indonesia
Gedung FMIPA Universitas Isam Indonesia
Kampus Terpadu UII, Jl. Kaliurang Km 14, Sleman, Yogyakarta, *email: isfatimah@uii.ac.id

Abstract

Understanding in physical chemistry science is essentially qualitative yet is often expressed in mathematical equation. Most teachers and students spend so many time and effort doing calculations which are complex and require each understanding behind each equation. The condition is potentially reflects learning objective and teaching-learning effectivity. Along with recent information technology, calculations and the meaning behind the calculation were efforted to be served by using visualization and simulation to promote learning and teaching process. This paper will examine a variety of ways in enhancing conceptual comprehension in physical chemistry teaching through some visualization and simulation with e-learning project at a university teaching grant. Classroom experiences and some aspects affect to classroom practice will be shared and discussed.

Keywords: e-learning , visulatization, physical chemistry, teaching-learning effectivity

Introduction

So far both the microscopic and macroscopic point of view in a detailed explanation of the physics of chemical materials have been used. To sharpen mastery of the material commonly used practice and mastery of the concept of numerical calculations of the students, the rest, physical chemistry lab is used to apply these concepts. It can be seen from several learning resources such as books and websites. Although considered effective, physical chemistry lab by presenting some of the experiments seems difficult to be implemented. In addition to the allocation of time in one meeting that does not make learning effective, operational costs and the selection of appropriate experimental method are another aspects and issues need to be considered. Refers to some research and exploration of chemical physics class action, one technique that can be developed within the framework is the visualization of chemical materials physics using multimedia technology combined with the use of online learning resources that are interactive activitity in the classroom. Visualization will have a broader scope, not only on stage but also the planting of evidence theory concept, while it can be presented in an interactive tutorial for longer and depending on the interests of learners anytime and anywhere through e-learning system (Thomas, 2011). For example, the basic meaning of energy and energy changes as well as several types of system changes can be extracted from a very varied and easily developed by professors at the same time. With this greater flexibility, learning objective of teaching physical chemistry can also be more easily associated with local objective of study program for example adjoining local content of essential oil development. Visualization of the material can be conducted by flash or other animation system that can be created, downloaded or purchased from the software provider. Furthermore, to improve the efficiency of the time, directed learners in active learning by accessing e-learning sources, although not in all the lecture material.

Background in these ideas, aim of this project is to collect data on the effect of proposed visualization program in physical chemistry teaching to support the teaching-learning activity. It was hypothesized that visualization and interactive tutorial give mutual relationship with learning objective and conceptual achievement. From the visualization and interactive tutorials that have been presented, teachers explored the opportunity for cognitive and affective aspects of learners through the presentation of material in combination with the lecture method is still required to present a numerical evaluation capabilities.

Physical chemistry lecture is characterize as a fundamental, theoretical and descriptive but the basis for another field of chemistry. In practice, physical chemistry are generally delivered with a mathematical approach so the learners have to got calculus courses before that is contain material of differential equations. On the other hand, physical chemistry courses as other courses that are required in order to adjust the specific and characteristic goal of study program that may be not directly related with physical chemistry material. These two circumstances are problems that is causing some aspects related to learning outcomes including final grades of students who are generally more evaluate cognitive aspect but low in the aspect of understanding to the material. In study, the problem was tried to be solved by a constructivist approach.

The basic design of constructivist learning approach including:

- Approaching theory with a question / issue
- Approaching theory by a Case Study
- Approaching theory as a part of the Long-term Project

• Multi-project integrated in the curriculum

• Depending on learners capability and potency

An intense loading of mathematical approach and construction is the specific problems in physical chemistry teaching while one important goal of the whole physical chemistry teching is worthwhile to think about the philosophy of chemistry as well. Another factor in limitation physical chemistry teaching activity is low motivation of students that is correlate to the abstract concepts in physical chemistry and how the knowledge can be applied in advance purpose.

By these main characteristics of the scheme, the constructivist approaches the utilization of some problems or issues and then the learners are required to pull the root of the problem, evaluate, analyze, and apply to the problem compared to another equal or more complex problems. As tool in a learning scheme, case studies and projects are designed in such a way depends on the situation, the potential and characteristics of students so flexible teaching-learning process can be developed by the faculty. Of the existing literature, several methods can be used such as experiments / laboratory small project or a long term project, virtual experiments, visualization of the material in the classroom. Application of experiment or laboratory involves the provision of infrastructure and funding that potentially becomes a new problems, while the use of a virtual experiment in many cases have limitations on student learning outcomes that are less focused. The power of information technology and internet to make a simple process and transfer in visualization of an abstract subject is a great deal of excitement in the educational community involved in university. Such visualization in medicine and pharmacy learning contribute to reduce cost and shorter achievement time of learning objective are significant examples for the purpose of information technology. These may a more powerful educational methods that can be adopted for theoretical chemistry teaching and learning.

By these considerations, in this program visualization and interactive tutorials colaborated in the classroom enriched with self e-learning program was choosen. At the end of the semester the success of teaching-learning program was determined from some aspects of learning achievements of students and lecturers teaching success based on existing resources on very diverse student's academic potential.

Teacher's preparation for a lecture carefully is an important stage in the design of teaching-learning activity. Because of the characteristics of the materials that is abstract and fully contained theoretical and mathematical aspects, and seems far from applicable, the initial step of preparation is attract motivation of students. According to Zielinski and Zwens (2004), the design of effective teaching of physical chemistry based on the concept of constructivism is accompanied by the continuous development of teaching methods. Along with the development of visualization technology, the learning will interest not only when performed by introducing a change in the style of study but also by using modern teaching methods. A new design concept of teaching focuses on investment in an interesting and related to the purpose of the study program will be very useful to improve the quality of teaching physical chemistry (Tuvi-Arad and Blonder, 2010). Some steps that aimed to developt quality of learning-teaching in this program are:

a. Development of the substance of learning: visualizing some of the material present in Physical Chemistry II courses are directly targeted to the local genius Studies Program.
b. Development of methods to learn Lecture method is typically used in full in chemical physics lectures will be combined with visualization and active learning methods (active learning) in the interactive tutorial.

Effectiveness of learning will be achieved through the assignment to students who performed with the interactive design and evaluation carried out using e-Leaning klassiber facilities are already available. For example: the course material liquid-gas phase equilibria are presented in the form of animation and is associated with essential oil distillation process (Figure 2). Research on effectivity of the program was evaluated and reported in this paper.

Participants in the study were 30 undergraduate students enrolled in one meeting for class evaluation, 8 meeting courses consist of course with visualization, 3 courses without visualization and 12 online courses available in the online teaching-learning system provided by university. Among the participants, 12 were females and 18 were males. The topics of course are phase diagram (3 meetings) and ideal and non ideal solution (3 meetings), colligative properties (2 meetings), chemical equillbrium (4 meetings). Design of teaching-learning project is illustrated in Figure 1.

At the first stage, motivation and cognitive aspect of students were evaluated by conducting online quistionare. Cognitive pre-test is contained by several items refer to the aim of courses as listed in Table 1. For e-learning activity, some visualisation and interactive materials were involved within the e-learning system. Subject, goal and evaluation of each material is listed in Table 2.

Table 2.

Question		Aim of Evaluation
1	Number Quiz in klasiber too much	interest
2	Quiz in lectures damning me	comprehension
3	Lecture delivery methods Chemical Physics II more fun than delivering lectures Physical Chemistry I	interest
4	Animation is used makes me understand the material	Interest and comprehension
5	interest	
6	e-learning system helped me	comprehension
7	Task in e-learning system is too hard for me	comprehension
8	Animation of distillation is interesting and make the material clear	comprehension
9	I can study material offline freely	interest
10	I have many time to try the animation	interest

At the final stage of the project, analysis of the effectiveness of the visualization combined by e-learning program was conducted by quallitative approach.

For analysis purposes, motivational and cognitive aspect of target students were evaluated by representative activity monitored by e-learning system aim and mini-quizz of each course. For example, in e-learning system studentswere showed an animation on vapor pressure and its relationship with Raoult and Henry's Law. Interactive activity of this course consist of simulation for some different pair of pure subtance in a mixture and students have to measure and analyze the total pressure of mixture refer to Raoult formulae. As control, another online course based on Henry's Law was served without any visualization neither in classroom nor in

ISBN: 978-602-73192-0-2

the e-learning system. Evaluation was conducted by comparing achievement of each student with their each baseline and refer to their motivation.

Discussion

From studies conducted around the world (and Stacy Teicher, 2002; Coll and Taylor, 2002) reported that the traditional approach to the structure of teaching pengajran Physical Chemistry including thermodynamics and chemical bonding are ineffective. Petersonand Treagust (1989) and Taber (2001) found that students often do not have a deep conceptual understanding. Because of its cargo is loaded with philosophical theories and concepts as well as closely related and in sync with the field of physics, physical chemistry learning often stuck to the mathematical approach and not a description of the chemical's completely to students. Moreover, the concepts that are the basis is not explicitly visible and felt by students when carrying out tasks independently; thesis or field practice.

Harrison and Treagust (2000) states that there are three levels that represent the material. It is a macroscopic (physical phenomenon), the microscopic (particle) and symbolic (chemical language and mathematicalmodels). According to Coll and Treagust (2002), an understanding of the concept involves the ability to represent the chemical issues and translate them into the three forms of representation. The physical model considered quite helpful in the teaching and learning of chemical bonding and structure in which students who previously did not have an understanding of basic concepts, can have the experience to overcome a few problems with either description. However, if there penyalahartian levels can cause misconceptions (Wanyonyi, 2010). Meanwhile, changes in concepts such as energy, structure, reaction rates and mole concept in all chemical systems rated as the "heart" of chemistry.

So far both microscopic and macroscopic point of view in detail explanation of the material has been used chemical physics. To sharpen the mastery of material commonly used practice mastery of concepts and numerical calculations of the learners, rest, physical chemistry lab used to implement these concepts. It can be seen from several learning resources such as books and websites. Although considered effective, practical physical chemistry by presenting some experiments seem difficult. In addition to the allocation of time in one meeting that makes learning ineffective, operating costs and the selection of appropriate experimental method is a separate issue. Referring to some of the research and exploration of physical chemistry class action, one of the techniques that can be developed within the framework of physical chemistry is a visual content using multimedia technology with the use of online learning resources that are interactive in the classroom. Visualization will have a broader scope, not only on stage but also the planting of evidence theory concept, while the interactive tutorial can be presented in a much longer and depends on the interests of learners anytime and anywhere via the e-learning system (Thomas, 2011). For example, the basic meaning of the energy and energy changes as well as some changes to the system can be extracted from a very varied and also easy to be developed by the faculty. With this greater flexibility, chemical materials physics can be more easily associated with oil development atisiri local genius. Visualization of matter can be shown with flash animation or other systems that can be created, downloaded or purchased from the software provider. Furthermore, to improve the efficiency of the time, directed learners in active learning by accessing the e-learning tutorial source klasiber though not at all lecture material.

Development of learning including e-learning system was implemented in several phases:

a. Evaluation of the class

Theoretically, the evaluation of the required classes in physical chemistry instructional design include:

1. Learners are engaged in learning: what is their background, and what their goals?
2. Learning materials
3. The point of view used in the study: whether the point of view of macroscopic or microscopic
4. Transfer of scientific methods to be used
5. Linking practical activities with the material discussed in class
6. The extent to which the use of computers and multimedia technology in the classroom
7. How to design tasks to students to accelerate learning targets pencaiapan (Ellison and Schoolcraft, 2008).

Evaluation of learners needed to classify students according cognitive abilities and their enjoy in e-learning system.

Action research activity was listed in Table 1.

ISBN: 978-602-73192-0-2

Table 1. Activity of action research

No.	Activity	Achievement
1	Introducing visualization program to the students	positive
2	Materials were delivered by visualization and non-visualization	A positive response was detected by the inquiry increase of students even by student with low to moderate cognitive ability. Some aspects of inquiry ability:
3	Evaluation on student's motivation and achievement from each mateiral	Positive- in general the students understand the meaning of the basic variables in the equations of thermodynamics, can express meaning of phase diagrams, Raoult's law, Henry's law and the principle of spontaneous distillation in the correct manner

Interest aspects of the assessment of whether the tasks indicated in the e-learning system is too burdensome, whether visualizations in the classroom aid learning, and whether in the physical chemistry lecture the students can learn better than in physical chemistry lectures delivered through conventional lectures. Assessment using a system of weighting the options with a maximum value of 1 where the maximum value represents the positive influence of visualization and engagement in e-learning system (klasiber).

The mean response to the evaluation of students demonstrated by the histogram in Figure 1

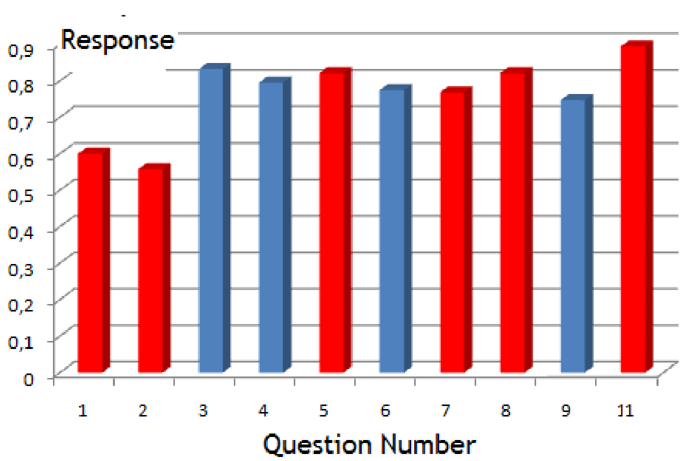

Figure 1. The mean response of Students in the Final Evaluation Course

Generally, the whole question has a weight average above 0.5 good response from the evaluation of the interests and understanding of this poll shows measured values and the positive influence of visualization and engagement in e-learning system.

Visualization Effects On Comprehension

Effect of visualization on the understanding of the material in the evaluation poll questions submitted through clause 4 and clause 9. To confirm this, an analysis of the results of the evaluation in the final examination was conducted. The exam contains 6 (six) questions that should be done with an open book within 75 minutes. Recapitulation question, objective evaluation and weighting values and relation to delivery of related material is presented in Table 2.

Table 2. Evaluation of the effect of visualization on Student's comprehension

Question No.	Material	Aim of Test	Maximum Score	Achievement
1	Colligative properties of solution Delivered with interactive visualizations and provided in the e-learning system (Klasiber)	Aspects of understanding the concept of change-freezing solution at various concentration - The concept of freezing enthalpy change	15	11,47
2	Colligative properties of solution-relationships and changes in osmotic pressure freezing Material-specific visualization but not delivered by the partial material delivered through visualization and interactive visualization provided in the e-learning klasiber	-Aspects of understanding the concept of osmotic pressure in relation to the other properties of the solution colligative freezing point changes. -Students are expected to interpret the basic definition of colligative properties -Students are expected to analyze and subsequently synthesize complex problem resolution more than two issues	15	7,03

ISBN: 978-602-73192-0-2

		that are not directly connected		
3	Solubility; Delivered with interactive visualizations and provided in the e-learning klasiber	- Concept of heat of fussion	20	12,43
4	Electrochemical equilibrium: Delivered with interactive visualizations and provided in the e-learning klasiber	- The principles of reduction-oxidation half reaction The relationship between electrode potential and electrochemical equilibrium	20	16,33
5	Osmotic pressure	The basic principle of solubility and osmotic pressure	15	14,33
6	Constant of solubility product	Concept of heat fussion in relation with solubility	15	12,40

In general, the average achievement was more than 50% of the maximum value except for the item about the number 2. The purpose item number 2 is to know about student learning success in analyzing and then synthesizing more complex problem resolution of the two issues are not directly related, in contrast to other items that are about the recall (recalling) aspects of analyzing, evaluating, calculated from the material that has been visualized in the classroom. From the description of the questions explored aspects can be concluded that the overall visual effect is good for understanding the cognitive aspects such as analyze, evaluate and calculate the simple structure of the material. However, when students are asked to synthesize and combine the two phenomena, it is still an obstacle.

As with the samples, studied the effects of visualization in the delivery of content electrochemical equilibrium. Visualization held in the classroom and provided in the e-learning klasiber. There is an increasing interest in learning the weights indicated by the mean value for that item question number 1.2, 5, 7, 8 and 11 (stem red histogram). From a grain of questions asked, it was concluded that visualization helps students understand the material pekuliahan. Positive aspects of the interest shown by the high repon (.895) against the number 11 item questionnaire that examined the importance of visualization statements to other subjects like physics chemistry cluster of Chemistry and Institute of Chemical Kinetics. Lowest value of the interest in testing the response obtained from the evaluation point number 2. Item evaluation is derived from the consent of the statement "I am damning Quiz in lectures" aimed to evaluate the student's interest in doing the task in klasiber. Shows the mean number of 0.53 means the number of students who feel overwhelmed by the task in the e-leaning klasiber as many students do not feel overwhelmed. This, in the following discussion will be seen from the evaluation of the material accessible from e-learning and its role klasiber determine the success of student learning. Recommendations that can be drawn from this evaluation is :

a. On the evaluation of the suitability of visualization with the material, 63% of students choose material electrochemical equilibrium and 17% of students chose Gibs function changes, and only 4% of students choose material distilled. This suggests that the material electrochemical equilibrium is more easily understood and least interesting than other materials delivered using visualization. The grant program linked with increased emphasis on learning methods with local genius volatile oil development courses, has not seen the benefits of visualization for students is well demonstrated by the lack of student assessment.
b. Recommendations from the evaluation is to improve methods of visualization in sub-chapter distillation processes connected with the production of essential oils. Repairs to the composition of the visualization needs to be done on them by presenting interactive reading materials and additional allocation of time in the classroom. These recommendations are outlined in the repair unit lecture program (SAP Appendix).
c. Further testing of the successful development of the program is in terms of the number of students access to the material in the e-learning materials and the percentage klasiber accessible.

E-learning interaction data show that students actually provide less interest in independent learning activities through klasiber, unless there is a strong impetus and the reason given by lecturers, namely completing the task / quiz. Motivation utilization of the e-learning material to the deepening of the activity in class, in this case has not been fully achieved. However, many similar problems were reported by researchers from the action research system of distance learning (e-learning).

In teaching literature with visualization and interactive tutorials, the effectiveness of the delivery of content will increase if it involves greater opportunities for students to explore curiosities in order to achieve learning objectives. Therefore, the material presented in meetings online visualization and interactive tutorials in e-learning klasiber. The important thing that needs to be examined from the success of the program is the interest of learners as delivered from some literature that e-learning relies on learning the awareness factor and interests of learners, especially if learners are adult learners (Smith, 2008).

E-learning can be considered as a new learning method that is continuous together with the concept of self-learning, active learning, self-directed learning (self-directed learning), simulation and visualization. Most methods are based on the theory of constructivism in which, according to Reiser (2001), learners become responsible for managing their own learning process. Motivation is a factor that leads to private students, independent, and dependent on the active participants in the learning metacognitive (Marten et al., 2012). According to a summary Cocea and Weibelzahl (2012), is the main motivating factor that drives the success of the self-study e-learning systems. In principle, E-learning provides a virtual environment without any physical contact with others, therefore it is difficult for learners to feel the presence of the natural of the traditional learning environment (Garrison, 2007).

Research there has shown that, with the perception of social presence and teaching presence provides an experience of "involvement" in the classroom directly and give the role of motivation (Xia, 2003).

Conclusion

Some outcome can be inferred from the description of the discussion and analysis are as follows:

1. Visualization significant effect on student understanding and achievement of learning outcomes indicated final grade distribution, student interest in classes in Physics and Chemistry subjects approval visualization applications on the same subjects clumps at the next level.

2. From a series of visualizations are presented in klasiber, emphasis on local genius oil has not been seen clearly. Repairs to the composition of the visualization needs to be done on them by presenting interactive reading materials and additional allocation of time in the classroom.
3. Factor plays an important interest of learners in successful learning through e-learning klasiber. From a series of learning methods have been explored, students still lack the motivation to learn independently through e-learning klasiber. Improvements in material design in e-learning klasiber need to be refined.

The next recommendation of the program is the use of a continuous visualization and interactive tutorials with interactive tutorial system improvements in order to enable learners independently.

References

Cocea, M., Weibelzahl,S., Motivation – Included Or Excluded From E-Learning, (2002). Evaluation of Adaptive Systems, http://www.easy-hub.org/, diakses tanggal 10 Juli 2012.

Coll, R.K. and Treagust, D.F. (2010).Investigation of Secondary School, Undergraduate and Graduate Learners" Mental Models For Ionic Bonding. *Journal of Research in Science Teaching*, 40 (5), 464-486.

Harrison, A.G and Treagust, D.F (2000).Learning about Atoms, Molecules Chemical Bonds: A Case-Study of Multiple Model Use in Grade-11 Chemistry. Science Education. 84, 352-381

Martens, R., Gulikersw, R., Bastiaensw, T., 2012. The impact of intrinsic motivation on e-learning in authentic computer tasks, *Journal of Computer Assisted learning* 20, pp368–376.

Randler, C.,Bogner, F.X., (2008). Planning Experiments in Science Education Research: Comparison of a Quasi-Experimental Approach with a Matched Pair Tandem Design, *International Journal of Environmental & Science Education,* 3(5)95-103 .

Reiser R. (2001) A history of instructional design and technology. Part 2: a history of instructional design. Educational Technology, Research and Development 49, 57–67.

Sharma, Y. K. & Sharma, M. 2006. Educational Technology and Management. Kanishka Publishers, Distributors, New Delhi-110 002. Vol-1. pp. 28, 31, 40-47, 57-58, 83, 142-143.

Suleiman, Q., Aslam, H.D., Sarwar, S., Shakir, M., Shabbir, F., Hussain, I.(2011). Effectiveness of Educational Technology in Teaching Chemistry to Secondary School Students in Khyber Pukhtunkhwa, American Journal of Scientific Research, 41(2011), :115-131.

Tuvi-Arad and R. Blonder, (2010). Continuous symmetry and chemistry teachers: learning advanced chemistry content through novel visualization tools, *Chemistry Education Research and Practice* 11(1), 48-58.

Wang A. Y. and Newlin, M. H.(2002). Predictors of web-student performance: The role of self-efficacy and reasons for taking an on-line class. In *Computers in Human Behavior*, 18, 151-163.

Wanyonyi, M.(2010). Secondary School Students‟ Understanding of Structure and Chemical Bonding Concept: A case of Bungoma West District Unpublished MSc. Thesis, MasindeMuliro University of Science and Technology, Kakamega, Kenya.

Xia, S. (2003). Thinking towards teaching *Physical Chemistry* in China: How to increase the learning interest in this course, China Peper, July, 23-25.