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Content

ISBN: 978-602-73192-0-2

Keynote Speaker 1

Nobuyoshi Koga

A Multidisciplinary and Comprehensive Chemistry Teaching/Learning for Next Generation

Nobuyoshi Koga

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Abstract

It is recognized that the successful promotion of STEM education is continuous subject for realizing the sustainable development of the world with the aid of scientific and engineering innovations. For promoting STEM education, science education involving chemistry education should play an important role because of its multidimensional objects. When the educational objects, involving the trainings and acquisitions of scientific concepts, knowledge, methodologies, skills, logical thinking, science ethics, and so on, were sufficiently achieved as the results of highly motivated student inquiries, the teaching/learning activities in science education can be the core for linking different STEM subjects and promoting the overall STEM education. For chemistry education, many distinguished materials and phenomena applicable to introduce different chemical topics at different learning stages are available in our neighborhood. Using those instruction materials, well-organized inquiry activities for studying chemistry can be designed with different types of scientific inquiry processes. For the success of chemistry education, systematic organization of the multiplicities of the instruction materials and pedagogical designs in chemistry learning programs and curriculums appears to be one of the keys.

In this talk, a possible strategy for realizing such a multidisciplinary and comprehensive chemistry teaching/learning in K-12 level is discussed by reviewing our challenges of research based educational practices in STEM-focused schools. First, the basis for developing the next generation chemistry teaching/learning is considered on the basis of the present status and issues of chemistry education. A possible curriculum design is then proposed with an emphasis of the requirement of storylines of chemistry learning for students. A series of learning programs with different styles of inquiry-based laboratory exercises applied at different learning stages and situations construct the storyline, which closely correlates everyday chemistry learning based on content-based learning and periodically introduced inquiry-based learning. Instruction materials utilized in the learning programs can be found in elsewhere. The learning programs using household materials [1,2], minerals [3], and thermochemical phenomena [4-9] are introduced by describing the multiple faces of these instruction materials and pedagogical logics and by reviewing our educational practice in schools. The multifaceted feature of the instruction materials links length and breadth of the different learning topics in chemistry, the different subjects in science education, and further the different STEM subjects. At the end, ability being required for chemistry teachers for promoting the ideal chemistry education is discussed by introducing the know-how of pre-service and in-service teacher trainings accumulated in our Department of Science Education, Graduate School of Education, Hiroshima University.

[1] N. Koga, T. Kimura, K. Sigedomi, *J. Chem. Educ.*, 88(9), 1309-1313(2011).
[2] T. Wada, N. Koga, *J. Chem. Educ.*, 90(8), 1048-1052(2013).
[3] N. Koga, Y. Matsuda, H. Tanaka, *Chem. Educator*, 10(6), 440-443(2005).
[4] M. Tesaki, N. Koga, Y. Kawasaki, Y. Furukawa, *Chem. Educator*, 12(4), 248-252(2007).
[5] N. Koga, T. Kimizu, M. Sakamoto, Y. Furukawa, *Chem. Educator*, 14(5), 225-228(2009).
[6] T. Tatsuoka, N. Koga, *J. Chem. Educ.*, 90(5), 633-636(2013).
[7] N. Koga, K. Sigedomi, T. Kimura, T. Tatsuoka, S. Mishima, *J. Chem. Educ.*, 90(5), 637-641(2013).

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[8] N. Koga, Y. Goshi, M. Yoshikawa, T. Tatsuoka, *J. Chem. Educ.*, 91(2), 239-245(2014).
[9] T. Tatsuoka, K. Sigedomi, N. Koga, *J. Chem. Educ.*, (2015), doi: 10.1021/ed500947t.

Keynote Speaker 2

Bhinyo Panijpan

Chemistry Education at Tertiary Levels

Bhinyo Panijpan

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Abstract

Chemical education has to keep abreast of on going research and development in chemistry in light of the omnipresence of electronic data, information, knowledge and knowhow. Curriculum or instruction, pedagogy and assessment need to be constantly modified. Frequent instructor - student interaction is necessary. Research and development by instructors are essential.

Keywords : Frequent instructor

Introduction

One prominent aspect that distinguishes this present century from the past 20th century in the omnipresence of the Internet . The Internet facilitates ever faster and wider same-time accessibility to electronic information and communication worldwide. Now people everywhere could be equal in learning about things past, present and the near future given the opportunity, the will and necessary resources. They can receive and distribute information almost instantly. The likes of Google, Wikipedia, on-line publications, electronic databases, posted lectures and animations, social media, etc. make it possible for people to intelligently learn about their world and beyond.

Thus we are no longer confined to textbooks, monographs, paper-based publications, etc. Learners and instructors can dig into the world' s treasures of good data, information, knowledge and wisdom as much as they want. Now the challenge is how to benefit the most from what is available in terms and

electronic and human resources.

In the last few decades leading chemistry research works and their applications have undergone some significant transformations. However, textbooks and materials used to teach undergraduates lack behind realities in the field more than before. The mode of instruction in the lectures and student laboratories also lacks behind. We therefore have to concentrate more on present works in chemistry that will lead to usage in the near future.

Changes in Chemistry

For good reasons research in chemistry has recently emphasized more on biologically important problems of big molecules, biological mimic structures, applications at the sub-micron and nano levels. Synthesis of unusual and large structures has also been more and more ambitious. Novel sensors, energy converters, catalysts are intensely researched and commercial applications are made not too long after R&D. Analytical tools have also been more powerful as well as sensitive.

Gigantic biological structures and functions have become solved routinely by nuclear magnetic resonance, x-ray diffraction, mass spectrometry, Raman spectroscopy, spectrofluorometry, etc. Single molecule studies are more possible. Also atomic force microscopy is becoming more far reaching. These techniques must be taught at lower levels now.

Elements beyond the third period that used to be ignored or relegated to a few mentions in introductory courses have now become more prominent commercially and in research &development, these heavier elements used in the semiconductor and superconductor industries should be emphasized more,

Changes in Pedagogy

The above calls for big changes in pedagogy toward student-centered learning which is now more justified than before.

Since students can learn about things any time and anywhere which come with instant and ubiquitous accessibility to the internet, the emphasis now must be on their profound learning at levels not quite emphasized before, e.g., ability to compare and contrast, to analyze and synthesize, to evaluate what is being presented. Students also have to be able to work together collaboratively because the world now demand creativity and innovation. Instructors have then to be value-added agents by being interactive with students so that the latter own their knowledge by actively learn and reflect on what they acquire in class and outside class. Instructions have to be challenging and authentic so that students will carry out laboratory work more actively. Assessments of success and achievement have also be authentic as well as futuristic.

Thus curriculum has to be constantly changing to respond to the real world that our graduates have to face upon graduation and beyond in their employment. They will have to be knowledge workers, life-long learners with creativity and ability to communicate well.

New Roles for Instructors

Instructors have to move away from their conventional teaching approaches to lecture, laboratory and assessment of students' performance. They have to interact with students more so that they can assess them formatively to ensure better learning for higher numbers of students.

Instructors have to actively do research, attend seminars and conferences on chemistry. They have to work together with other instructors to find better ways to instruct, e.g., being good coaches, guides, facilitators, mentors, etc.

In addition instructors should read published work on chemical education. Better still they should carry out chemical education research and use their own works as well as others' to help in their instruction. Instructors should invent apparatuses for demonstration and electronic simulations and games to attract interest of students. The author will provide several of his published works to show that these works are possible while one pursues conventional research, publication and other duties.

Conclusion

In this fast changing world of instant accessibility to chemical information and new trends of rapid application of chemical research, instructors and learners have to interact more frequently for more profound life-long learning. Curriculum/instruction, pedagogy and assessment have to take advantage of the changes above. Instructors have keep abreast of the field by carrying out conventional research and following published chemical education research works.

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Keynote Speaker 3

Kamisah Osman

Students as Digital Game Designers: Addressing the 21st Century Chemistry Education Needs in Malaysia

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Abstract

In order to meet the challenges in the global economy market of the 21st century, Malaysia needs to produce students who master both the knowledge of chemistry and 21st century skills. Chemistry is one of the important branches of science. However, chemistry is perceived as a difficult and unpopular subject due to the abstract nature of chemical concepts. The purpose of this paper is to propose an instructional approach that emphasizes simultaneously on enhancing conceptual understanding and developing the 21st century skills. Many studies have reported that digital game-based learning can provide positive impact on students‟ learning. Commercial and educational digital games have been developed for classroom integration. However, there are many obstacles to implementing the students as game consumers approach in the educational settings. One alternative approach offered by some researchers is to allow students to take on the role of game designers, developing digital games during teaching and learning process. It is believed that this approach can create a platform that allows students to deepen subject content knowledge, and practice various 21st century skills in real situations. Based on this approach, a module known as MyKimDG has been developed. This paper also demonstrate a brief lesson in MyKimDG to the teaching and learning of a specific unit in the Malaysian Chemistry Curriculum.

Keywords: chemistry learning, constructivism, constructionism, and learning through designing.

Introduction

Malaysia needs to produce students who are competent in the field of science and technology (S&T), and hence capable of generating S&T innovation to contribute to the well-being of mankind as well as to trigger the country‟s economic growth. To become competent in the field of S&T, students must be STEM (Science, Technology, Engineering and Mathematics) literate and have mastery of the 21st century skills.

STEM literate students must have master the knowledge of chemistry because knowledge of chemistry applied across most of the fields of S&T (Balaban and Klein, 2006). Indeed chemistry is often called the central science (Brown et al., 2011; Chang, 2007). According to Risch (2010), the knowledge of chemistry is the foundation for innovation, scientific literacy and most notably problem solving in connection with sustainable development. With chemistry knowledge, materials can be designed to solve various problems in everyday life. In the 21st century, chemistry will continue to play a leading role in the field of S&T and contribute towards solving the problems of human life.

Apart from knowledge, innovation in the 21st century requires a new range of skills known as 21st century skills. For example, innovation in today"s world is driven by the formation of networks with multiple parties including experts and researchers with related interests as well as consumers and customers. The 21st century skills enable one to communicate and collaborate effectively with various parties.

In short, students who are competent in the field of S&T must master both the knowledge of chemistry and the 21stcentury skills. Therefore, chemistry education in Malaysia in the 21st century should be given simultaneously on integration of knowledge acquisition and nurturing of 21st century skills to ensure that students are equipped with knowledge, skills and values that are relevant to the current needs so that they can adapt themselves to the 21st century work and social environments.

Chemistry Education in Malaysia

In the early 1960s, students at upper secondary level learn science based on the syllabus by the Cambridge Examination Syndicate. In 1972, Modern Chemistry subject was introduced at upper secondary level. The syllabus was adapted from the Nuffield Chemistry 'O' level course.

In 1989, an indigenous form of curriculum that best suit the national context, known as the Integrated Curriculum for Secondary School (KBSM), was implemented in Malaysian secondary schools. The Malaysian Science Curriculum was developed based on the National Education Philosophy, National Science Education Philosophy and taking into consideration the vision and mission of the national and global challenges.

Chemistry is one of the elective science subjects in the Malaysian Science Curriculum offered at the upper secondary level. The Chemistry curriculum has been designed not only to provide opportunities for students to acquire chemistry knowledge and skills, develop thinking skills and thinking strategies, and to apply this knowledge and skills in everyday life, but also to inculcate in them noble values and the spirit of patriotism (Bahagian Pembangunan Kurikulum, 2012).

In line with the current global changes in the 21st century as well as the national vision and mission, Malaysia has concentrated its efforts to produce students who are equipped with the knowledge, skills, and values that need to be mastered to succeed in life and careers in the 21st century. Starting in 2011, the national curriculum is giving greater emphasis on Higher Order Thinking Skills (HOTS), and various 21st century skills such as reasoning, creativity and innovation, entrepreneurship, and information and communication technology (ICT). Thus, in teaching and learning, teachers need to emphasise the mastery of those skills together with the acquisition of knowledge and the inculcation of noble values and scientific attitudes.

Digital Games and Chemistry Learning

Chemistry is usually considered difficult. The abstract nature of many chemical concepts is one of the key factors that cause difficulty in learning chemistry. While the literature is replete with studies and papers, which investigate students" understanding of chemical concepts and suggest potential remedies, fewer studies focus simultaneously on enhancing conceptual understanding and developing the 21st century skills. Hence, educators should be encouraged to design innovative and effective learning strategies to enhance both conceptual understanding and 21st century skills development. In this case, a change in chemistry teaching and learning (T&L) practices is critical. This is especially more crucial when dealing with today"s students who are „native speakers" (Prensky, 2001) of the digital language of computers, digital games and the internet. The T&L practices must meet the needs of these digital natives and subsequently achieve the desired aspiration.

One approach suggested by researchers to educate the digital native generation is the integration of digital games in the T&L processes as digital game is a medium favoured by students. In Malaysia, Rubijesmin (2007) showed that 92.1% of students involved in the study were familiar with digital games. After several years, Lay and Kamisah (2015) revealed that the percentage has increased to 98.8%, and 21.8% of them used at least 3 hours per day for playing digital games. Nowadays, the integration of digital games in learning or digital game-based learning (DGBL) is gaining popularity parallel with their popular reputation among students (Kamisah and Aini, 2013). Many studies have reported that DGBL can provide positive impact on students" learning. In general, the studies on DGBL were carried out through two approaches, namely (1) student as game consumer or player, and (2) student as game designer.

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In the first approach, the students were involved in playing digital games developed by educators or commercial digital games in the market. However, there are many obstacles to implementing the student as game consumer approach. For instance, the contents of commercial digital games are inaccurate or incomplete (Van Eck, 2006) and the development of professional educational digital games is time consuming (Hwang et al., 2013). In addition, many digital game players do not play educational digital games as they do not find the game play in these games to be compelling (Pivec, 2009). This happens because educational digital games are designed by academics who do not really understand the art, science and culture of digital game design (Van Eck, 2006). As a result, the product has failed dismally as a game. Prensky (2008) also raised this issue and states „*..the students had no input into its creation, and the stuff came out cute to the adults, but boring to the kids*". According to Prensky (2008), students even told straight forwardly: „*Don't try to use our technology, you'll only look stupid*."

One alternative of DGBL approach that has been proposed by some scholars (such as Kafai, 1996; Papert, 1998; Jung and Park, 2009; Kamisah and Aini, 2013) is for students to design their own digital games. Many studies have reported that this approach provide opportunities for students to explore ideas according to their own interests (Kafai & Ching, 1996); become active participants and problem solvers, engage in social interaction by sharing their designs and helping each other, and take ownership of their own learning (Baytak & Land 2010); acquire knowledge of programming (Kafai et al., 1997); as well as develop ICT literacy to produce new things and develop new ways of thinking based on the use of ICT tools (Kafai, 2006). Digital game design activities also open the door for young digital game players to become producers of digital games (Kafai, 2006). In addition, Vos, van der Meijden and Denessen (2011) has reported that this approach is a better way to increase student motivation and deep learning compared to the student as game consumer approach. In Malaysia, Yusoff (2013) also found that this approach can enhance students' knowledge in addition to creating a fun environment. In short, the student as game designer approach can enhance deep learning and provide a platform for students to develop the 21st century skills.

Therefore, we have initiated an innovation approach which involves students as digital game designers while learning chemistry to deepen their understanding in chemical concepts,

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and practice various 21st century skills. Students are expected to apply concepts learned in the course as well as ICT skills to collaboratively design digital games.

Learning Theories

The student as game designer approach is inspired by two important theories in learning and education which are constructivism and constructionism (Resnick, 2003).

1. Constructivism

According to constructivist theory of learning, learner is knowledge builder. Learner does not receive knowledge passively, but he/she interpret the knowledge received and then modify the knowledge in a form that acceptable to him/her. In other words, individual learner actively constructs new knowledge pursuant to his/her existing knowledge. Construction of new knowledge can be improved through social interaction. Vygotsky (1978) gave important to the role of social interaction in learning and cognitive development. He believed that collaboration between learner and teacher or more skilful peers will provide scaffolding to learner within the Zone of Proximal Development to construct new knowledge. However, no interaction would be beneficial if the new information is presented to students traditionally. Instead, students should be given the opportunity to explore the new knowledge. Bruner (1966) believed that learning and problem solving emerged out of exploration of new knowledge.

2. Constructionism

The theory of constructionism is built on the theory of constructivism which defines learning as knowledge construction in the student"s mind. In addition to the constructivist theory, constructionist theory of learning asserts that the construction of new knowledge happen felicitously in a context where students are consciously involved in the production of external and sharable artefacts (Papert 1991). This theory goes beyond the idea of learning-by-doing as indicated by Papert (1999a) that „*I have adapted the word constructionism to refer to everything that has to do with making things and especially to do with learning by making, an idea that includes but goes far beyond the idea of learning by doing*". Indeed, Papertian constructionism challenges the learner applying the knowledge being explored to construct more complex ideas or larger theory. This theory emphasizes the role of design (making, building or programming) (Kafai and Resnick, 1996) and external objects (Egenfeldt-Nielsen, 2006) in facilitating the

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knowledge construction. In this process, the designers (or learners) create artefacts which are significant to themselves based on their interests, learning styles and their experience, and shares their artefacts as well as the artefacts‟ designing process with others.

Computers play a role in the constructionist learning theory. Computers can be used as a building material (Papert, 1999a). The idea of using the computer as a construction material submitted by Papert is very different from the idea of using the computer as a tutor, tool and tutee put forward by Taylor (1980). For Papert and Franz (1988), a computer is a „material to be messed about with‟. Learning occurs when learners are 'messing about' with the computer. The introduction of computers is also able to change the context of learning (Papert, 1991). Computers can serve as a convivial tool (Falbel, 1991). The willingness of learners to learn will increase because they can use the computer in building artefacts (Papert, 1991). Papert (1980) has described that „*The computer is the Proteus of machines. Its essence is its universality, its power to simulate. Because it can take on a thousand forms and can serve a thousand functions, it can appeal to a thousand tastes*‟. However, he stressed that the main focus is not on the computer but on the minds of students (Papert, 1980).

Additionally, constructionist theory also values the diversity of learners and social aspects of learning. According to Kafai and Resnick (1996), this theory recognizes that learners can build relationship with knowledge through various ways, and community members can act as collaborators, coaches, audiences and co-constructors of knowledge in the constructionist learning environment.

Both constructivist and constructionist theories imply that learning depends on the learners themselves and learning can be enhanced through social interaction and discovery. Additionally, constructionist theory suggests that learning can be further enhanced if learners are involved in collaborative artefact designing projects using ICT as construction material.

Conceptual Framework of MyKimDG

Based on constructivist and constructionist theories, a module known as Malaysian *Kimia* Digital-Game (MyKimDG) has been developed as a mechanism for enhancing conceptual understanding and developing the 21st century skills. The conceptual framework of this study is summarized in Fig. 1.

ISBN: 978-602-73192-0-2

1. Learning Approach

Learning approaches such as collaborative learning, discovery learning and learning through designing digital game (student as game designer) are integrated in MyKimDG.

Collaborative Learning. Activities in MyKimDG are designed so that students engage in discussion, share and exchange ideas in groups. Through this approach, triggering of cognitive conflict and restructuring of ideas will occur when students share their ideas from their own perspective. It also improves students‟ 21st century skills such as collaboration, communication and interpersonal skill because students are able to practice in the real world.

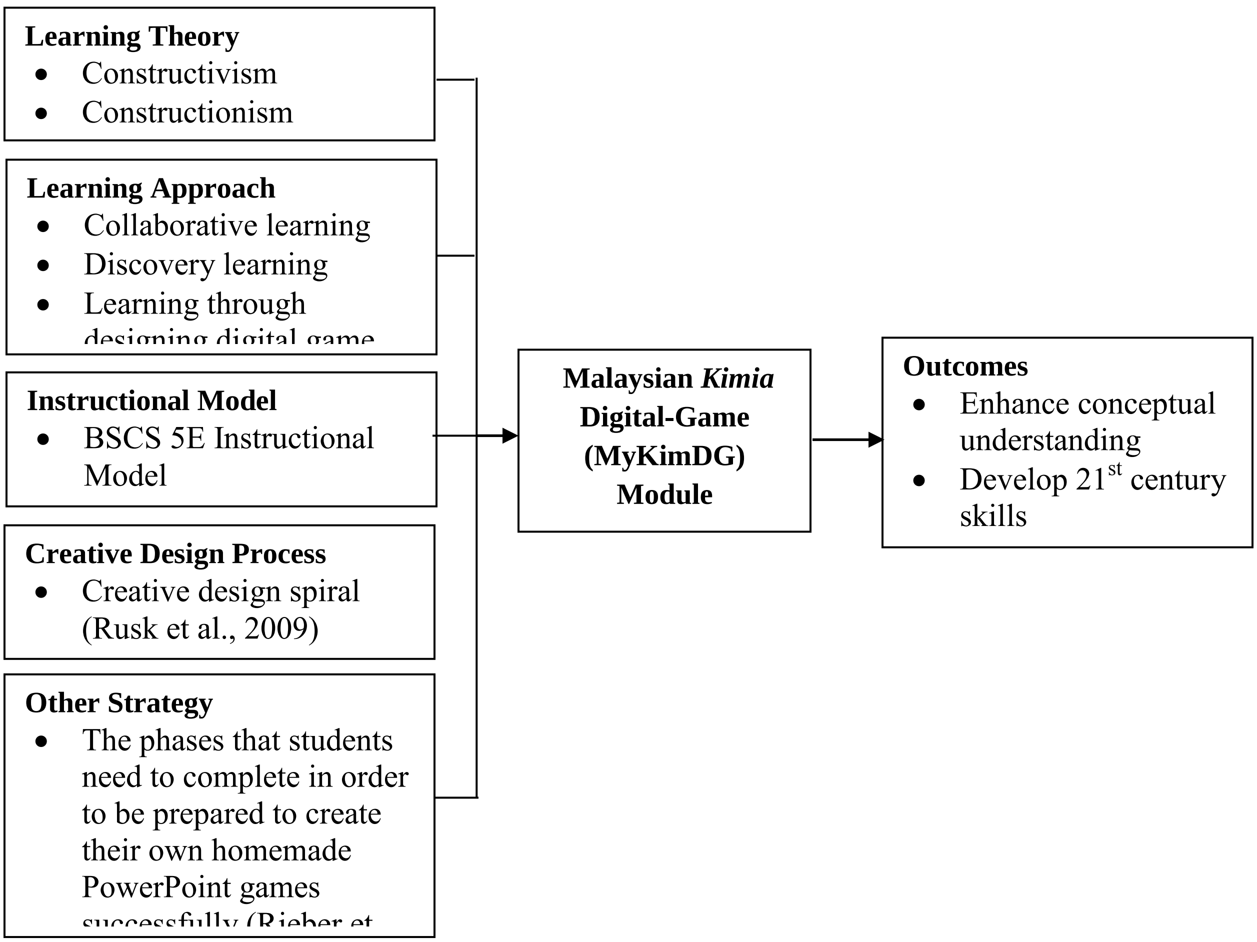

Fig. 1 Conceptual framework of study

Discovery Learning. Students are guided towards exploring chemical concepts. Students will gain deeper understanding when they are given opportunities to discover new concepts for themselves. It also lets students acquiring problem-solving skill, experiencing the exploration and discovery activities, and stimulating their own thinking. As students embark on the discovery process, teacher reminds them of the important of the process in learning. If they can perceive the values of the process, they will be motivated to learn chemistry. In this approach, students are empowered to take responsibility for their own learning and practice the 21st century skills in real situations.

Learning through Designing Digital Game. In MyKimDG, students are involved in designing PowerPoint games related to chemical concepts. They discuss in groups and apply the concepts learned to design PowerPoint games. With this, students can visualize the concepts in the sub-microscopic level.

PowerPoint game is selected as Microsoft PowerPoint software is available at all schools and the use of the software does not involve additional cost and complicated programming languages. The only technical skill that students need to master to design PowerPoint games is how to create custom animations. In addition, existing PowerPoint game templates are available online and can be modified by students to help them progressively master the game designing skills. This strategy is parallel with the development phases proposed by Rieber, Barbour, Thomas and Rauscher (2008). However, students are also encouraged to use other software like *Game Maker* and programming languages such as *Java*, *Logo* and *Scratch* if they are skilled in the software.

When students carry out their digital game designing project, they are guided to move through the creative design spiral (Rusk et al., 2009) in order to help them develop new ideas. Students are also given the autonomy to choose their own game design, plan and carry out the project based on the group‟s consensus. The students are also told that the PowerPoint game will be used to help their peers who face difficulty in learning the chapter. It is expected that this strategy will improve students‟ perceived competency, autonomy and relatedness, and hence increase their motivation in chemistry.

The learning through designing approach aims to deepen students‟ conceptual understanding in chemistry as cognitive conflict may be triggered during activities and hence, new understanding may discover. As the same time, it provides a platform for students to develop the 21st century skills.

ISBN: 978-602-73192-0-2

2. Instructional Model and Strategy

Studies have revealed that mastery of science concepts will be enhanced if students become aware of their misconception. To help students realize their misconception and replaced it with scientifically acceptable concept (i.e. conceptual change), cognitive conflict strategy has been proposed by scholars such as Piaget (1977) and Posner, Strike, Hewson and Gertzog (1982). Therefore, the BSCS 5E Instructional Model (Bybee et al., 2006) designed to facilitate conceptual change is applied in MyKimDG.

To help students understand the chemical concepts, students are guided to explain macroscopic experience at the sub-microscopic and symbolic levels. It is known that conceptual understanding in chemistry involves making use of three main representations or levels. The triplet relationship is the key model in chemical education (Gilbert & Treagust 2009).

In this study, the phases of the BSCS 5E Instructional Model and Creative Design Spiral have been modified and standardized. The resultant phases are Inquiry, Discover, Produce, Communicate and Review. Table 1 shows the phases in MyKimDG, and related phases of the BSCS 5E Instructional Model and Creative Design Spiral.

Table 1. Phases in MyKimDG and related phases of the BSCS 5E Instructional Model and Creative Design Spiral

MyKimDG	BSCS 5E Instructional Model	Creative Design Spiral
Inquiry	Engage	Imagine
Discover	Explore	Experiment
Produce	Elaborate	Create
Communicate	Explain	Share
Review	Evaluate	Reflect

During implementation of MyKimDG, students are guided to experience and realise the phases. As the process is done repeatedly, new ideas are always generated and students‟ 21st century skills such as inventive thinking skills are developed. Students are expected to practice the process in everyday life and in the workplace.

Apart from that, it is expected that the acronym IDPCR can help students remember the five important clusters of 21st century skills which need to be integrated in the Malaysian science curriculum, i.e. Inventive thinking, Digital-age literacy, high Productivity, effective Communication and spiritual values (*nilai Rohani*). The five clusters of 21st century skills have been identified by Kamisah and Neelavany (2010). Table 2 showed the outline of instructional activities in MyKimDG.

Table 2. Outline of Instructional Activities in MyKimDG

Phase	Purpose	Activity
Inquiry *Predict, ask, hypothesize, identify problem, brainstorm*	1. Arouse students‟ interest 2. Access students‟ prior knowledge 3. Elicit students‟ misconceptions 4. Clarify and exchange current conceptions	1. Teacher shows discrepant events. 2. Students make observations and explain the phenomena at the sub-microscopic and symbolic levels. 3. Students discuss in groups and compare their ideas with their peers.
Discover *Investigate, experiment, explore*	1. Expose to conflicting situations 2. Modify current conceptions and develop new conceptions 3. Provide opportunities for students to demonstrate their conceptual understanding, and skills	1. Students perform hands-on and minds-on activities in groups. 2. Students are encouraged to engage in discussions and information seeking using ICT. 3. Students generate explanation of the observed phenomenon. 4. Students practise the skills needed in an experiment or activity. 5. Students are asked to communicate in groups and report back with their findings.
Produce *Create, construct, invent, build, design, tinker, elaborate*	1. Challenge and deepen students‟ conceptual understanding and skills 2. Provide additional time and experiences that contribute to the generation of new understanding	1. Students apply their new ideas by conducting additional activities 2. Students perform additional tasks that are more complex and involve HOTS. 3. Students carry out open-ended projects. 4. Students create digital games.
Communicate *Explain, share, discuss with peers, ask an expert, defend*	1. Provide opportunities for students to share their new understanding and skills 2. Provide opportunities for students to exchange their new understanding	1. Students report back with their new ideas and skills. 2. Students also listen to input from peers and defend their ideas. Peer‟s input may guide them towards deeper level of understanding. 3. Students compare their ideas with the

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		teacher's explanations.
Review *Check, evaluate, reflect, improve, repair*	1. Students assess their understanding, skills and competencies 2. Students think creatively for the purpose of improvement 3. Teachers evaluate student progress toward achieving the learning outcomes	1. Students reflect upon the extent to which their understanding, abilities and competencies have changed. 2. Students improve their ideas or skills based on reflection or input from peers. 3. Teacher conducts a test to determine the level of understanding of each student.

Implementation of MyKimDG

In the following section, the authors present a brief lesson in MyKimDG to the teaching and learning of a specific unit (i.e. preparation of insoluble salts) in the Malaysian Chemistry Curriculum which involved precipitation reaction.

Inquiry

1. Teacher demonstrates two reactions that may be used to prepare lead(II) sulphate:

	Reaction	*Observation*	*Chemical equation*
A	Lead(II) nitrate solution + sodium sulphate solution		
B	Excess solid lead(II) carbonate + dilute sulphuric acid		

2. Students record the observations and write the chemical equations involved.
3. Students describe how to obtain lead(II) sulphate from the mixture in Reaction A and B.
   (a) Draw the set-up of the apparatus is involved.
   (b) In your opinion, which reaction is more appropriate to prepare insoluble salts such as lead(II) sulphate? Explain your answer.
4. Students make a conclusion about the appropriate reaction to prepare insoluble salts.
5. Students share their findings with other groups.
6. Students are asked to explain the strategy used, i.e. inquiry-discovery.

Discover

1. Students plan experiments to prepare lead(II) iodide and silver chloride in group.
   (a) Discuss the materials needed to prepare lead (II) iodide and silver chloride.
   (b) Write the chemical equations involved.
   (c) Plan the procedures for experiment by constructing flowchart.
2. Students carry out experiment to prepare lead(II) iodide and silver chloride.
3. Students generate explanation of each phenomenon.
4. Students are asked to report back with their findings.

Produce

1. Students play a game related to the precipitation reactions involved in the preparation of insoluble salts.

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2. Students are asked to differentiate between a good game and a bad game.
3. Students are asked to improve the game to make it more educational and entertaining following phases of IDPCR, in order to help their peers who face difficulty in learning the concept.
4. Students are told that they may commercial their innovative product to benefit financially.
5. Students are reminded to apply 21st century skills during the project.

Communicate

1. Students share their digital games with other science or chemistry educators.
2. Students improve their digital games.

Review

1. Students plan and carry out experiments to prepare lead(II) chromate and barium sulphate in group.
2. Students write the chemical and ionic equation involved.
3. Students reflect upon the extent to which their understanding, abilities and competencies have changed.

Conclusion

In this study, collaborative learning, discovery learning and learning through designing digital game are integrated in the MyKimDG. The learning approaches will create supportive learning environments for student to learn chemical concepts meaningfully. Most importantly, MyKimDG allows students to practice the 21st century skills in real situations. In conclusion, the implementation of MyKimDG can help improve students" achievement in chemistry and their 21st century skills.

References

Bahagian Pembangunan Kurikulum, 2012, *KBSM: Spesifikasi Kurikulum Kimia Tingkatan 4,* Putrajaya: Kementerian Pelajaran Malaysia.

Bahagian Pembangunan Kurikulum, 2013, *KBSM: Spesifikasi Kurikulum Kimia Tingkatan 5,* Putrajaya: Kementerian Pelajaran Malaysia.

Balaban, A. T., and Klein, D. J., 2006, Is chemistry "The Central Science"? How are different sciences related? Co-citations, reductionism, emergence, and posets. *Scientometrics*, *69*(3), 615–637. http://doi.org/10.1007/s11192-006-0173-2.

Baytak, A., and Land, S. M., 2010, A case study of educational game design by kids and for kids. *Procedia - Social and Behavioral Sciences*, *2*, 5242–5246. http://doi.org/10.1016/j.sbspro.2010.03.853.

Brown, T. L., LeMay, H. E., Bursten, B. E., Murphy, C., and Woodward, P., 2011, *Chemistry: The Central Science* (12th ed.), New Jersey: Prentice Hall.

ISBN: 978-602-73192-0-2

Bruner, J. S., 1966, *Toward a Theory of Instruction*. Cambridge, MA: Harvard University Press.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J., Westbrook, A., and Landes, N, 2006, *The BSCS 5E Instructional Model: Origins and Effectiveness*. Colorado Springs, CO: Biological Sciences Curriculum Studies.

Chang, R., 2007, *Chemistry* (9th ed.), New York: McGraw-Hill.

Egenfeldt-Nielsen, S, 2006, Overview of Research on the Educational Use of Video Games. *Digital Kompetanse*, *1*, 184–213.

Falbel, A., 1991, The Computer as a Convivial Tool. In I. Harel & S. Papert (Eds.), *Constructionism* (pp. 29–37), Norwood, NJ: Ablex Publishing Corporation.

Gilbert, J. K., and Treagust, D. F., 2009, Introduction: Macro, Submicro and Symbolic Representations and the Relationship Between Them: Key Models in Chemical Education. In J. K. Gilbert and D. Treagust (Eds.), *Multiple Representations in Chemical Education* (pp. 1–8). Dordrecht: Springer Netherlands.

Hwang, G.-J., Sung, H.-Y., Hung, C.-M., Yang, L.-H., and Huang, I., 2013, A Knowledge Engineering Approach to Developing Educational Computer Games for Improving Students‟ Differentiating Knowledge. *British Journal of Educational Technology*, *44*(2), 183–196.

Jung, J. Y., and Park, H., 2009, Learning by Doing via Game Making. In D. Gibson and Y. Baek (Eds.), *Digital Simulations for Improving Education: Learning Through Artificial Teaching Environments* (pp. 394–406), Hershey, PA: Information Science Reference.

Kafai, Y. B., 1996, Learning Design by Making Games: Children‟s Development of Design Strategies in the Creation of Complex Computational Artifact. In Y. Kafai and M. Resnick (Eds.), *Constructionism in Practice: Designing, Thinking, and Learning in a Digital World* (pp. 71–96), Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Kafai, Y. B., 2006, Playing and Making Games for Learning: Instructionist and Constructionist Perspectives for Game Studies. *Games and Culture*, *1*(1), 36–40.

Kafai, Y. B., and Ching, C. C., 1996, Meaningful Contexts for Mathematical Learning: The Potential of Game Making Activities. In *Proceedings of the 1996 International Conference on Learning Sciences* (pp. 164–171).

Kafai, Y. B., Ching, C. C., & Marshall, S. (1997). Children as Designers of Educational Multimedia Software. *Computers & Education*, *29*(2-3), 117–126.

Kafai, Y. B., and Resnick, M., 1996, Introduction. In Y. Kafai and M. Resnick (Eds.), *Constructionism in Practice: Designing, Thinking, and Learning in a Digital World* (pp. 1–8). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Kamisah Osman and Marimuthu, N., 2010, Setting New Learning Targets for the 21st Century Science Education in Malaysia. *Procedia - Social and Behavioral Sciences*, *2*, 3737–3741. http://doi.org/10.1016/j.sbspro.2010.03.581.

Kamisah Osman and Bakar, N.A., 2013, Teachers and Students as Game Designers: Designing Games for Classroom Integration. In S. de Freitas, M. Ott, M. M. Popescu, & I. Stanescu

(Eds.), *New Pedagogical Approaches in Game Enhanced Learning: Curriculum Integration* (pp. 102–113). Hershey, PA: IGI Global.

Lay, A.-N., and Osman, K., 2015, Framework for 21st Century Chemistry Instruction: A Guide to Teaching and Learning of Qualitative Analysis. *Technics Technologies Education Management*, *10*(2), 216–230.

Papert, S., 1980, *Mindstorm: Children, Computers, and Powerful Ideas*. New York: Basic Books.

Papert, S., 1991, Situating Constructionism. In I. Harel & S. Papert (Eds.), *Constructionism* (pp. 1–28). Norwood, NJ: Ablex Publishing Corporation.

Papert, S., 1996, A Word for Learning. In Y. Kafai & M. Resnick (Eds.), *Constructionism in Practice: Designing, Thinking, and Learning in a Digital World* (pp. 9–24). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Papert, S., 1998, Does Easy Do It? Children, Games, and Learning, *Game Developer Magazine*, 88.

Papert, S., 1999a, *Eight Big Ideas Behind the Constructionist Learning Lab* (Vol. 405), Retrieved from http://stager.org/articles/8bigideas.pdf

Papert, S, 1999b, Introduction: What is Logo? Who Needs It? In C. Fonseca, G. Kozberg, M. Tempel, S. Soprunov, E. Yakovleva, H. Reggini, D. Cavallo (Eds.), *Logo Philosophy and Implementation* (pp. IV–XVI), Canada: Logo Computer System Inc.

Papert, S., and Franz, G., 1988, Computer as Material: Messing About with Time. *Teachers College Record*, *89*(3), 408–417.

Piaget, J., 1977, *The Development of Thought: Equilibration of Cognitive Structures*. New York, NY: Viking Press.

Pivec, P., 2009, *Game-based Learning or Game-based Teaching?* British Educational Communications and Technology Agency (BECTA). Retrieved from http://dera.ioe.ac.uk/id/eprint/1509

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A., 1982, Accommodation of Scientific Conception: Toward a Theory of Conceptual Change. *Science Education*, *66*(2), 211–227.

Prensky, M., 2001, Digital Natives, Digital Immigrants. *On the Horizon*, *9*(5), 1–6.

Prensky, M., 2008, Students as designers and creators of educational computer games: Who else? *British Journal of Educational Technology*, *39*(6), 1004–1019.

Resnick, M., 2003, *The Clubhouse Learning Approach: Learning by Designing*. Retrieved from http://web.media.mit.edu/~mres/clubhouse/handouts/design-v6.pdf

Rieber, L., Barbour, M., Thomas, G., and Rauscher, D., 2008, Learning by Designing Homemade Powerpoint Games. In C. T. Miller (Ed.), *Games: Purpose and Potential in Education* (pp. 23–42). New York, NY: Springer.

Risch, B, 2010, *Teaching Chemistry around the World*. Munster: Waxmann.

Rubijesmin Abdul Latif, 2007, Understanding Malaysian Students as Gamers: Experience. In *Proceedings of the 2nd International Conference on Digital Interactive Media in Entertainment and Arts* (pp. 137–141). New York, NY: Association for Computing Machinery.

Rusk, N., Resnick, M., and Cooke, S., 2009, Origins and Guiding Principles of the Computer Clubhouse. In Y. B. Kafai, K. A. Peppler, & R. N. Chapman (Eds.), *The Computer Clubhouse: Constructionism and Creativity in Youth Communities* (pp. 17–25). New York, NY: Teachers College.

Taylor, R. P., 1980, Introduction. In R. P. Taylor (Ed.), *The Computer in School: Tutor, Tool, Tutee* (pp. 1–10), New York: Teachers College Press.

Van Eck, R., 2006, Digital Game-Based Learning: It‟s Not Just the Digital Natives Who Are Restless. *EDUCAUSE Review*, *41*(2), 16–18, 20, 22, 24, 26, 28, 30.

Vos, N., van der Meijden, H., and Denessen, E., 2011, Effects of Constructing Versus Playing an Educational Game on Student Motivation and Deep Learning Strategy Use. *Computers & Education*, *56*, 127–137. http://doi.org/10.1016/j.compedu.2010.08.013

Vygotsky, L. S., 1978, *Mind in Society: The Development of Higher Psychological Processes,* Cambridge, MA: Harvard University Press.

Yusoff, M. H., 2013, Knowledge Development through Constructionism Game-Based Learning Application: An Evaluation of Students‟ Performance, *International Journal of Future Computer and Communication*, *2*(3), 232–236.

Preparation and Applications of Clove Leaf Oil as Biopesticides Against of Lichenes on Stone Conservation at the Borobudur Conservation Body

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Abstract

The research of preparation and applications of clove leaf oil as biopesticides against of lichenes on stone conservation has been done. The methods for e*xtraction of* clove leaf oil are using steam-water distillation. The steam-water *distillation process* will take about *6 hours* for completion. The main compounds clove leaf oil are eugenol (62,25%), β-caryophyllen (31,08%), humulene (3,91%) and other compounds. Essential oil of clove leaf is made into the test solution concentration of 1, 5, 10, 15, and 25% using a solvent of 9% tween 80 in destilled water. The results showed that the essential oil at a concentration of 1, 5, 10, 15, and 25% can inhibit the growth of fungi of lichenes. The diameters of zone of inhibition at each concentration are 5.5; 7.0; 12; 20; and 23 mm, respectively. The optimum concentration of the test solution used for the study is the concentration of 25%.

Keywords: Lichenes, clove leaf oil, stone, conservation.

Introduction

Borobudur temple site made of andesite have various problems related with damages such as degradation by the influence of chemicals, as well as biological organisms. Factors that cause damage to the historic building that is chemical, physics and microbiology plays an important role in this process (Suihko *et al*. 2007). Microbial colonization of stones depends on environmental factors such as water availability, pH, climatic exposure, nutrient sources, and petrologic parameters, such as mineral composition, type of cement as well as porosity and permeability of the rock material (Warscheid *et al.* 2000).

Biotic damage is caused by growth and activity of high-level bodies in the form of plants, animals and microorganism. Bodies activity due to growth and metabolism can be accelerated physical and chemical environmental conditions which favor. Damages is getting worse because of the rock temple is an outdoor building so that it can be damaged due to physical factors (mechanical), chemistry and biology that can stand alone or a combination of more than one factor. The process of growth and metabolism of organisms require water, high relative humidity, nutrients, and to require the bodies of photosynthetic light (Santiko, 2012).

In terms of rock weathering process (first process of the formation of ground level), has recognized the important role of lichens, mosses, algae and some other microbe. Lichens are often the first occupants of the rock surface. Pleurococcoid algae can live with fungi that form symbiotic lenders and the beginning (protoliken). According to Santiko (2012), lichens can damage the rock in several ways, among others, due to the increase of mass during growth in cracks or crevices of rocks. With mechanical power due to stretching and shrinking colonies mainly on the type of crustaceous lichens and excretion of organic acids can damage the rock.

According to Adamo et al. (2000); Chen et al. (2000); Schiavon (2002); Dochne and Price (2010), has been reviewing the actions of Lichens and confirmed that Lichens have physical and chemical effects. Mechanical damage caused by the penetration of hyphae into the rock and the expansion and shrinkage of the thallus (vegetative part of the fungus) under changes in humidity. Chemical Damages, however, is more important and can occur in three ways: by their secretion of oxalic acid, the formation of carbonic acid, and the formation of other acids capable of forming ions such as calcium chelate.

The damage to stone cultural heritage objects caused by lichens requires a cleanup effort. Cleaning process use of pesticides, fungicides and insecticides synthetic such as AC 322 for cleaning lichens is not considered, because these materials contain the hazardous and toxic materials, especially the content of Arcopal at AC 322 which is hazardous and toxic materials that causing danger to humans who undertake conservation efforts, visitors, and the environment around cultural heritage objects. These materials can cause cancer because it is carcinogenic and mutagenic.

Alternative materials for the conservation of cultural heritage object using natural pesticides or vegetable has the potential to be developed. Botanical pesticides are pesticides that can be an alternative to reduce the use of synthetic pesticides. One of the natural materials that are easily obtainable, low cost and high effectiveness is essential oils. Some essential oils contain compounds benzene and the OH group, so that it can act as a botanical pesticide. Essential oil-based pesticide registration has escaped from the EPA (Environmental Protection Agency) and declared safe from the GRAS (Generally Recognized as Safe) so friendly to humans and the environment (Koul, et al., 2008).

Natural oils are divided into three groups such as mineral oils, vegetable and animal oils are edible (edible fat) and essential oil. Essential oils, also known as the etheric oils or fly oil (essential oil, volatile) produced by plants. This oil is volatile at room temperature without decomposition, has a bitter taste (pungent taste), and has good smelled fragrance accordance with the producing plants odor. Clove flower containing 20% oil, while the clove stem and clove leaf oil contains about 4-6%. Randemen, chemical and physical properties of essential oils depending on the source and quality of cloves, treatment before refining (chopped or without chopped). Essential oil extraction methods used desalination, water-steam distillation or direct distillation (Guenther, 2007).

Clove oil has a biological activity of, such as antibacterial, antifungal, insecticide, and antioxidant properties, and is traditionally used as flavorings, and antimicrobials in food (Lee and Shibamoto, 2001; Huang et al., 2002). The high content of eugenol in clove oil contributes to the antimicrobial strength. Phenolic compounds can denature proteins and react with cell membrane phospholipids then changed permeability (Bhuiyan et al., 2010).

Experimental

Preparation of Clove Leaf Oil

Clove leaf essential oil samples taken from the manufacturing plant essential oils CV. Surya Wulan, Kulonprogo, Yogyakarta generated from oil refining process which uses a system of steam distillation, steam distillation apparatus made of stainless steel with a capacity of 1000 kg of raw material. Clove leaf samples used for isolation is a sample of the type zanzibar clove leaf that has been dried, molt, and fell from the clove tree. The content of essential oil was analyzed by GC-MS Shimadzu QP 2010. Columns and detectors are used according to the essential oil of clove. Analysis of heavy metals contained in the volatile oil consisting of Cr, Cd and Pb is done by using Atomic Absorption Spectrophotometer (AAS) Perkin Elmer 5500.

Isolation of fungus of lichens and colony selection

Fresh lichenes scraped from the stone temples. All equipment such as scrapered, petri dished, should be in a state of sterile to avoid contaminants that interfere observations of other microorganisms. Lichens which has been scraped then inserted uniformly into three sterile petri dishand cultured in a medium PDA using poured method , allowed for 27-48 days to grow colonies. After colonies formed in third petri dished method , then selected a type of fungus that grows predominantly on third petri dished method then chosen as the fungus of lichens. the fungus culture was inoculated into a new PDA and inoculated on an agar medium slant for the purposes of the stock. Types of fungi were identified using a microscope.

Testing Antifungal Activity of Clove Leaf Essential Oils diffusion method

Paper disk diameter of 6 mm dipped on the test solution which concentration of 1%, 5%, 10%, 15%, and 25%, then taken cultured lichen fungi using aseptic way and put in a sterile petri dish, then poured PDA medium and twisted around to flatten culturing the fungus in a petri dish. After becoming semi-solid medium, paper aseptically placed on a layer of agar, sought to put the filter paper in the middle of the circle petri dish. Then incubated at room temperature to form a fungus colony. Inhibitory zone was observed and measured to the nearest 0.5 mm with a ruler. Determined the effectiveness of the inhibition zones of the five variants of concentration and made optimum concentration.

Testing Inhibition Effects of Essential Oils of Clove Leaf In The Field

Applied test solution concentration of 1%, 5%, 10%, 15%, and 25%, to the surface of the lichen on the rocks of cultural heritage. Observations were made 24 hours after application of the oil, and observed for 5 days after the application of of essential oils. Observations were made in two ways are visually by observing the change in color of the surface of the lichens are applied, where the color change compared with the observation of discoloration on the control and using Scanning Electron Microscope (SEM) JEOL JSM-IT300.

Result and Discussion

The analysis of chemical components contained in the clove leaf oil using GC-MS is shown in Figure 1.

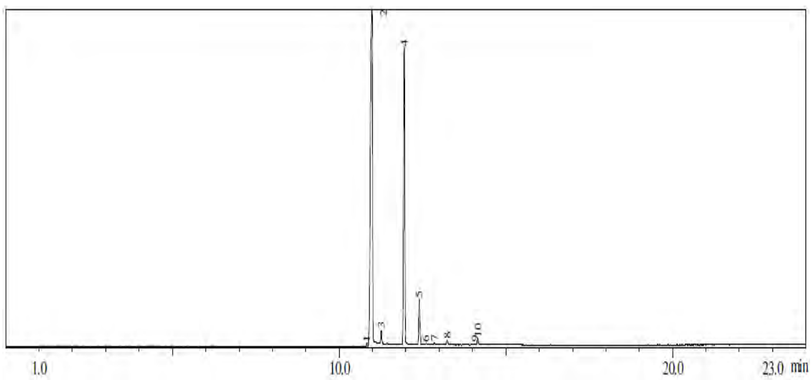

Figure 1. Chromatogram of clove leaf oil

Figure 1 shows that on chromatogram there are ten peaks were detected. Each peak has a characteristic retention time and% component as shown in Table 1.

Table 1. Chromatogram peak characterization of Clove Leaf Essential Oil Components

Peak Number	Retention time (min)	% Area
1	10,829	0,21
2	10,980	62,25
3	11,271	1,03
4	11,955	31,08
5	12,407	3,91
6	12,600	0,12
7	12,860	0,18
8	13,235	0,53
9	14,075	0,08
10	14,157	0,63

Identify the components of the three dominant peak is done by comparing the mass spectra contained in the library are stored in a computer in MS. Identification obtained from the three dominant peaks in sequence is the peak number 2 shows the components eugenol, the peak number 4 shows the components of β-kariofilen, and the peak number 5 shows the components humulen. The other peaks other than eugenol, humulen, and β-kariofilen obtained by using GC-MS are α-Cubeben, α-Copaene, Farnesene, δ-Cadinene, Caryophyllen oxyde. This shows that the component eugenol is the main compound in the essential oil of clove leaf. Analysis of heavy metal content in the essential oil of clove leaf used in this study, carried out using instruments Atomic Absorption Spectrophotometer (AAS), and the result as shown in Table 2.

Table 2. Result of heavy metals analysis by using AAS

No.	Heavy Metal	Concentration (mg/L)
1	Krom	0,0498
2	Kadmium	0,0694
3	Timbal	0,0253

Heavy metals can serve as an antimicrobial because it may precipitates enzymes or proteins in a cell. Antimicrobial properties of heavy metal, which in small concentrations can kill microbes. This power is called power oligodinamik, because that heavy metals can be used as a disinfectant and antiseptic. From the nature property of these heavy metals therefore a test for heavy metals in the clove leaf oil is important, and of the three heavy metals Cadmium, Chromium and Lead has been analyzed using atomic absorption spectrophotometers (AAS), it is known that clove leaf oil contains heavy metals with very small concentrations, so it is suspected in the study, the response of materials to the inhibition of the growth of microorganisms lichens instead of heavy metals but from the essential oil of clove leaf.

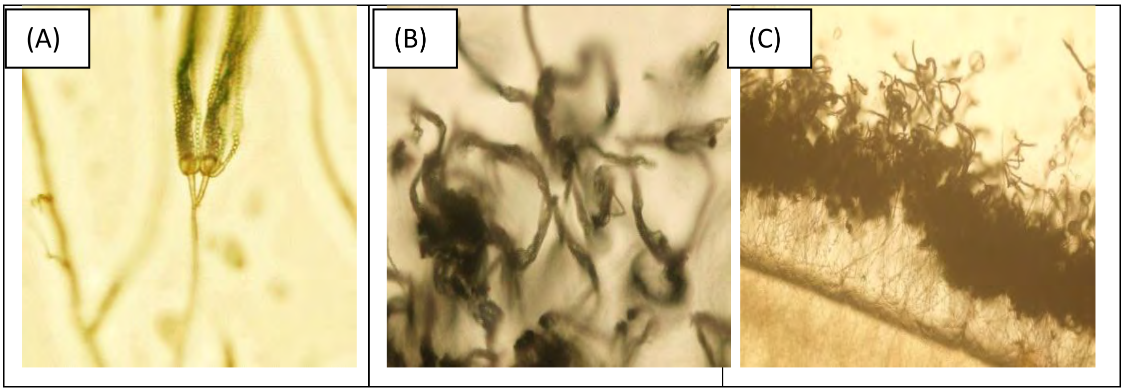

Figure 2. Pencillium sp fungus observations using a microscope using a magnification of 400 X, where (A) fungi that live singlely (B) fungi that live in colonies and (C) sectional fungus Penicillium sp

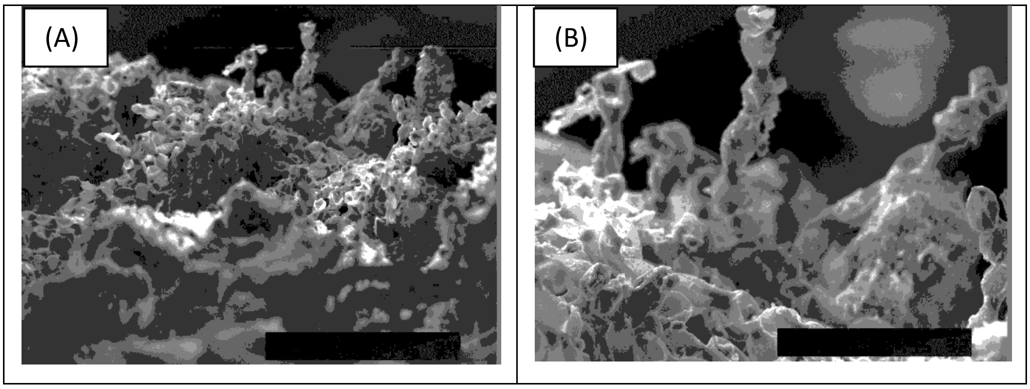

Figure 3. Observations result of fungal culture using SEM, where (A) using a magnification of 200 (B) magnification of 500

Identification results shows that this type of isolated lichen fungus belonging to the family of *Penicillium* sp. The same results were also obtained using the SEM, which types of isolated lichen fungi is a fungus belonging to the family of *Penicillium* sp. So there is similarities result on the identification using microscopy and SEM. Results of testing the antifungal activity of the clove leaf oil with various concentrations using the agar diffusion method against fungi in lichens are presented in Table 3.

Table 3 Inhibition zone measurement of test solution for antifungal Test On Media PDA

No.	Solution test concentration (%)	Inhibition zone diameter (mm)
1	Control	0
2	1 %	5,5
3	5%	7,0
4	10%	12
5	15%	20
6	25%	23

Based on Table 3 observed visually can be seen that the antifungal test using the test material showed inhibition on the growth of fungi lichens, either in antifungal test using the test material concentration of 1%, 5%, 10%, 15%, and 20%. This is also evidenced by the results of the measurement of the inhibition zones as shown in Table 6. The presence of inhibition occurred at concentrations of 1%, 5%, 10%, 15%, and 25% were compared with a control which is the inhibition test using test solutions tween 80 9 % + distilled water which can then be known that the inhibition of control does not occur. Therefore, it can be said that the solvent for the test material has no effect on the inhibition of the fungus. Diameter zone of inhibition by the test substances on the growth of lichens have a linear relationship between the concentration of the constraints zone, where the greater concentration of the test material used generate the larger diameter of the inhibition zone. However, the tests conducted, the diameter of inhibition zone in antifungal test concentration of 15% shows clear limit. Likewise shown in antifungal test using test material concentration of 25%, indicating inhibition zone limits is very clear, therefore, from the 5th test materials used to test the antifungal properties of essential oils of clove leaf on lichens, the concentration of the test material 25% considered to be the most effective concentration to inhibit the growth of microorganisms forming fungus as lichen on the stone.

Their inhibition by essential oils on the growth of fungi has been demonstrated by several researchers previously. According Ridawati *et al* (2011) the constituent hydrophobic molecules of essential oils can cause changes in the permeability of membranes and membrane damage that eventually leads to cell death. Molecules of essential oils can also affect the enzymes bound to the cell membrane of yeast, thereby disrupting the work activity in the cell membrane.

Eugenol as antifungal research has also been conducted by previous researchers. Bevilacqua

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et al. (2008) explains that the antimicrobial activity of eugenol influenced by a secondary alkyl group, and a phenolic OH group of highly reactive form hydrogen bonds with the enzyme. Moreover, according to Knobloch *et al* in Harni *et al*. (2013), the compound eugenol inhibit fungal metabolic processes so that interfere with growth. The chemical components of essential oils that are antifungal can penetrate cell walls of fungi and would interfere with the metabolic processes in cells so that experiencing cell death.

In the previously research, Park *et al*. (2007), mentioned that the eugenol compound in clove oil is an antifungal that can inhibit the growth of *Penicillium frequentans*. Where the antifungal properties of the compound eugenol is higher than the clove oil. In the research by Rakotonirainy and Lavendrine (2005), in contrast to research by Park *et al.* (2007), which states that crude oil has antifungal properties were higher in *Penicillium frequentans.* However, these two studies can support outcomes conducted by researchers that eugenol on clove oil capable of inhibiting the growth of the fungus *Penicillium* sp families.

From observations in the field antifungal test results using SEM, it can be seen that in the control shown in Figure 4A, the surface of lichens tend still strongly attached to substrate rock. While the test using a 15% concentration of the test material shown in Figure 4B, the surface of lichens tend to be separated from the rock substrate, so that it can be said that the test substance concentration of 15% causes the roots of the lichens that tend lifted from the pores of the rock. This is shown also in Figure 4C, where the use of test materials 25%, lichens is lifted from the substrate rocks and almost detached. This shows that the release of lichens on the stones using test materials 25% more effective than the concentration of 15%, and 25% test solution concentration was concluded as the most effective concentration.

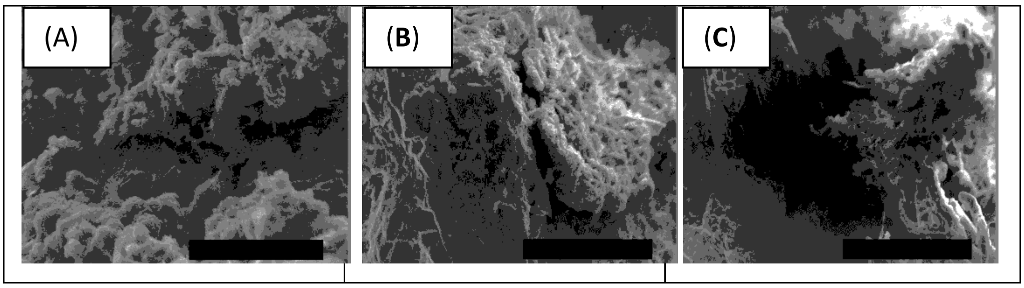

Figure 4. Antifungal test observations using SEM, where (A) control, magnification 1000x, (B) the concentration of 15%, a magnification of 750x, and (C) the concentration of 25%, a magnification of 500x.

Conclusion

Physical properties of essential oils of clove leaf includes the state of the color is dark brown distinctive clove leaf essential oil; worth 1.0278 specific gravity; and a refractive index of 1.5282. While the composition of the essential oil of clove leaf contains three main components eugenol, Caryophyllen, and Humulen, and Cadinen, Copaen, Farnesen and Caryophyllen oxyde.The test solution of clove oil concentration of 1%, 5%, 10%, 15%, and 25% inhibitory effect against the fungus Penicillium sp culture of the family, where the inhibition of the fungus can inhibit the growth of lichens

The most effective concentration to inhibit the growth of lichens that grow on rocks inferred heritage is a concentration of 25%.

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References

Adamo, P., and P. Violante. 2000. Weathering Of rocks and neogenesis of minerals associated with lichen activity. *Applied Clay Science*.16 (5-6): 229-56.

Al-Thani, R.f. H.A. Al-Meri, 2011. Study of Some Lichens of Qatar (Short Communication). *Atl.J.Biol*. 1(3):41-46.

Bevilacqua, A., M., R. Corbo, and M. Sinigaglia. 2008. Inhibition of *Alicyclobacillus acidoterrestris* spores by natural compound. Int. *J. Food. Sci. Technol.* 43 : 1271-1275.

Bhuiyan, M.Z.I., J. Begum, N.C. Nandi and F. Akter. 2010. Constituents of the essential oil from leaves and buds of clove (*Syzigium caryophyllatum* L.). *African Journal of Plant Science.* 4(11) : 451-454.

Chen, J., Blume., P, and Beyer,L. 2000.Weathering of rocks induced by lichen colonization-A review. *Catena* 39 (2) : 121-46.

Doehne, E., and Price, C.A.,2010, Stone Conservation, An Overview of Current Research. 2nd edition, The Getty Conservation Institute, Los Angeles.

Guenther, E. 2007. *Minyak atsiri. Jilid 1*, Terjemahan S Ketaren, Universitas Indonesia, Jakarta.

Harni, R., Amaria W., Supriadi. 2013. Keefektifan beberapa formula fungisida nabati eugenol dan sitronella terhadap Phyrophthora palmivora Bult. Asal kakao. *Buletin RISTRI*. 4(1) :11-18.

Hartati, S.Y. 2012.Prospek Pengembangan minyak atsiri sebagai pestisida nabati. *Perspektif* Vol.11 No.1. ISSN : 1412-8004.

Huang, Y., Ho, S. H., Lee, H. C., & Yap, Y. L. 2002. Insecticidal Properties of Eugenol, Isoeugenol and Methyleugenol and Their Effects on Nutrition of *Sitophilus zeamais*

Motsch. (Coleoptera: Curculionidae) and Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae*).*

Indrajati, D.Y., 2015, *Uji Efektifitas Minyak Atsiri Cengkeh Untuk Menghambat Pertumbuhan Lumut Kerak (Lichenes) Pada Cagar Budaya Batu,* Skripsi, The Faculty of Mathematic and Science, Universitas Islam Indonesia, Yogyakarta.

Koul, O., S. Walia, and G. S. Dhaliwal. 2008. Essential oils as green pesticides: Potential and constrains. *Biopesticides. Int*. 4(1): 63-84.

Lee, K. G., and Shibamoto, T. 2001. *Antioxidant Property of Aroma Extract Isolated from Clove Buds [Syzygium aromaticum (L.) Merr. et Perry]*. *Food Chem*. (74) : 443–448.

Park, M., Gwak, K., Yang, I., Choi, W., Chang, J., Jeung, E., Choi, I., 2007. Antifungal activities of the essential oils ini *Syzygium aromaticum* (L.), Merr.Et Perry and Leptospermum petersonii Bailey and their constituents against various dermatophytes. *The Journal of Microbiology*. 45 (5): 460-465.

Rakotonitainy, M.S., Lavedrine, B. 2005. Screening for antifungal activity of essential oils and related compounds to control the biocontamination in libraries and archives storage areas. *International Biodeterioration and Biodegradation*. 55: 141-147.

Ridawati, Jenie, B.S.L., Djuwita, I., Sjamsuridzal, W. 2011.Aktivitas antifungal minyak atsiri jinten putih terhadap *Candida parapsilosis* SS25, *S.orthopsilosis* NN14, *C. metapsilosis* MP27, Dan *C.etchellsii* MP18. *Makara Sains*. Vol 15. 1 : 58-62.

Santiko, H., 2012, *100 Tahun Pascapemugaran Candi Borobudur, Trilogi II: Dekonstruksi dan Rekronstruksi Candi Borobudur,* Balai Konservasi Peninggalan Borobudur, Magelang.

Sastrohamidjojo, H., 2004, *Kimia Minyak Atsiri*, Gadjah Mada, Yogyakarta.

Suihko, L. M., Alakomi, L. H., Gorbushina, A. A., Fortune, I., Mar-quardt, Saarela, M .2007. Characterization of Aerobic Bacterial and Fungal Microbiota on Surfaces of Historic Scottish Monuments, *Syst. Appl. Microbiol*. 30: 494-508.

Warscheid, T.H., Braams, J. 2000. Biodeterioration of stone: a review, *Int. Biodeterioration Biodegrad*. 46: 343-368.

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