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# PROCEEDING

# The 1st International Seminar on Chemical Education 2015 (ISCE 2015)

## Theme "Chemistry Education as an Industry Development's Agent in Indonesia"

Abdul Kahar Muzakkir, Conference Hall
30th September 2015
UNIVERSITAS ISLAM INDONESIA

Organized by:

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Department of Chemistry Education
Faculty of Mathemathics and Natural Sciences
UNIVERSITAS ISLAM INDONESIA

RISTEKDIKTI

Himpunan Kimia Indonesia

# Preface

International Seminar on Chemical Education 2015 (ISCE 2015) is conducted by Departement of Chemistry Education, Faculty of Mathematics and Natural Science, Islamic University of Indonesia, Yogyakarta at September 30, 2015. This conference was also prepared to celebrate 72th anniversary of Islamic University of Indonesia. The seminar under the theme Chemistry Education as an Industry Development's Agent in Indonesia.

The aim of the seminar is to explore and develop the concept of learning, innovation and competence building as a chemistry education framework. The objective of ISCE is to stimulate the establishment of knowledge based strategies or teaching development in Senior High School and College. The idea of the seminar is to bring together interesting issues about what is going on ASEAN countries, school, university and to share experience regarding methodology of design thingking in teaching area.

The papers ware distributed in 6 topics, they ware chemistry education curriculum and policy, teacher learning and education (in-service and pre-service teachers), student learning in K-12 levels, chemistry education, at tertiary levels, enviromental and social issues in chemistry, and chemistry education effect on industry development.

The seminar was organized by Departement of Chemistry Education, Faculty of Mathematics and Natural Science, Islamic University of Indonesia, Yogyakarta, Himpunan Kimia (Indonesia Chemical Society), and Himpunan Kimia Indonesia Cabang Yogyakarta (Chemical Chemical Society Yogyakarta Branch) and supported by Directorate General of Higher Education (DGHE)*, Ministry of Research and Technology and Higher Education,* Republic of Indonesia. In this seminar, we hope that many experts will come together at Yogyakarta and we would like to discuss exchange the information about the recent chemistry research and also interchange each other.

**Chief of Organizing Committee**
**Riyanto, Ph.D.**

# Welcoming Address by the Organizing Committee

*Assalamu'alaikum Wr. Wb.*

Honorable Rector of Universitas Islam Indonesia
The distinguished invited speakers, and
All participants of the ISCE 2015

Welcome you at the 1st International Seminar of Chemical Education 2015 (ISCE 2015) this morning here at the Auditorium Kahar Muzakkir Universitas Islam Indonesia, Yogyakarta. The international conference is an annual conference of the Department of Chemistry Education, Indonesian Chemical Society (Himpunan Kimia Indonesia, HKI), Yogyakarta branch and supported by Directorate General of Higher Education (DGHE), Ministry of Education and Culture, *Ministry of Research and Technology and Higher Education.* This conference was prepared to celebrate 72th anniversary of Universitas Islam Indonesia. This conference with the theme Chemistry Education as an Industry Development's Agent in Indonesia.

The conference comprises both oral and poster presentation in English and Indonesian with conference publication of full papers in Proceeding Conference. There are 43 papers presented orally and poster covering wide-variety subjects of chemical education and chemistry. We would like to thank to all the participants ISCE 2015. The seminar participants ISCE 2015 came from lecturer, researchers, teachers and students. Special thanks to the invited speakers:

1. Prof. Nobuyoshi Koga, Ph.D. C.Sc. from Graduate School of Education Hiroshima University, Japan.
2. Prof. Binyo Panijpan from Mahidol University, Thailand.
3. Prof. Kamisah Osman from University Kebangsaan Malaysia, Malaysia.

*Thanks your very much to Ministry of Research and Technology and Higher Education, Republic of Indonesia for financial support.*

We hope you will enjoy a pleasant and valuable seminar at Universitas Islam Indonesia.

*Wassalamu'alaikum Wr. Wb.*

Chairman
Riyanto, Ph.D.

## Opening Speech from the Dean of Faculty of Mathematic and Natural Sciences, Universitas Islam Indonesia

Welcome you at the 1st International Seminar of Chemical Education 2015 (ISCE 2015) at Department of Chemistry Education, Faculty of Mathematic and Natural Sciences, Universitas Islam Indonesia, Yogyakarta. This conference was prepared to celebrate 72th anniversary of Universitas Islam Indonesia.

The 1st International Seminar of Chemical Education 2015 (ISCE 2015) will be the 1st event in the ISCE conference series, started in 2015, that brings together individuals involved in chemistry related fields (education chemistry, chemistry, pharmacy, environmental science, chemical engineering, molecular biology, material science, etc.) or institution in chemistry-related sectors.

ISCE 2015 will be organized by Department of Chemistry Education, Indonesian Chemical Society (Himpunan Kimia Indonesia, HKI), Yogyakarta branch and supported by Directorate General of Higher Education (DGHE), Ministry of Education and Culture, *Ministry of Research and Technology and Higher Education, Republic of Indonesia.*

Special thanks to the invited speakers, Prof. Nobuyoshi Koga, Ph.D. C.Sc. from Graduate School of Education Hiroshima University, Japan, Prof. Binyo Panijpan from Mahidol University, Thailand and Prof. Kamisah Osman from University Kebangsaan Malaysia, Malaysia.

Congratulations to the ISCE 2015 committee for this conference.

Thanks you're very much.

**Dean of Universitas Islam Indonesia**

**Drs. Allwar, M.Sc., Ph.D.**

# Opening Speech from the Rector of Universitas Islam Indonesia

*Assalamu'alaikum Wr. Wb*

The distinguished invited speakers, and all participants of the First International Seminar on Chemical Education 2015 (ISCE 2015).

Firstly, I would like to express my great appreciation to the Department of Chemistry Education UII as one of the organizers of the program the First International Seminar on Chemical Education 2015 (ISCE 2015) with the theme Chemistry Education as an Industry Development's Agent in Indonesia.

I am proud that this interesting event is being organized and held in Yogyakarta. As the biggest and the oldest private university in Yogyakarta, University Islam Indonesia is committed to the excellence in research and teaching. Recently, we are preparing UII as one of the world class universities. Knowing that committee has selected outstanding speakers from various prestigious institutions. I believe that all of the participants will enjoy the discussion of issue covered by the topic of this seminar.

Finally, I would once again like to thank the organizer for organizing this event, and to thank all the participants attending this ISCE 2015 event as well as delivering their scientific presentations. I do really hope that you can enjoy this seminar and have excellent stay in Yogyakarta.

*Wassalamu'alaikum Wr. Wb.*

Dr. Ir. Harsoyo, M.Sc.
Rector of Universitas Islam Indonesia

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## Content



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# A Multidisciplinary and Comprehensive Chemistry Teaching/Learning for Next Generation

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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.

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# Chemistry Education at Tertiary Levels

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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.

# 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 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.

## 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.

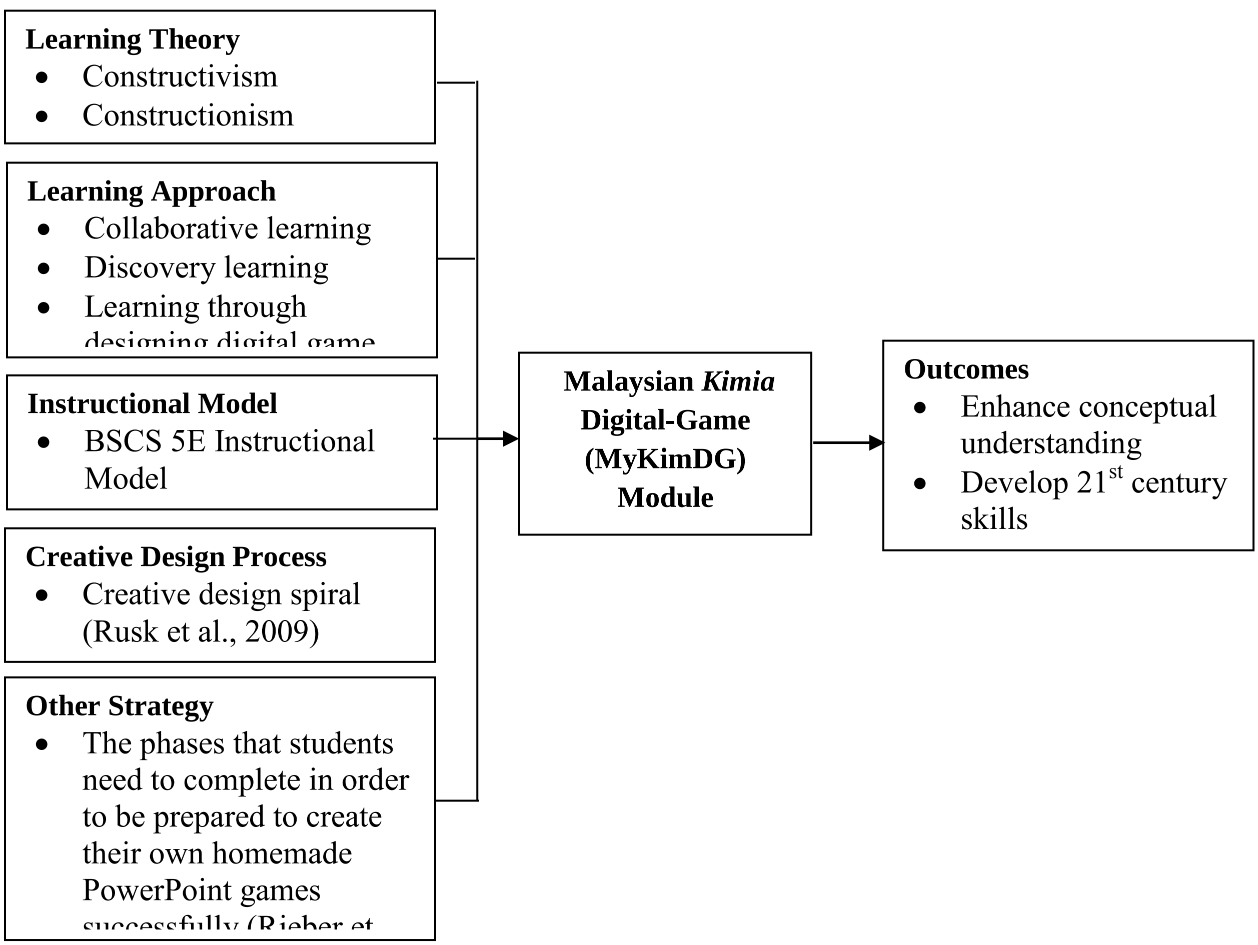


**Fig. 1** Conceptual framework of study

**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.

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

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| | | |
|---|---|---|
| | | teacher's explanations. |
| **Review**<br>*Check, evaluate, reflect, improve, repair* | 1. Students assess their understanding, skills and competencies<br>2. Students think creatively for the purpose of improvement<br>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.<br>2. Students improve their ideas or skills based on reflection or input from peers.<br>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.

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# Implementation of Character Education in Chemistry Learning

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## Abstract

The aim of research to study the real and ideal implementation of character education in chemistry learning. The research use phenomenology method in qualitative approach. This research is conducted in two step. The first step aims to describe the real condition of character education implementation in chemistry learning. The respondents are chemistry teachers. The second step aims to conceptualization and construction of ideal condition of character education in chemistry learning. The respondents are chemistry education experts. The result showed that the implementation of character education in chemistry learning requires improvement and reinforcement. Teacher has been know about the urgency of character education, but it's not integrated in implementation. The character education requires the teacher's awareness to give exemplary. The character education in chemistry learning should be held in the integration involving the purpose and the process that is developed by essence of chemistry: product , process, attitude. Implementation of character education in teacher college also needs improvement. It requires design of curriculum that involving character education and exemplary of academic community.

**Keywords:** character education, chemistry leaning

## Introduction

A number of events that lead to moral decadence shows that Indonesia is experiencing a degradation of character. While the education system seems not yet ready to choose a character education as the performance of cultural and religious in public life (Jalaludin, 2012). The existence of a nation is determined by the character possessed. Character education has actually been pursued since the beginning of independence until now, but have not shown optimal results. National Education Minister Mohammad Nuh said that "there is no denying about the importance of character, but the more important is how to compile and estimate it" (MONE, 2010). MONE has compiled directions, phases, and the character of the nation's education priorities in 2010-2025. The implementation of character education is very important to be pursued.

Character education is actually not a new concept in education. Attention to character education increased due to the increase in criminal activity and a teenager deviant behavior (Williams, et al., 2003). Beforehand, character education in the formal subjects included in Civic Education, Religious Education, Moral Education Pancasila, and so on. But so far has not been able to develop the character of students. Actual character education can not be separated from any learning material. Character education requires a commitment of educators to be good examples and readiness to give the learning experience loaded with character

According to Khusniati (2012), the inclusion of the character through the study of religion and nationality is not enough. This is because both the new subjects encompass cognitive knowledge about values. Religion and nationality learning activities not encourage internalization of values. Character education needs to involve all disciplines. However, teachers are still lacking in attention to character development, especially high school teacher. High school teacher only focus on the material that they teach (Leming, 2006)

According to Ibrahim (2012), the character will be quickly constructed through the observation of the model and is transmitted through the sample and habituation. Character and other learning outcomes should be simultaneously built, integrated with learning all subjects. From this it can be understood that the character education can be given through learning chemistry, as well. Chemistry as part of science has the potential to teach character education.

Science with a phenomenon that has the potential to be a model of behavior, attitude, and character. Every phenomenon in science (IPA) can be used as a model and many phenomena in science can even explain human behavior and characteristics. The process of science activities such as observing, measuring, classifying, analyzing, experiments can develop character. So teachers must give as many opportunities as possible for students to think and be involved in the process of science (Mundilarto, 2013)

Character education according to Effendy (2013) is a well-planned effort to realize students know, cares and internalize the values so that the students behave as a perfect man. By this definition it is understood that character education should cover the entire potential of the individual, which includes cognitive, affective, psychomotor. Character education that only concerned with the cognitive aspects, will not produce the internalization of values within the individual.

Research carried out by Izfanna et al, (2012) showed that the character education requires an environment and conditions that support, and the opportunity to apply. So that the culture of schools or a university culture is very important to develop the character of students. Intergratif efforts are needed in the implementation of character education. Research carried out by Depiyanti (2012) stated that the method of habituation and experience directly became the main method in the implementation of character education. Character education should take place in the whole process of education (Rukiyati, 2013).

Research carried out by Ikhwanuddin (2012) showed that the implementation of character education can increase learning achievement. Implementation of character education in chemistry learning can be done with a variety of approaches. There has been a research and study that discusses the implementation of character education in learning science and chemistry specifically, such as by a contextual approach (Khusniati, 2012), cooperative learning (Ikhwanudin, 2012), meaning learning model (Ibrahim, 2012).

Growing and development of the character will be difficult to do immediately. Learning should be designed to be able to organize the education of character (Pala, 2011). In order for the implementation of character education can be effective, it needs a clear understanding of the definition of the character and practical understanding of the theory by all players in education (Bajovic, et.al, 2009). It required a study of the implementation of character education in chemistry teaching. Chemistry has potential in growing effort and character development. The purpose of this study was to determine the condition of the real and the ideal implementation of character education through chemistry learning at the high school and the Institute of Education Personnel (LPTK). LPTK authorized as the delivery of professional education for teachers should be designed in an integrated manner in order to produce a professional teacher and character (Hasnah, 2013).

**Method**

The study was conducted in two step. The first step is a description of the implementation of character education in chemistry learning at high school. The results from this step is drafting a description of the condition of the real implementation of character education. The second step is the conceptualization and construction of the character education through learning chemistry. The results of the second step is the drafting of descriptions, concepts, strategies, under ideal

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conditions the implementation of character education in chemistry learning. This study use qualitative approach with phenomenological method, the deciphering of person's life experience about a phenomenon or a concept, in this research that is character education.

**First Step**

The first step focused on data collection implementation of character education through high school chemistry teaching. From the data will be obtained descriptions of real implementation of character education. Data collected by questionnaires. Indicators in the preparation of the questionnaire is as follows: (1) the description, (2) the urgency of the application, (3) the intensity of application, (4) implementation strategy, (5) contributions LPTK in character education. Data from the questionnaire, carried description real condition of character education.

Respondents are high school chemistry teacher. The number of respondents were 58 teachers from 22 MGMP. Expected from 22 MGMP (Subject Teacher Council) can give a description of the real implementation of character education through learning chemistry.

**Second Stage**

Collecting data on the second stage also uses a questionnaire. The questionnaire focused on the conceptualization and construction efforts of character education in chemistry teaching. Descriptions obtained from this phase, learning strategies chemistry oriented character education, expert opinion on the condition of ideal character education through learning in high school chemistry and LPTK. Indicators in the drafting of the question is as follows: (1) the description, (2) the urgency of the application, (3) implementation strategy, (4) constraints of the application, (5) the application of high school, (6) the application in LPTK.

Respondents second stage is an expert in chemical education. Selected 2 respondents Prof. Dr. Ashadi, Professor of the Department of Chemical Education FKIP UNS as respondents 1 and Prof. Dr. Nurfina Aznam, SU. Apt, Professor of Mathematics and Natural Sciences Department of Chemistry Education UNY as respondents 2. The selection of respondents is based on a consideration of aspects of expertise in the field of chemical education.

**Result and Discussion**

**First Stage**

From stuffing questionnaire respondents teacher, obtained a description of the real implementation of character education through learning chemistry. In the description indicator

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understanding of character education, some 82.7% of respondents understood the character education. While 10.3% of respondents did not understand. Description of teacher respondents regarding character education can be categorized into 4 groups. Grouping based on shared keywords and core answer. A number of 40.6% of respondents said that character education is an education that integrates the valuesof virtue (character) in the learning process. Planting in the learning values, such as discipline, honesty, responsibility. A number of 33.7% of respondents believe that character education is an education that aims to establish and develop the character of students. Expected to be produced students who are faithful, devoted, noble have a certain character. The characters are composed of the high-minded, resilient, honest, disciplined, critical, tolerant. A number of 21.5% of respondents believe that the character education consists of two aspects, processes and objectives to be achieved (results). Character education is integrated in the learning values that aims to establish and develop the character of students. 4.2% of respondents believe a number of character education is education in accordance with the curriculum of 2013.

In the urgency of implementing the indicators, all of the respondents said the need for the implementation of character education in the classroom. However, only 46.6% of respondents always instill character education. A number of 37.9% of respondents frequently, 15.5% of respondents rarely.

Strategy implementation of character education through learning chemistry, respondents use a variation of the 5 strategies, namely through learning methods, exemplary, habituation, chemical materials, curriculum. Planting character through the selection of instructional methods used by 53.4% of respondents. Learning methods can be used to instill character in students. For example, through the study of chemistry with cooperative learning can instill character appreciate differences, to lend a hand, and cooperation. Through a chemistry lab (experimental method), students are educated to not manipulate the data, so as to foster an honest character, objectively. Chemistry lab can also foster curiosity, hard work character, communicative, responsibility, cooperation. In a class discussion, students learn to respect the opinions of others, communicative.

Growing character through a chemical material used by 50.0% of respondents. According to respondents, in transfer of chemical material can be associated with the values of the characters.

For example, the material elements of the periodic system, students are directed to explore the greatness of Allah SWT through the regularity properties of the elements.

Growing character through habituation is used by 36.2% of respondents. Habituation is an activity that is carried out continuously between teachers and students. These activities include learning begin and end with prayer, to inculcate religious character. Each meeting familiarized teachers say hello or shake hands, to instill respect other people's character and manners. In addition, students are conditioned to not cheating during replay, working on individual tasks honestly and independently. Habituation discipline can be done by applying rules such schools should not be late for class.

Growing character through the example used by 12.1% of respondents. According to respondents teacher holds an important position in the cultivation of students' character. Exemplary teachers are indispensable in the cultivation of character. Students will be borne observe, assess, and eventually mimic the actions of teachers. Teachers should be able to be a role model and example.

Growing character through the curriculum used by 6.9% of respondents. According to respondents planting characters do not stand alone, must be thorough in the learning process. In the preparation of curriculum, syllabus, lesson plans should clearly define what character will be established on the student. Methods, materials, and assessment systems attention and include characters to be achieved.

On the indicator contributed LPTK in character education, some 37.9% of respondents answered already, but not optimal, 36.2% of respondents answered already, 13.8% replied yet, 12.1% did not know. Respondents who stated in a briefing LPTK not optimal character education, argues that there are still many LPTK graduates who do not have the character as an educator, in fact it is often a bad example to the students. Education in LPTK still theoretical in character education. Still less provide a real experience. Although there have been courses that discuss the teaching profession, but there is no special material that discusses character education. There are still many teachers in LPTK less cultivate the character of students. Respondents who stated already, found many LPTK who have the vision and mission form the teacher character. Besides the courses are designed to form a teacher characterized as Professional Education, Educational Psychology, Teaching and Learning Strategies. Regulation is applied as a way to dress also indirectly shape the character of prospective teachers. Of respondents stated that education LPTK not equip chemistry teacher candidates with character education, found only LPTK emphasis on cognitive abilities. Focus cultivated is how to form an intelligent teacher. When confronted on character education, teachers become not know how it is applied.

Respondents provided input on LPTK that LPTK as an educational institution for prospective teachers hold an important position in shaping the character of the teacher. Teachers as the spearhead of education in Indonesia, should be established as a man of character and understanding about how the character education. Should be organized special course that discusses character education. So the teacher had no trouble when it must develop a curriculum that includes character education. Difficulties often experienced teacher is when should create a syllabus, lesson plans, selecting methods, integrate character education in chemistry teaching, and evaluation systems. In chemistry learning, faculty need to provide a description of the characters that can be embedded in each chemical material. Difficulties experienced teacher is when should relate to the character of chemical material that can be implanted. Teachers still think about the character of what can be implanted through the material being discussed. LPTK also participated in the development of high school chemistry curriculum. LPTK should be able to as a source of reference in the development of chemistry curriculum that includes character education. In the process of education, the character became one of the aspects of evaluation. In fact, there are respondents argue that when a student has not appeared character educators should not be passed in advance of LPTK. Modeling the entire academic community LPTK very important in establishing the character of prospective teachers. For that LPTK need to implement regulations supporting character education, both for faculty, staff, and students. Summary of Phase 1 research data can be seen in Table 1.

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**Tabel 1.** Summary of Phase 1 Research Data

| No | Aspect | Responce | Percent |
|---|---|---|---|
| 1 | Understanding | Understood | 82,7% |
| | | Did not undestand | 10,3% |
| 2 | Description | An education that integrates the values of character in learning process. | 40,6% |
| | | An education that aims to establish and develop the character. | 33,7% |
| | | Consists of process and objective to develop the character. | 21,5% |
| | | The curriculum of 2013 | 4,2% |
| 3 | The urgency of implementation | Need for implementation of character education | 100% |
| 4 | The frequen of implementation | Always | 46,6% |
| | | Frequenly | 37,9% |
| | | Rarely | 15,5% |
| 5 | Stategy of implementation | Instructional methods | 53,4% |
| | | Content | 50,0% |
| | | Habituation | 36,2% |
| | | Give example | 12,1% |
| | | Curriculum | 6,9% |
| 6 | The contributed LPTK in character education | Optimal | 37,9% |
| | | Did not optimal | 36,2% |
| | | Did not contributed | 13,8% |
| | | Did not know | 12,1% |

**Second Stage**

Respondents 1 and 2 of the opinion that the implementation of character education through the study of chemistry is important. According to respondent 1, the character is the target of educational goals to be achieved. In the Republic Act number 20 of 2003 on National Education System clearly mentioned that the character or characters into one national education goals. Target formation and character development will be contributed by all subjects in the curriculum, including the chemical. Chemistry can contribute to the formation of character given regarding chemical products, processes and attitudes. Chemical products containing among others the abundance of elements in nature that a lot of benefit in humans. From here can bring people to admiration for the creator of this nature, gratitude-faith. Chemical products also contain principles, laws, theories can guide before the Creator of man that man is very small why should overbearing and so on. Studied chemistry also means learning the manner in which the experiment-experiment demanded honesty, objective, good cooperation with friends, respect the opinions of others, so that the chemical can familiarize people learn to be honest, objective, and so on. Thus chemistry education can contribute to character education. In line with the first respondent, respondent 2 also argued that the chemical is suitable for the cultivation of character education. This is because chemistry is a science that can be seen and felt in everyday life. Can be used to instill a sense of gratitude for God's creation. In the process of teaching and learning chemistry is certainly no observation or experiment, this process can be used as a vehicle to train, among others, honesty, responsibility, and cooperation. Character education should be organized in a chemistry lesson, it is to equip the students have a comprehensive understanding of the chemistry that can give insight into the chemistry for the widest possible utilization for the benefit of the community, state and nation.

The implementation of character education in high school today, according to the respondents 1 and 2 are still lacking.

Chemistry education can actually be used to embed. The issue is whether teachers of chemistry now understand and realize the link between chemistry with characters that should be implanted. In addition there is a tendency chemistry teacher just taught chemistry knowledge, lacking in character cultivation. For that we need a strong debriefing about: 1) the chemical and also 2) the character of a good man.

The implementation of character education in LPTK according to respondents 1 can be done in two ways, namely education affixed character inherent in chemistry learning (embedded) and given a standing of its own, apart from learning. The second way is necessary because the chemical can not cover all aspects of the personality of the teacher desired. Character educators who wish to be implanted and developed structured curriculum. Syllabus character for prospective teachers may be slightly different from the prospective accountant or lawyer, but there are the basics of the same subject that must be mastered by the students. Thematically structured syllabus, the syllabus good arrangement applied by lecturers of the graduate LPTK appropriate in addition to master the science of the field of study also has its own character.

According to respondents 2, LPTK must prepare lecturers character, aware he becomes a role model for students and surroundings, and can teach chemistry at the same time instill good character education without feeling forced or tacked carelessly. LPTK also must prepare systems, infrastructure (programs and facilities for physical and non-physical) that support the implementation of character education.

The implementation of character education in chemistry teaching according to the respondents 1 and 2, relating the chemical nature itself, which includes products, processes, and attitudes. Chemistry learning aimed at planting and character development can be done through chemical materials, the learning process, and attitudes that are taught in chemistry. In the implementation of exemplary character education is absolutely necessary.

Constraints implementation of character education through the study of chemistry according to the respondents 1 and 2 are exemplary aspect. Character education was not enough talking or informed. Educators should be able to give examples of good role models. This is not an easy job. For example lecturers to go to class and out of class on time, diligent lecturer accessing new information, diligent discussion and research with peers, an honest assessment. Often, professors and teachers are less able to embed, implement character education in learning. Lecturers and teachers are less aware that they should be role models for students

**Discussion**

Data from this research is that respondents and respondents' expert teachers have the same views on the urgency of character education. Character education in chemistry teaching is important and needs to be held. Respondents' opinions regarding the description of the character education teachers vary. Character education by a minority of teachers (4.2%) is still viewed narrowly, namely as education according to curriculum Curriculum 2013. 2013 is just one of the means for the implementation of character education. According to respondents experts, the characters must be a goal or target in learning. Chemistry can greatly contribute the sight of the role in the implementation of character education. Chemical covering products, processes, and attitudes may contribute to the planting of the values on learners. Character education according to respondents experts, covering the objectives and processes. Character must be target in learning. In its application can be through chemical nature as the products, processes, and attitudes. Respondents teachers who see education as a character.

According to respondents experts, character education in chemistry learning can be organized through the nature of the chemical itself, which includes products, processes, and attitudes. Chemical products which include principles, laws, and theories can foster a sense of awe at God.

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Chemical products reveal about regularity, equilibrium processes, and benefits for life. A sense of awe in God can develop religious character, the character of the subject to be possessed learners. According to Effendy (2013), the chemical process is a procedure in solving problems that include: (1) identification of the problem, (2) the formulation of a hypothesis, (3) designing an investigation, (4) investigation, (5) data collection and analysis, (6) drawing conclusions, (7) the communication results of the investigation. Chemical process can introduce learners among other things about the character of an honest, curious, objective, able to work, logical thinking, critical, creative, and innovative. Attitudes can be curiosity be a natural phenomenon, causality can be solved through proper procedures

Respondents teachers have not looked through the cultivation of character chemical integrative. Some consider planting a character through the material or chemical products, in part through a chemical process. So it is still necessary socialization about how the chemistry learning organized for the establishment and development of character.

The main obstacle in the implementation of the expert respondents character education is exemplary. Teachers often do not realize that the teacher's behavior is observed and modeled by students. Teachers do not simply provide information to students, but also have to give the example of what has been presented in class. Expert opinions of respondents supported by data from the questionnaire respondents teacher. Modeling is only chosen by 12% of respondents in an effort to provide education teacher character. Still needed socialization and strengthening the ideals that must be held by teachers. In the design of Ministry of National Character Education Parent mentioned that the character formation can be done through exemplary strategies.

LPTK about character education, teacher and expert respondents varied. However, it can be summarized that still needed improvement in the supply of candidates LPTK chemistry teacher educators with character and a good understanding of character education. LPTK need to prepare curriculum integrative. The education system must accommodate the character education. LPTK also participated in the development of high school chemistry curriculum. LPTK should be able to as a source of reference in the development of chemistry curriculum that includes character education. Exemplary aspect must be raised in the implementation of character education in LPTK.

**Conclusion**

The implementation of character education through the study of chemistry is still in need of repair and reinforcement. Teachers already know the urgency of character education, but the implementation has not been carried out in an integrated manner. Needed awareness and preparedness of teachers to provide exemplary. Character education through the study of chemistry should be done in an integrated manner. Character education in chemistry learning includes objectives and processes developed through chemical nature covering products, processes, and attitudes.

Still needed improvement in LPTK in terms of character education for prospective teachers. In the operation of the character education curriculum that includes the necessary design and exemplary character education academic community.

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