DEVELOPMENT OF LEARNING OBJECT MODULES ON GHS AND CHEMICAL SAFETY FOR UNIVERSITY STUDENTS

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ABSTRACT

The objective of this research was to develop two learning object modules on Globally Harmonized System of Classification and Labelling of Chemicals (referred to as GHS) and Chemical Safety. This research was conducted by compiling and analyzing all needed contents for two learning object modules from reference resources of relevant documents, the GHS manual, and the Internet in order to develop as learning content. The learning object modules were then drafted based on the Adobe Flash cs6 program. These two learning object modules on GHS and Chemical Safety were tried by 53 B.Sc. (Occupational Health and Safety) students and 44 M.Sc. (Industrial Environmental Management) students. The learning object modules were then revised according to the students' suggestions. The National Chemical Policy Development Center of the Food and Drug Administration arranged a meeting for GHS experts to share their experiences and provide suggestions for the final revision of the learning object modules. The findings of this research were that in developing the learning object modules contents, one of the steps involved is to try out the draft learning object modules contents to solicit students' comments. Two groups of students from two different programmes of study were engaged in the try out session. The comments were taken into consideration in finalizing the contents of the learning object modules. The contents of the first learning object module on GHS: Classification and Hazard Communication of Chemical on Health and Environment consisted of: 1) Introduction to GHS; 2) Chemical Hazard Classification; and 3) Chemical Hazard Communication. Those of the second learning object module on Chemical Safety consisted of: 1) Introduction and 2) Chemical Safety Management by Label and Safety Data Sheet. The learning object modules would be modulated to various universities in the network of the Office of Higher Education Commission.

Keywords: *Learning object modules, University student, Globally Harmonized System of Classification and Labelling of Chemicals, Chemical safety*

INTRODUCTION

The United Nations had developed the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) in 2003 due to the existence of various chemical management systems. GHS is an international system designed to replace the various classification and labelling standards used in different countries by using consistent criteria for classification

and labelling on a global level. The GHS classification system is a complex system on physical, health and environmental hazards with data obtained from tests, literature and practical experience. The main elements of the hazard classification criteria are summarized below:

Physical hazards include: 1) Explosives; 2) Flammable gases; 3) Flammable aerosols; 4) Oxidizing gases; 5) Gases under pressure; 6) Flammable liquids; 7) Flammable solids; 8) Self-reactive substances; 9) Pyrophoric liquids; 10) Pyrophoric solids; 11) Self-heating substances; 12) Substances which on contact with water emit flammable gases; 13) Oxidizing liquids; 14) Oxidizing solids; 15) Organic peroxides; and 16) Substances corrosive to metal.

Health hazards include: 1) Acute toxicity; 2) Skin corrosion/ irritation; 3) Serious eye damage/ eye irritation; 4) Respiratory/skin sensitizer; 5) Germ cell mutagenicity; 6) Carcinogenicity; 7) Reproductive toxicity; 8) Specific target organ toxicity (STOT) single exposure; 9) Specific target organ toxicity (STOT) repeated exposure; and 10) Aspiration hazards.

Environmental hazards include: 1) Hazardous to the aquatic environment and 2) Hazardous to the ozone layer.

It is crucial to harmonize them within the same standard in chemical classification with regard to physical, health and environmental hazards. Then, hazard communication should be made to target groups of workers, transporters, emergency responders and consumers through labels and safety data sheets (SDS).

Thailand has voluntarily accepted GHS. Subsequently, it has been compulsorily used in the industrial sector under the collaboration of relevant offices including the Ministry of Industry, the Ministry of Agriculture and Co-Operatives, and the Ministry of Public Health since 13 March 2012. The main objective was to make hazard communication accessible and understandable to the mentioned targets. Most Thais, particularly consumers, still face a health risk from dangerous chemicals. One of the guidelines to prevent and reduce the risk is to promote awareness on chemical safety among Thai children and adolescents. They will be important human resources in order to survive safely in the current situation of daily use of chemicals and chemical-based products. Additionally, chemicals are widely used in various agricultural, industrial and community enterprises. Preparedness in coping with environmental pollution or accidents incurred from chemical problems is a significant issue.

The National Strategic Plan on Chemical Management IV (2012-2021) pays attention to the challenging topic of human development to disseminate knowledge and build capacity for chemical safety management through education institutes which are crucial strategic partners. FDA as the Secretariat of the National Committee on Strategy Development for Chemical Management has been conducting projects of knowledge and life skill development on chemical safety by creating awareness among youths in collaboration with the Office of Basic Educational Commission, in order to develop instruments for learning process in primary and secondary schools.

In order to extend the aforementioned projects, FDA collaborated with the School of Health Science, Sukhothai Thammathirat Open University (STOU), to develop Learning Object Materials (LOMs) on GHS and Chemical Safety for the students in B. Sc. (Occupational Health and Safety) and M. Sc. (Industrial Environmental Management) since these students will pay a significant role in dealing with various chemicals in their work as safety officers in the industrial sector. It is envisaged that the LOMs will develop the students' potential for classification and labelling of chemicals based on GHS and build basic knowledge and skill

in chemical safety management. Moreover, these LOMs are intended to be disseminated through the electronic media and websites of the STOU School of Health Science in order to provide GHS knowledge to other university students.

OBJECTIVE OF PAPER

To develop Learning Object Modules (LOM) on Chemical Safety in Chemical Management for students in the B.Sc.(Occupational Health and Safety) and M.Sc. (Industrial Environmental Management programmes.

METHODOLOGY

1) **Compilation and Analysis**
Contents of LOMs on GHS were compiled from various documents, handbooks and the Internet including: 1) UNITAR-Thailand Workshop on Training and Capacity building for the Implementation of the GHS; 2) Handbook on Hazardous Chemical Management by Department of Industrial Works, Ministry of Industry; 3) http://ipcs.fda.moph.go.th; and 4) GHS *Purple Book* in Thai version from http://www.npc-se.co.th/pdf/ghs_thai_full.pdf.

2) **Development of LOMs**
The GHS contents were designed as two storyboards for two LOMs on: 1) GHS and 2) Chemical Safety. The storyboards were submitted to the National Center for Policy Development on Chemicals, FDA, Ministry of Public Health, for consideration and suggestions. The storyboards were revised and sent to a technician at the E-Learning Center of STOU to be developed with Adobe Flash cs6. The LOMs were resubmitted to the National Center for Policy Development on Chemicals for consideration and suggestions. The LOMs were then revised before trying out.

3) **Try-out of LOMs with University students**
Two LOMs were uploaded to the website of the STOU School of Health Science with the School's approval in June 2014. A total of 53 students in B.Sc. (Occupational Health and Safety) and 44 students in M.Sc. (Industrial Environmental Management) tried out the LOMs. Results and suggestions from the try-out were evaluated by means of a questionnaire reviewed by the National Center for Policy Development on Chemical Safety on satisfaction and knowledge acquisition.

4) **Meeting for Experience Sharing and Suggestions from Experts on GHS**
The National Center for Policy Development on Chemical Safety arranged a meeting for 10 GHS experts to share experiences and present suggestions by using results and suggestions from the LOMs' try-out in order to finally revise the LOMs.

5) **Development of LOM Dissemination Strategy**
These LOMs were developed by STOU in collaboration with the National Center for Policy Development on Chemical Safety, therefore, they would be initially disseminated via the websites of School of Health Science, STOU, and Thai FDA for relevant students and interested individuals. The LOMs will be further planned for dissemination via Uninet under the Office of Higher Education Commission in order to make use of them among the relevant students in various Thai university networks.

RESULTS

1) Try-Out of LOM on GHS: Classification and Health and Environment Hazard Communication of Chemicals (LOM 1)

LOM 1 was tried out by 53 students in the B.Sc. (Occupational Health and Safety) programme. The majority (50.9%) were female, with an average age of 31 to 40 years (41.5%) and were working as company personnel (58.5%). A total of 52.8% possessed GHS knowledge on classification and labelling of chemicals. They had satisfaction and understanding at a high level (75.5%). They also had a rating step of presentation at a high level of 77.4%. About 66% took an average of 49.15 minutes for training. Some of their suggestions are shown in Table 1.

Table 1: Results of Try-Out of LOM 1

Suggestions	Revision
Main topic and sub-topic should be on the Main Page	LOM 1 was revised.
Repeat voice button should be installed, Different chemicals should be presented with different colours. The letters in most tables should be magnified.	Repeat voice button was installed as well as the colour and table magnification.
The contents were somewhat difficult; therefore, they should be studied repeatedly.	The objective of LOM 1 was to develop LOM for University students as basic knowledge on GHS. If the ones who would like to make self-classification, they should have further training
Some sub-topics should have voice for making some contents clearly.	LOM 1 was revised as much as it can, particularly physical hazards.
Some slides should be described, particularly, formula calculation.	LOM 1was revised with formula, calculation, and results as step by step.
LOM 1 should have voice volume adapter and content menu leading to the past content or next contents directly. The contents should have pre-test and post-test for all parts.	Voice volume adapter had been revised. Content menu for sub-topics had been revised as much as it can. Actually, each LOM should not be studied more than 30 minutes. If it has many pre-test and post-test, it would take time. Anyway, LOM 1 had overall pre-test and post-test for self-evaluation.
LOM 1 should be presented as E-training without downloading Adobe Flash cs6 program before using.	The objective of this LOM was to develop for studying as on-line internet and by Adobe Flash cs6 with a lot of complicated contents, therefore, downloading this program is needed before using.

2) Try-Out of LOM on Chemical Safety (LOM 2)

LOM on Chemical Safety was tried out by 44 students in M.Sc. (Industrial Environmental Management). Most of them were female (54.5%), average age of 21-30 years (38.6%), working as company personnel (65.9%), having GHS knowledge on chemical safety (79.5%), having satisfaction at the high level (79.5%), having understanding at the high level (68.2%), rating step of presentation at the high level (75.0%), making use at the high level (72.7%), average time for training of 45.38 minutes. Some suggestions of the students were shown in Table 2.

Table 2: Results of Try-Out of LOM 2

Suggestions	Revision
Main topic and sub-topic should be on Main Page	LOM 2 had been revised.
After finishing pre-test, the content could not be shown on the screen and some slides with figures should not be narrated.	A button for going towards learning content was dded as well as crucial figures had already been narrated.
Announcement of the Ministry of Industry on Manual on Dangerous Chemical Storage 2008 should be applied for chemical storage content.	Content of the Announcement is so complicate and out of LOM scope. This LOM is to present overview of chemical storage. Those who are interested should study further from the Manual.
Some figures and calculation should have exercises for making clear.	Those had already been done.
Pop-up should be added page by page in order to learn easily	LOM 1 and 2 had already been revised by adding < and >buttons

After LOMs revision according to students' suggestions, National Center for Policy Development on Chemical Safety had arranged a meeting of GHS experts for LOM suggestions at FDA on 31 July, 2014. The experts had a lot of discussion and the suggestions were summarized as follows:

(1) Since these LOMs had used Adobe Flash cs6 for developing media through internet as E-training, the meeting had suggested that these LOMs should be further applied as Mobile-Learning which would be suitable for smart phone used among the University students. Anyway, the LOMs contents are so complicated and need much attention by displaying on large screen such as notebook, PC, Tablet in order to get more effectiveness from e-training.

(2) The target groups of the research should be changed from the students in B.Sc. (Occupational Health and Safety) and M.Sc. (Industrial Environmental Management) towards the undergraduate and graduate students and those interested. The LOM contents are suitable for the students on the subjects relating to chemicals in various courses as fundamental knowledge for advance studying. Therefore, the meeting had consensus agreement to change the LOM 1 title from "Classification and Labelling of Chemical based on GHS" to "GHS: Classification and Hazard Communication of Chemicals on Health and Environment" owing to the more complicated contents were focused on health and environmental hazards whereas the LOM 2 title was still the same name as "Chemical Safety".

(3) LOM 1 should present three major types of hazards, including physical hazards with definition and hazard communication, as well as health and environmental hazards with definition, hazard classification criteria, and hazard communication.

(4) Narration in some slides should be revised to correspond with contents and figure. Moreover, definitions of 16 physical hazard should be narrated.

(5) Some slide figures should be revised clearly and appropriately to the contents. Some slide figures should be omitted or added to correspond with the contents.

(6) Narration in some slides should be revised as well as voice should be consistent and correspond with Notification of the Ministry of Industry on GHS.

(7) Voice volume should be adjustable for the users who want to study silently.

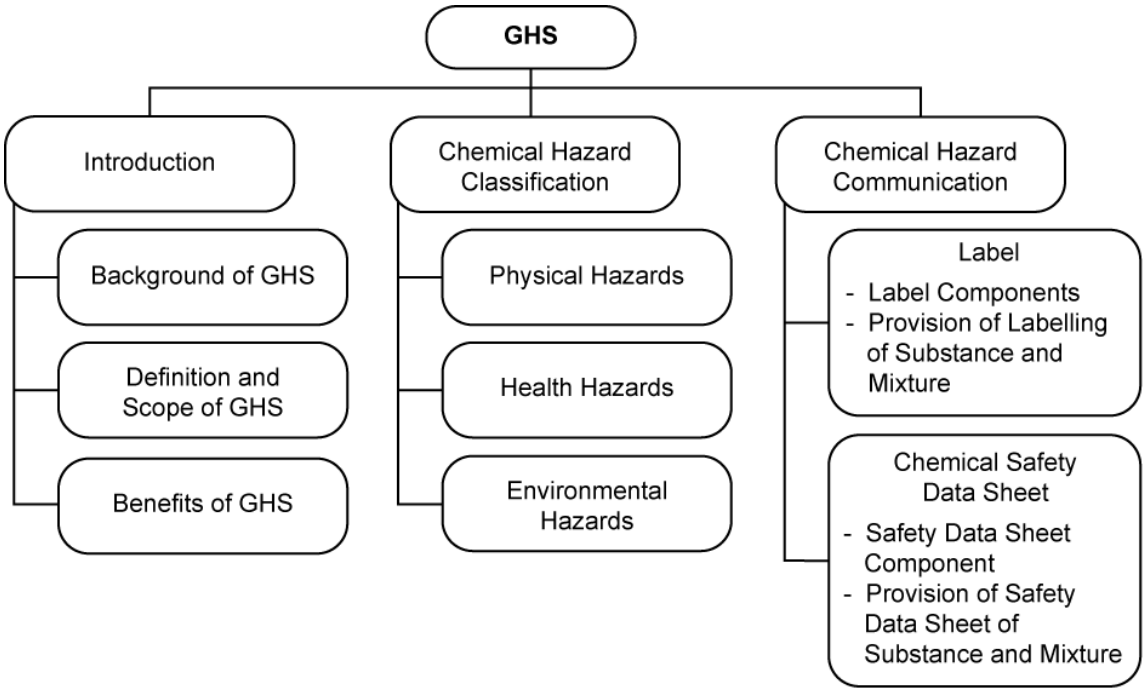
(8) Some figures should be added to attract attention appropriately and correspond with the contents and users' learning.

(9) Pre-test and post-test should be revised more suitable for learning module.

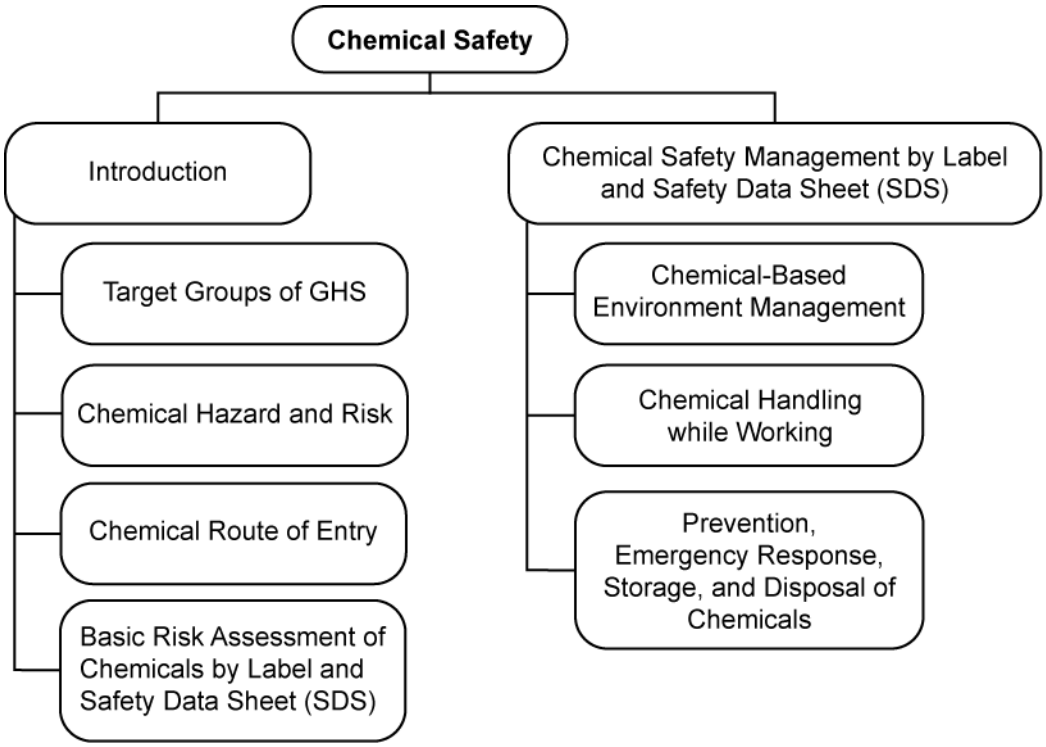
DISCUSSION AND SUMMARY

From the experts' suggestions, the researcher had revised LOM 1 and LOM 2 again, therefore, the structure of the 2 LOMs were as follows:

LOM 1 "GHS: Classification and Hazard Communication of Chemicals on Health and Environment"



LOM 2 "Chemical Safety"



These two LOMs had then been displayed on the websites of School of Health Science and STOU. For further planning, FDA will co-ordinate with the Inter University Network (UniNet) of the Commission of Higher Education to disseminate LOMs to central and regional universities in Thailand.

The benefits of these LOMs were as follows:

(1) These LOMs were used for students at the School of Health Science, STOU, as learning-supplementary media for a course on Systems, Tools and Risk Management for Industrial Environment in M.Sc. (Industrial Environmental Management) and a course on Toxicology and Occupational Medicine in B.Sc. (Occupational Health and Safety).

(2) These LOMs were useful and practical in promoting learning of youths at university level in relevant fields. Additionally, these could be used both inside and outside the classroom in developing knowledge and skills on GHS and chemical safety.

(3) These LOMs should be disseminated through electronic media and websites of the School of Health Science, STOU, to provide GHS knowledge to other university students.

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