Effects of Reasonable Inquiry-Based Learning System on Cloud Learning to Enhance Undergraduate Students' Critical Thinking

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ABSTRACT

The purposes of this research study were: 1) to compare pretest and posttest score, 2) to compare the posttest score with 80 percent criterion score, 3) to compare critical thinking abilities before and after teaching, and 4) to study students' satisfaction towards the Reasonable Inquiry-Based Learning System on Cloud Learning. This research study is experimental research. One group pretest-posttest design was used. The sample in this research study consisted of 40 Nakhon Pathom Rajabhat University undergraduate students who enroll in the Information and Communication Technology course during the first semester of the academic year 2016. They were selected by using multi-stage random sampling. The research instruments included Reasonable Inquiry-Based Learning lesson plan, cloud learning, instructional media, pretest and posttest, Cornell Critical Thinking Test Level Z and satisfaction questionnaire. Data were analyzed using mean ($\overline{x}$), standard deviation (S.D.) and dependent t-test. The research findings were as follows: 1) the posttest score was significantly higher than the pre
test score at .01 level, 2) the posttest score is higher than the 80 percent criterion score at .01 level, 3) Critical thinking abilities after teaching was significantly higher than before teaching at .01 level, and 4) in overall, students were satisfied after learning with the Reasonable Inquiry-Based Learning System on Cloud Learning at high level

Keyword: Inquiry-based learning, Cloud learning, Critical thinking.

1. Introduction

Partnership for 21st Century Skills has developed learning vision which supports thinking framework for learning in the 21st century by altogether combining knowledge, specific skills, expertise and awareness in various aspects, in order to strive both work and life success. Such thinking framework emphasizes development of a very important skill – critical thinking.

In 2014, Pearson Research Institute, jointly with the Economist magazine, analyzed education-related data comparing the educational systems of 39 countries and economic zones. The analysis evaluates students' thinking skill and their ability to

achieve the academic goal. The analysis outcome points out that Thailand is ranked 35th, being one of the very last among all countries. This results from the fact that the majority of Thais have been convinced by the leading class that knowledge is mere information that can be found in textbooks. As a result, education format in Thailand has relied heavily on lecturing by an instructor and students are passive learners. Such learning format is quite outdated so to speak. Learners are not prepared to develop their capacity in gaining knowledge, thinking, analyzing, synthesizing, and applying the knowledge (Office of the Education Council, 2016). This is consistent with Chiu (2009) which states that students in Asia are submerged under the influence of the Confucius culture to a various degree. The culture induces students to physically bow to the superior in order to show their allegiance and avoid any conflict in the public sphere. Such practice technically has a significant impact on student's critical expression of opinion verbally.

Critical Thinking is reasonable reflective thinking focusing on deciding what to believe or do (Ennis, 1993). This is consistent with what Beyer (1995) has explained: critical thinking means making clear, reasoned judgments. The way to instill critical thinking habit in undergraduate students could be done by encouraging them to conduct research in order to acquire information (Haghparast, Hanum, & Abdullah, 2013). As such, the best way to achieve learning objective is to make students engage in constructivist activities, either individually or in groups (Li, 2013). Critical thinking will develop through openness to ideas of others and reflective synthesis of reliable information (Wei, 2012).

Research study of Chen et al. (2010) finds that inquiry-based learning enhances learning effectiveness and higher order thinking, consistent with Li (2013) which demonstrates that inquiry-based learning is effective. Especially, students view it is more important than classroom lectures and literature research. The BSCS 5E Instructional Model is an example of the inquiry-based learning, consisting of 5 learning phases which are: (1) engagement, (2) exploration, (3) explanation, (4) elaboration and (5) evaluation (Bybee et al., 2006).

Information and communication technology is an effective tool that helps improve teaching and learning and supports critical thinking (Haghparast, Hanum, & Abdullah, 2013). For such purpose, cloud computing has applied for learning system (Lee & Park, 2013). The cloud computing setup has been used in the inquire-based learning in order to facilitate communication, co-working, and knowledge sharing between students and the instructor. This is key to achieve academic success (Eteokleous & Ktoridou, 2012).

Cloud computing contributes to the growing number of useful services that are now available on the internet and provides a wide range of services useful to students and

teachers, such as direct access to different academic resources, research applications and higher education tools (Mell & Grance, 2011). Cloud computing can help educational institutions overcome challenges in the form of cost reduction, enabling quick and effective communication, security and privacy and ensuring flexibility and accessibility (Alshuwaier & Areshey, 2012).

For this research, the researcher has developed the Reasonable Inquiry-Based Learning System on Cloud Learning (RI-BL on Cloud Learning System) to enhance undergraduate students' critical thinking. It is used with the sample for a period of 15 weeks. Critical thinking and learning achievement have been compared and students' satisfaction has been examined. The research result will be discussed next.

2. Purpose of the study

2.1 To compare pretest and posttest score.

2.2 To compare the posttest score with the 80 percent criterion score.

2.3 To compare critical thinking abilities before and after teaching.

2.4 To study students' satisfaction towards the RI-BL on Cloud Learning System.

3. Method

3.1 Scope of the Study

The population in this research study consisted of undergraduate students in their first semester of 2016 from 40 Rajabhat Universities nationwide.

The sample comprises 40 Nakhon Pathom Rajabhat University undergraduate students who enroll in the Information and Communication Technology course during the first semester of the academic year 2016. They are selected based on the multi-stage random sampling method.

First step: randomize a region based on the simple random sampling method.

Second step: randomize Rajabhat University from the randomized region based on the simple random sampling method.

Third step: randomize students only from the randomized University based on the cluster random sampling method.

3.2 Variables of the research

The independent variable was the RI-BL on Cloud Learning System to enhance undergraduate students' critical thinking and the dependent variable was learning achievement, critical thinking and students' satisfaction.

3.3 Research duration

This research was conducted during the first semester of the academic year 2016, totaling 15 weeks of study, 3 periods each week and each period lasts 60 minutes.

3.4 Content

The content used in the research is the content from the Information and Communication Technology course.

4. Research Methodology

This research study is experimental research. One group pretest-posttest design was used.

4.1 Research instruments include:

4.1.1 The lesson plan designed according to the RI-BL on Cloud Learning Model to enhance undergraduate students' critical thinking; each plan lasts 180 minutes. The learning model is illustrated in Fig. 1 and the learning process is illustrated in Fig. 2.

Fig. 1. RI-BL on Cloud Learning Model

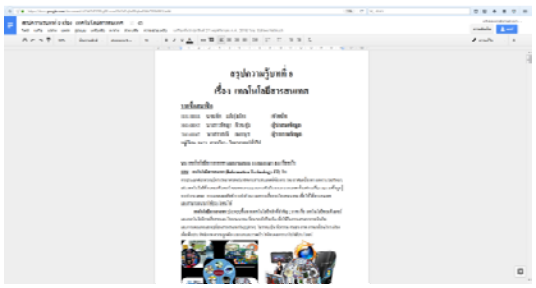
Fig. 2. RI-BL on Cloud Learning Process

4.1.2 Cloud learning: it is a format of learning that employs digital resources available on the internet to improve the learning process. It is a combination of a set of tools and services in the cloud computing system, allowing a learning setting that the instructor and students are not necessarily present in the same classroom (Sanchez, Aguilar, Cordero, & Valdiviezo-Diaz, 2015). Academic personnel have been benefited from the capacity and convenience of cloud usage. In class, cloud learning has been the center of attention of many academic institutions which are interested in replacing it with or supplementing it to traditional learning. One of the reasons is to reduce expensive IT costs and provide services easily accessible from devices such as Moodle, Google Apps and YouTube. It is one of not many cloud-based services that make classroom more communicative, collaborative, creative, and connected.

Moodle is an open source learning management system developed by Martin Dougiamas. Currently, Moodle running on the cloud system is readily accessible for learners. Learners can visit learning resources inside Moodle stored in the cloud. This way, education institutions do not need to purchase expensive web servers to host their learning management systems. They do not need to hire an information technology team to maintain and update the systems. For students, they do not need to buy devices that have huge storage space and strong computation ability. (Wang, Chen, & Khan, 2014) Functional abilities of MoodleCloud are: (1) quick, easy and up to date, (2) able to create quality courses, (3) flexible, (4) mobile friendly, and (5) scalable (Moodle Pty Ltd, 2017). MoodleCloud is shown in Fig. 3.

Fig. 3. MoodleCloud

Google Apps are applications run on cloud computing. Their flexibility suits teaching at the university level. Usage is free of charge. The instructor and learners may share ideas quickly and get things done. In addition, they have got an efficient communication and sharing tools (Alshuwaier & Areshey, 2012). Eteokleous & Ktoridou (2012) finds that the community of inquiry is developed by using Google Apps. Google Apps is shown in Fig. 4.



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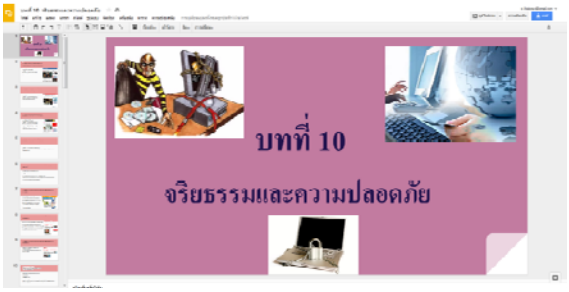

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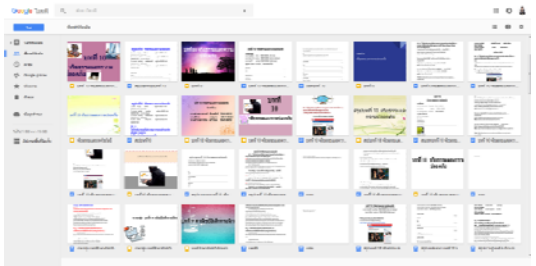

Google Drive

Google Sites

Fig. 4. Google Apps

YouTube is a very famous video sharing website. From the observation, students enjoy learning content from YouTube clips, while contents may be rewind and replayed. By using YouTube, the learning is personalized and less stressful for students. This illustrates YouTube potentials as a powerful tool. YouTube is shown in Fig. 5.

Fig. 5. YouTube

4.1.3 Instructional media is consisted of subject content, slides, multimedia, and relevant websites;

4.1.4 The format of pretest and posttest for the Information and Communication Technology is composed of 100 objective questions, with 4 answer choices for each question, covering 6 aspects of Bloom's Taxonomy of Objectives: recall, comprehension, application, analysis, synthesis and evaluation. The test is given before and after study, with IF between .23 - .80, ID between .22 - .76, and reliability equal to .95, measured by using the KR-20 formula of Kuder-Richardson.

4.1.5 The Cornell Critical Thinking Test Level Z (1985) by Robert H. Ennis and Jason Millman, 5th Edition, is a form of evaluation on induction, credibility, prediction and experimental planning, fallacies, deduction, definition and assumption identification for advanced or gifted high school students, college students and other adults (Ennis, 1993).

4.1.6 Satisfaction questionnaire evaluates student's impression on a 5-level rating scale according to Likert. The questionnaire may be divided to 2 parts which are student's satisfaction towards the RI-BL on Cloud Learning Model and student's satisfaction post-study using the RI-BL on Cloud Learning System.

4.2 Steps to conduct the research experiment are as follows:

4.2.1 Measure pretest;

4.2.2 Measure critical thinking abilities before the teaching commences;

4.2.3 Proceed with teaching according to 10 designed lesson plans, 180 minutes for each plan within a 15-week time span;

4.2.4 Measure posttest

4.2.5 Measure critical thinking abilities after teaching

4.2.6 Examine students' satisfaction by using questionnaire

4.3 Data analysis is conducted as follows:

4.3.1 Compare pretest and posttest score based on the dependent t-test;

4.3.2 Compare the posttest score with the 80 percent criterion score;

4.3.3 Compare critical thinking abilities before and after teaching by using the dependent t-test;

4.3.4 Analyze students' satisfaction by using mean ($\overline{x}$) and standard deviation (S.D.), then comparing mean ($\overline{x}$) with the Likert scales anchored with terms highest, high, moderate, low and lowest.

5. Results

The research finding after using the RI-BL on Cloud Learning System in the Information and Communication Technology course is as follows:

5.1 The learning achievement of students who take the Information and Communication Technology course based on the RI-BL on Cloud Learning System appears that the posttest score is higher than the pretest score at a significant level of .01 as shown in Table 1.

Table 1.

Sample	N	$\overline{x}$	S.D.	df	t	*p*
Pretest	40	39.40	5.578	39	40.110*	.000
Posttest	40	84.05	6.706			

*$p < .01$

5.2 The learning achievement of students who take the Information and Communication Technology course based on the RI-BL on Cloud Learning System appears that the posttest score is higher than the 80 percent criterion score at a significant level of .01 as shown in Table 2.

Table 2.

Sample	N	Criteria	$\overline{x}$	S.D.	df	t	*p*
Posttest	40	80	84.05	6.706	39	3.820*	.000

*$p < .01$

5.3 Critical thinking abilities after teaching of students who take course based on the RI-BL on Cloud Learning System is higher than those before teaching at a significant level of .01 as shown in Table 3.

Table 3.

Sample	N	$\overline{x}$	S.D.	df	t	*p*
Critical thinking abilities before teaching	40	18.60	3.357	39	17.788*	.000
Critical thinking abilities after teaching	40	30.10	3.288			

*$p < .01$

5.4 Students' satisfaction after learning with the RI-BL on Cloud Learning System is as shown in Table 4.

Table 4.

Items	$\overline{x}$	S.D.	Satisfaction level
Part 1 students' satisfaction toward the RI-BL on Cloud Learning Model			
1. Preparation before learning			
1.1 Provide orientation to students	4.08	0.62	High
1.2 Register students on Cloud Learning	4.15	0.74	High
1.3 Measure pretest	4.30	0.65	High
1.4 Measure critical thinking abilities before the teaching commences	4.08	0.62	High
2. RI-BL on Cloud Learning Process			
2.1 Preparation step			
2.1.1 Building the learning environment	4.08	0.66	High
2.1.2 Build positive relationship with students	4.48	0.55	High
2.1.3 Examine students' prior knowledge	4.28	0.64	High
2.2 RI-BL Step			
2.2.1 Engagement	4.05	0.71	High
2.2.2 Exploration	4.18	0.71	High

2.2.3 Explanation	4.23	0.62	High
2.2.4 Elaboration	4.25	0.67	High
2.2.5 Evaluation	4.28	0.68	High
2.3 Reflective Step			
2.3.1 Students and instructor engage in a discussion that reflects issues arising from the current teaching, which may be adopted as a guideline for future improvement	4.30	0.61	High
3. Measurement and evaluation			
3.1 Measure and evaluate learning achievement after teaching	4.35	0.70	High
3.2 Measure and evaluate critical thinking abilities after teaching	4.13	0.65	High
3.3 Use questionnaire to examine students' satisfaction after learning by the RI-BL on Cloud Learning System	4.25	0.63	High
Summary	4.21	0.65	High
Part 2 Students' satisfaction after learning by the RI-BL on Cloud Learning System			
1. Students are able to approach the instructor and communicate more.	4.28	0.60	High
2. Students build closer connection with their peers and communicate more.	4.43	0.55	High
3. Students participate in activities with their peers more.	4.43	0.59	High
4. Students are able to learn a variety of subjects which make the learning for interesting and less boring.	4.13	0.52	High
5. Students engage in more hands on practice and become more eager to acquire knowledge.	4.35	0.74	High
6. Students have an opportunity to present the knowledge acquired to their peers and gain different knowledge from exchanging ideas with their peers.	4.03	0.36	High
7. Students are confident to express their opinion with reasoning and open for other opinion without biases.	4.18	0.59	High
8. Students are able to link their prior knowledge and the newly acquired knowledge and conduct further research on the interested issue.	4.25	0.59	High
9. Students understand content more and the knowledge acquired endures.	4.38	0.70	High

10. Students know their test result immediately.	4.50	0.60	High
11. Students realize their improvement on learning.	4.35	0.58	High
12. Students' concern about their learning ability is reduced.	4.20	0.65	High
13. Students are content and enjoy learning.	4.25	0.74	High
14. Students are able to express their opinion freely.	4.40	0.55	High
15. Students are able to work conveniently with their peers anywhere and anytime by using the Cloud Learning.	4.40	0.67	High
16. Students gain interpersonal skill and are able to work with the others.	4.40	0.55	High
17. Students are able to think critically at a greater level.	4.28	0.64	High
18. Students are more content to learn this subject.	4.18	0.64	High
19. Students expect that their test result will improve.	4.48	0.68	High
20. Students prefer that this teaching and learning format applies to other subjects.	4.13	0.69	High
Summary	4.30	0.61	High

Note: Table 4 shows that students were satisfied with the RI-BL on Cloud Learning Model at high level ($\overline{x}$ = 4.21, S.D. = 0.65) and students are satisfied after learning with the RI-BL on Cloud Learning System at high level ($\overline{x}$ = 4.30, S.D. = 0.61).

Students have addition opinions that:

"The instructor's assignments to work or learn in this format makes student remember and understand the content more. The instructor excellently opens for student's expression of opinion, shows understanding and assists every student. This makes me more interested in information and communication technology which can be easily applied. The instructor has arranged the teaching in a very interesting way."

"This format of teaching and learning facilitates and expedites students' group work and can be easily applied to other subjects."

"The instructor has opened for a new way of teaching and learning which I have never experienced before. The teaching improves learning and not boring at all. The instructor also understands students quite well. The Cloud Learning helps us do the group work easily and fast. I'll adapt this to other courses. Hope the instructor maintains this teaching and improves it as necessary."

6. Discussion

The research finds that:

6.1 Students study based on the RI-BL on Cloud Learning System has a posttest performance statistically significantly higher that the pretest performance, consistent with Abdi (2014) which studies performance of students who takes science courses based on the Inquiry-based learning method, and Khrootmuang (2011) which studies performance of students who participate in the instructional package for the inquiry-based learning. It is found that students are interested and eager to learn when such method is employed. They exchange knowledge and communicate in class, consistent with Li (2013) which states that the best way for student to achieve learning objective is to engage in an inquiry-based learning which emphasizes constructivist activities through the assignment of individual or group task.

6.2 Students who take courses based on the RI-BL on Cloud Learning System have gained statistically significantly higher critical thinking abilities after teaching, as compared to before teaching, consistent with Magnussen et al. (2000) Quitadamo et al. (2008) and Wongkam et al. (2012) which presents that the inquiry-based learning supports students' critical thinking. This is in line with what Garrison et al. (2004) has stated that the practical inquiry model reflects an ability to think critically and cognitive presence.

6.3 Students' satisfaction after taking a course using the RI-BL on Cloud Learning System is at a great level. This is consistent with Ma et al. (2011) and Campbell (2012) which state that students have positive impression and attitude towards the inquiry-based system and the learning in the online environment.

7. Recommendations

Learning in the RI-BL on Cloud Learning System requires designing of learning activities that emphasize the role of students. The instructor's duty focuses on facilitating and giving advice to students. The instructor might not be able to employ an open inquiry at the outset. Therefore, it is recommended that structured inquiry is used in the starting period. The instructor's role should be flexible in order to make students feel comfortable with the inquiry-based learning. In the end, students themselves will identify issues or interested problems and design research or inquiry to reach a solution of such issue or problem. This is often seen in a form of project.

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REFERENCES

Abdi, A. 2014. The effect of inquiry-based learning method on students' academic achievement in science course, *Universal Journal of Educational Research*, 2(1), 37-41.

Alshuwaier, F.A., Alshuwaier, A.A., and Areshey, A.M. 2012. Applications of cloud computing in education, *Proceeding of 2012 8th International Conference on Computing and Networking Technology (ICCNT)*, 26-33.

Beyer, B.K. 1995. *Critical thinking*. Bloomington, IN: Phi Delta Kappa Educational Foundation.

Bybee, R.W. et al. 2006. *The BSCS 5E Instructional Model: Origins and Effectiveness*, Retrieved November 2, 2016, from https://bscs.org/sites/default/files/_legacy/BSCS_5E_Instructional_Model-Full_Report.pdf

Campbell, J. 2012. Inquiry-based learning case studies for computing and computing forensic students, *Journal of Interactive Technology and Smart Education*, 9(1), 4-15.

Chen, F.S., Chen, M.X., and Hsiao, Y.W. 2010. The learning effectiveness of an online inquiry-based course in Taiwan, *Proceeding of 2010 International Conference on E-Business and E-Gevernment*, 5598-5601.

Chiu, Y.C.J. 2009. Facilitating Asian students' critical thinking in online discussions, *British Journal of Educational Technology*, 40(1), 42-57.

Ennis, R.H. 1993. Critical Thinking Assessment, *THEORY INTO PRACTICE*, 32(3), 179-186.

Eteokleous, N., and Ktoridou, D. 2012. Community of inquiry developed through cloud computing for MIS courses, *Proceeding of 2012 IEEE Global Engineering Education Conference (EDUCON)*, 1-4.

Garrison, D.R., Anderson, T., and Archer, W. 2004. *Critical thinking, cognitive presence, and computer conferencing in distance education*, Retrieved January 6, 2017, from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.673.2691&rep=rep1&type=pdf

Haghparast, M., Hanum, N.F., and Abdullah, N. 2013. Modeling an e-learning tool to cultivate critical thinking in students based on information needs and seeking behavior, *Proceeding of 2013 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE)*, 521-526.

Khrootmuang, C. 2011. The development of the instructional package using by 5Es (Inquiry cycle) on the topic of unit of learning for the major science students in faculty of education, Uttaradit Rajabhat University, *Journal of Education*, 9(2), 51-66.

Lee, J.D., and Park, J.H. 2013. Application for mobile cloud learning, *Proceeding of 2013 16th International Conference on Network-Based Information Systems (NBiS)*, 296-299.

Li, X. 2013. Learning from industry by using an inquiry based learning approach, *Proceeding of 2013 IEEE Frontiers in Education Conference*, 943-949.

Ma, C., Xiao, R., Wei, Y., and Yang, H.H. 2011. An inquiry-based learning approach on a educational technology course, *Proceeding of 2011 IEEE International Symposium on IT in Medicine and Education (ITME)*, 422-424.

Magnussen, L., Ishida, D., and Itano, J. 2000. The impact of the use of inquiry-based learning as a teaching methodology on the development of critical thinking, *Journal of Nursing Education*, 39(8), 360-364.

Mell, P., and Grance, T. 2011. *The NIST definition of cloud computing*, Retrieved October 23, 2016, from http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf

Moodle Pty Ltd. 2017. *MoodleCloud*, Retrieved January 6, 2017, from https://moodle.com/cloud/

Office of the Education Council. 2016. Thailand's Educational System in 2014-2015: How to Reform Thailand's Education for the 21st Century, Retrieved November 15, 2016, from http://www.moc.moe.go.th/upload/68e2a13707.pdf

Partnership for 21st century skills. 2011. *Framework for 21st century learning*, Retrieved November 3, 2016, from http://www.p21.org/storage/documents/1.__p21_framework_2-pager.pdf

Quitadamo, I.J., Faiola, C.L., Johnson, J.E., and Kurtz, M.J. 2008. Community-based inquiry improves critical thinking in general education biology, *Journal of CBE Life Sciences Education*, 7(3), 327-337.

Sanchez, M., Aguilar, J., Cordero, J., and Valdiviezo-Diaz, P. 2015. A smart learning environment based on cloud learning, *International Journal of Advanced Information Science and Technology (IJAIST)*, 39(39), 39-52.

Wang, M., Chen, Y., and Khan, M.J. 2014. Mobile cloud learning for higher education: a case study of Moodle in the cloud, *The International Review of Research in Open and Distance Learning (IRRODL)*, 15(2), 254-267.

Wei, G.W. 2012. The use of wiki to facilitate critical thinking, *Proceeding of IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, H3C-1 – H3C-3.

Wongkam, N., Pinsuwan, D., and Chaowakeeratipong, N. 2012. *The effects of using the 7Es learning management approach emphasizing critical thinking activities in the topic of homeostasis on learning achievement and critical thinking ability of mathayom suksa IV students at Piriyalai Changwat Phara School in Phare*

Province, Retrieved December 25, 2016, from http://www.stou.ac.th/thai/grad_stdy/Masters/%E0%B8%9D%E0%B8%AA%E0%B8%AA/research/2nd/FullPaper/SS/Oral/O-SS%20022%20%E0%B8%99%E0%B8%B2%E0%B8%87%E0%B8%99%E0%B8%87%E0%B8%99%E0%B8%B2%E0%B8%8E%20%20%E0%B8%A7%E0%B8%87%E0%B8%84%E0%B9%8C%E0%B8%84%E0%B8%B3.pdf