



Information Technology for Collaborative e-Learning: the Measurement and Evaluation of TQF's Learning Outcomes

เทคโนโลยีสารสนเทศเพื่อการเรียนรู้ทางอิเล็กทรอนิกส์ร่วมกัน : การวัดและประเมินผล

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83 หมู่ที่ 11 ถนนสระบุรี-หล่มสัก ตำบลสะเดียง อำเภอเมือง จังหวัดเพชรบูรณ์ 67000

Abstract

Collaborative E-Learning (CEL) is one of modern learning methods, which is widely used in the 21st century. The learners can learn on demand, independently, and outside the classroom without time and place barrier. Information Technology provides the learners for this matter. They can create new knowledge together, which is a way of supporting life-long learning. In order to gain the quality, efficiency and effectiveness of collaborative e-Learning, this research addresses the Learning Outcomes (LOs) for undergraduate level defined by Thailand Qualification Framework (TQF). The general education course entitled Information Technology for Life conducted by the Phetchabun Rajabhat University is used as a case study. This research addresses the collaborative e-Learning that can support both generic and specific TQF's learning outcomes. The LOs' measurement and evaluation is collected by using e-Participation, e-Examination and e-Assignment. This data is then analyzed by using mathematical method. The result of this work shows TQF's LOs at the students' group and individual levels by using information technology for the future improvement.

Keywords: Collaborative e-learning, Learning outcome, Thailand qualification framework, Learning measurement and evaluation

บทคัดย่อ

การเรียนรู้อิเล็กทรอนิกส์ร่วมกันเป็นหนึ่งในวิธีการเรียนรู้สมัยใหม่ที่มีการใช้งานกันอย่างแพร่หลาย ในศตวรรษที่ 21 ผู้เรียนสามารถเรียนรู้ข้อมูลเมื่อต้องการอย่างอิสระและนอกห้องเรียนปกติ โดยปราศจากข้อจำกัดด้านเวลาและสถานที่ งานวิจัยนี้เน้นการประยุกต์ใช้เทคโนโลยีสารสนเทศเพื่อการสนับสนุนการเรียนรู้ของผู้เรียน ผู้เรียนสามารถเรียนรู้และพัฒนาองค์ความรู้ใหม่วร่วมกัน เป็นการเรียนรู้ตลอดชีวิต เพื่อเข้าถึงการ

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เรียนรู้ร่วมกันทางอิเล็กทรอนิกส์อย่างมีคุณภาพ ประสีพิธีภาพ และประสีพิธีผล การเรียนรู้แบบเน้นผลลัพธ์ การเรียนรู้เป็นลิ่งจำเป็น งานวิจัยนี้เน้นผลลัพธ์การเรียนรู้ในระดับปริญญาตรีตามกรอบมาตรฐานคุณวุฒิระดับ อุดมศึกษาแห่งชาติ ด้วยการพัฒนาระบบการเรียนรู้ร่วมกันทางอิเล็กทรอนิกส์โดยใช้กรณีศึกษาของรายวิชา เทคโนโลยีสารสนเทศเพื่อชีวิต หมวดวิชาศึกษาทั่วไปของมหาวิทยาลัยราชภัฏเพชรบูรณ์ การเรียนรู้ร่วมกัน ทางอิเล็กทรอนิกส์สามารถสนับสนุนผลการเรียนรู้เฉพาะด้านและผลการเรียนรู้ทั่วไปตามกรอบมาตรฐาน คุณวุฒิระดับอุดมศึกษาแห่งชาติ การวัดและประเมินผลการเรียนรู้เป็นการรวมผลลัพธ์จากการมีส่วนร่วม ทางอิเล็กทรอนิกส์ การสอนทางอิเล็กทรอนิกส์ และการมอบหมายงานทางอิเล็กทรอนิกส์ วิธีการทาง คณิตศาสตร์ใช้ในการวิเคราะห์ข้อมูล ผลจากการวิจัยพบว่า ผลลัพธ์การเรียนรู้ของผู้เรียนแต่ละรายเป็นไป ตามกรอบมาตรฐานคุณวุฒิระดับอุดมศึกษาแห่งชาติ สามารถเบรียบเทียบกับค่าเฉลี่ยของห้องเรียนและแสดง ผลในรูปแบบของแผนภูมิเรเดาร์ ที่ผู้เรียนสามารถใช้เป็นข้อมูลในการพัฒนาปรับปรุงผลการเรียนรู้ของตน ในอนาคต

คำสำคัญ : การเรียนรู้อิเล็กทรอนิกส์ร่วมกัน ผลลัมภุทธิ์การเรียนรู้ กรอบมาตรฐานคุณวุฒิระดับอุดมศึกษา แห่งชาติ การวัดและประเมินผลการเรียนรู้

Introduction

Collaborative Learning

Collaborative E-Learning (CEL) is the use of information technology, such as internet technology, mobile technology, or ubiquitous technology as tools for learning together. It provides an opportunity for students to learn at any place and time on demand. This is a way of supporting students the freedom to learn with learning activities, role play, and a channel of communication. This CEL leads to the skill and knowledge exchange, to find out the solution of problem solving, and to create new knowledge if required. Furthermore, collaborative e-learning can help students to develop the desired learning outcomes. Soller (2001) said that the model of collaborative learning will change the role of lecturers as a facilitator in this learning environment. They need to stimulate learning and to help support the development and fulfillment of students' learning outcomes. Hence, students can come up with their new knowledge, which is also known as constructionism. The constructionism or "learning by doing" is a method of encouraging students' interpersonal skill, group building and management skill, inquiry skill, conflict resolution skill and synthesis and presentation skill.

Education is the method of human development. People can learn throughout their life. There are various learning styles; however, the theory of Grasha and Riechmann classifies the pattern of learning according to its behavior into 6 categories (Baykul et al., 2010). They are learning independence, avoidant, collaborative, dependent, competition and participant learnings. This research focuses on collaborative learning which students and lecturers can use computer networking for learning, problem solving, and knowledge exchange. Hence, we address on students' learning outcomes, measuring and evaluation.

Collaborative e-Learning requires five basic elements of learning: positive interdependence, individual accountability, promotive interaction, social skills, and group processing. (Johnson & Johnson, 2001) This work uses online social network as a tool for collaborative e-Learning.

Learning Measurement and Evaluation

The learning measurement and evaluation is a way of getting to know the students' achievement, on which the capabilities and characteristics of students should focus. This can align with the learning activities or assignments, e.g. examination, project report, or practical work. Such a data can be used as a requirement to develop the information system addressing on students' field experience with respect to paper and pencil testing. In order to evaluate the characteristics of the students' expected learning outcomes and to focus on the actual of students' capability, the review of students' knowledge, cognitive skill, communication skill and information technology usage skill is illustrated. Furthermore, it must comply with the standards or criteria of how the authentic assessment activity allows students to practice and check their learning outcomes. The learning evaluation must base on the educational objectives, learning experience, and evaluation methods. (ThongThai, 2013) Furthermore, information technology quality can be used to improve the learning system by employing the management quality cycle or PDCA. (Suktorn et al., 2013)

Online Social Network

Online social networking is another method of interaction through a computer network in order to share resources, exchange information both social, economics and politics. In education, the social network is a tool to support collaborative e-Learning, which supports the process of knowledge development and knowledge sharing among the learners. Hence, it gives the learners an opportunity to exchange their ideas and experiences for problem solving. This leads to the concept of analytical process and learning process to gain the benefits of academic and professional study. There are seven types of social network: weblog, data and knowledge, online games, online community, photo management, media and business. (Raksri, 2010)

The problem of this research is that the teacher-center model does not give the high effectiveness of learning because the learners may not have sufficient development on knowledge, skill, problem solving, innovation or new knowledge creation. The collaborative learning in the classroom addresses on student-center; however, it has the limited time constraint. This research is therefore established as the Collaborative E-learning (CEL) to reduce the obstacle above. The collaborative e-Learning gives the learners to learn at any place and any time via computer network, which helps the learners to meet the desired learning outcomes.

Research Objectives

The objectives of this research are to provide the mathematical model of measuring students' learning outcomes according to Thailand Qualifications Framework (TQF) via collaborative e-learning system, and to present the result of the measurement.

Research Framework

This paper concentrates on mathematical model of measuring and evaluating students' learning outcomes and their results as a final part of the research framework, see Figure 1. Chaibuth et al. (2015) addresses the factors of supporting the collaborative e-Learning and five learning outcomes defined by Thailand Qualification Framework (TQF) for higher education. The learning outcomes at of the bachelor degree are illustrated. The measurement and evaluation of students' learning outcomes are e-examination, online report and students' participation on CELs. The aspects of data collection from e-Participation, e-Examination and e-Assignment are used as parameters on the mathematical model.

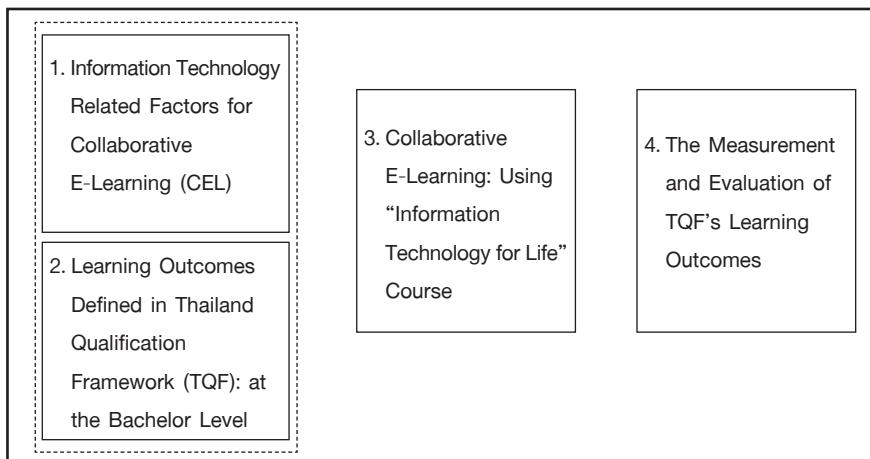


Figure 1 Research Model

Research Assumption

The learners with generation Z who were born since 1995 tend to accept information technology for learning (Schroer, 2014). Furthermore, the TQF's five learning outcomes (LOs) can be proportional measured and evaluated by e-Participation, e-Examination and e-Assignment.

Research Methodology

This research begins with the study of related work from journal and proceedings. Next, we analysis and define the research questions. The gathering data is come from students who attend the course "Information Technology for Life" at Phetchabun Rajabhat University. The data will be analyzed by using mathematical method.

Population and Sampling

The populations of this research are the students who register the general education course entitled “Information Technology (IT) for life” at Rajabhat Phetchabun University. The samplings are 28 IT students at the faculty of Science and Technology, who registered this course in the semester 2/2014. Even though this paper does not intend to illustrate the measurement methods of e-Participation, e-Examination and e-Assignment; we illustrate the mathematical model on measuring students’ learning outcomes using Collaborative E-Learning (CEL) system. Such a mathematical model uses three measurement methods as parameters.

Research Tools

The research tool is the students’ evaluation form on “Information Technology for Life” course. This form contains the raw scores of students’ e-Participation, e-Examination and e-Assignment. The mean and standard deviation are used for data analysis.

Research Results

This paper provides a mathematical model of data analysis, and the TQF’s learning outcomes for each student. The mathematical model uses students’ records on e-Participation, e-Examination and e-Assignment from 28 students who attends the “Information Technology for Life” course at Rajabhat Phetchabun University as parameters. Note that CEL system was built by considering the factors of accepting the use of system (i.e. reliability, benefit and ease of use), personal and emotion, and website quality as illustrated on Table 1. The method of CEL development and LOs measurement and evaluation is beyond the scope of this paper.

Table 1 Factors of supporting the collaborative e-Learning

Factors	Mean	Standard Deviation
1. Factors of Accepting the Use of Collaborative e-Learning	4.11	
1.1 a) Reliable System	4.11	0.79
b) Users’ Experience and Understanding	4.11	0.74
c) Open Mind for New Usage	4.21	0.63
1.2 Benefits from the System	4.07	0.86
1.3 Ease of Use	4.04	0.74
2. Personality and Emotional Factors of the Learners via CEL	4.15	
2.1 Emotional Stability and Calm	4.14	0.52
2.2 Fearless	4.18	0.61
2.3 Openness to Society	4.14	0.71
2.4 Assertive and Activist	4.14	0.76
2.5 Open Mind for Learning, Idea and Imaginary	4.14	0.59
2.6 Accept New Values	4.11	0.63



Factors	Mean	Standard Deviation
2.7 Collaborative, Trust and Compromise	4.00	0.67
2.8 Straightforward Idea and Polite	4.04	0.69
2.9 Self-discipline	4.29	0.66
2.10 Responsibility	4.29	0.66
3. The Quality of Website for CEL	4.16	
3.1 Information Quality	4.18	
a) Correctness	4.14	0.65
b) Reliability	4.18	0.67
c) Up to Date	4.25	0.70
d) Privacy	4.14	0.65
3.2 Service Quality	4.16	
a) Meet Users' Requirement	4.21	0.74
b) Easy to Understand	4.18	0.72
c) Provide Help	4.14	0.71
d) Error Handling	4.11	0.69
3.3 Process/System Quality	4.14	
a) Correctness	4.18	0.67
b) Consistency	4.11	0.74
c) Completeness	4.14	0.80

Note: from Chaibuth et al. (2015)

The Measurement and Evaluation of TQF's Learning Outcomes

The learning outcomes (LOs) identified by Thailand Qualification Framework (TQF) emphasizing on the Bachelor of Science Program in Information Technology, Rajabhat Phetchabun University are shown in Table 2. Three methods are using for measuring and evaluating TQF's LOs. They are e-Participation, e-Examination and e-Assignment. E-Participation is semi-automatically measured by students' record on accessing on CEL system and by lecturers on marking students' progress on problem solving and knowledge exchange. E-Examination is done automatically. Finally, students submit their assignments via internet and lecturers measure its quality. This paper uses our previous work on measuring the learning outcomes in order to find out a mathematical model for classifying TQF's learning outcomes for each student. The examples of measured and evaluated data of e-Participation, e-Examination and e-Assignment are shown in Table 3-4. The result of using the mathematical model for finding out the each student's learning outcomes is shown in Table 5.

Table 2 Learning Outcomes

Learning Outcome		Sub-learning Outcome
1	Moral and Ethics	1 Awareness of moral and ethical value, social responsibility, honest, public concerns, unity, love and compassion, and self-discipline.
		2 Recognize and appreciate the learning value, interest and enthusiasm in learning.
		3 Endeavor to work, determination, patience, perseverance, intelligent usage in tackling the success, and responsible for both individuals and teamwork.
		4 Awareness of moral and ethical value, social responsibility, honest, public concerns, unity, love and compassion, and self-discipline.
		5 Be a great leader and a follower, capability of teamwork and conflict resolution.
		6 With respect to the rules of institution, community and social, and appropriate attire.
2	Knowledge	1 Understand the principle, fact, and linkage of the study on a daily life.
		2 Capability in various knowledge integration, and application in daily life happy, both physically and mentally.
		3 Understand the human relationship, social and environment, and conflict management.
		4 Understand and thinking process that can be applied for everyday life.
		5 Understand the importance and role of technology for daily life.
3	Cognitive Skill	1 Develop the capability in system thinking.
		2 Develop the ability to think critically.
		3 Get the analysis, synergy and valuation skills.
		4 To be able to understand the causes and problem solving by using knowledge.
		5 To be able to collect, study, and summary the problem/ issues.
		6 Self-learning and responsible for the assigned tasks.
		7 Capability and skill development on planning, and operating as planned.
4	Social Skill	1 Skill development on building the relationships between students and others.
		2 Development of leadership skills and teamwork.
		3 Develop self-learning skills, responsibility on assignments, and on time.
		4 Skill development on social and individual interaction.
		5 Improve the performance of students' responsibility and behavior to lecturers.
		6 The ability to adapt both to work and life and dedication to public.
		7 Good personality, assertive, self-confidence, polite and sacrifice.
5	Analytics, Communication and Information Technology Skill	1 Skill development on communication, and information retrieval by using information technology.
		2 Develop quantitative analysis from case studies.
		3 Usage skill on mathematical information, statistics on problems solving, and creation.
		4 Skills on communication, listening, speaking, writing, and reading, report preparation, and presentation both Thai and/or English.
		5 Presentation skills using the appropriate tools and technologies.
		6 Skill development on publishing paper/work.

**Table 3** Example of the Proportion Scores for Five Areas of Learning Outcomes

Learning Outcome Measurement	Point	Moral & Ethics	Knowledge	Cognitive Skill	Social Skill	IT Skill
1 E-Participation on CEL (P)	20	16	-	-	2	2
2 E-Examination (E)	40	-	15	25	-	-
3 E-Assignment (A)	40	2	5	5	14	14
Total	100	18	20	30	16	16

Table 4 Example of Students' Records of Measurement

Student	1 E-Participation CEL (P=20)	2 E-Examination (E=40)	3 E-Assignment (A=40)
#1	20	30	20
#2	10	25	30
#3	18	32	38
....			
#n	15	38	38

Table 5 Example of Five Learning Outcomes of Each Student

Learning Outcome Student	Total Score (100)	Moral & Ethics (18 points)	Knowledge (20 points)	Cognitive Skill (30 points)	Social Skill (16 points)	IT Skill (16 points)
Student-1	70	17.00	13.75	21.25	9.00	9.00
Student-2	65	9.50	13.13	19.38	11.50	11.50
Student-3	88	16.30	16.75	24.75	15.10	15.10
....						
Student-n	91	13.90	19.00	28.50	14.80	14.80

Discussion

The results of employing information technology for collaborative e-Learning: the measurement and evaluation of TQF's learning outcomes are discussed as follows:

- The factors of accepting the use of Collaborative E-Learning (CEL) are reliability, experience and understanding, open mind, benefit, and ease of use as shown in Table 1. The mean of these factors is 4.11, which means that the adoption of CEL is depending on the reliability of CEL, students' experience on using technology, students' understanding, personality emphasizing on open mind, gained benefit and usability. Such a result conforms to the Technology Acceptance Model (TAM), which is a well-known theory and widely be used as an indicator for adopting technology, proposed by Davis. (Chaibuth et al., 2015; Davis, 1985) Our students were born after 1995. They are generation Z who familiar to use and are willing

to adopt technology. This conforms to the work of Hatthasak (2014) addressing on generation Z who intent to use information technology for learning.

- The personality and emotional factors are stable and calm emotion, fearless, openness, assertion and activist, open mind, new values acceptance, collaborative - trust and compromise, polite, self-discipline, and responsibility. Table 1 shows the average score of personality is equal to 4.15. This means that adopting CEL must also consider additional factors of personality and emotion of students. Furthermore, our work is consistent to the theory of human personality called “Big Five”, which contains neuroticism (i.e. emotion stability), extraversion, openness to experience, agreeableness and conscientiousness. (Sripan, 2012; Khuprasit, 2013) Therefore, the students’ personality will affect the adoption of CEL. This leads to an extended TAM with students’ personality (i.e. Big Five), as shown in Figure 2.

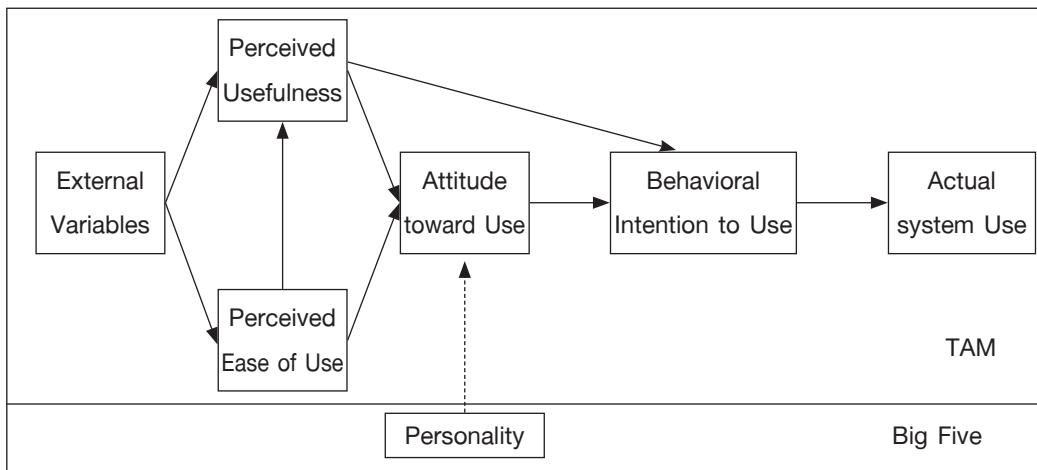


Figure 2 Extended Technology Acceptance Model (e-TAM) by Adding the Personality

- The factors of website quality can affect the use of Collaborative E-Learning (CEL) system. Table 1 shows the survey results of website quality for CEL which its average score is 4.16. Information quality, service quality and system quality are three key factors of website quality to consider whether or not students will use CEL. This infers that to persuade students to use CEL we must provide good quality of website. This result conforms to the concept of quality of websites in order to attract the users’ usage and satisfaction. (Bai et al., 2008; Funilkun, 2008; Blair, 2012). In addition, e-Learning in 21st century is a technology-based learning or web-based learning with respects to classroom learning. The website quality must pay attention on these three factors, which can support an intention to use the system, user satisfaction, and net benefit, respectively. Such work is aligns to the work of DeLone and McLean (2003), which our work extends information system quality containing information quality, service quality and system quality as shown in Figure 3.

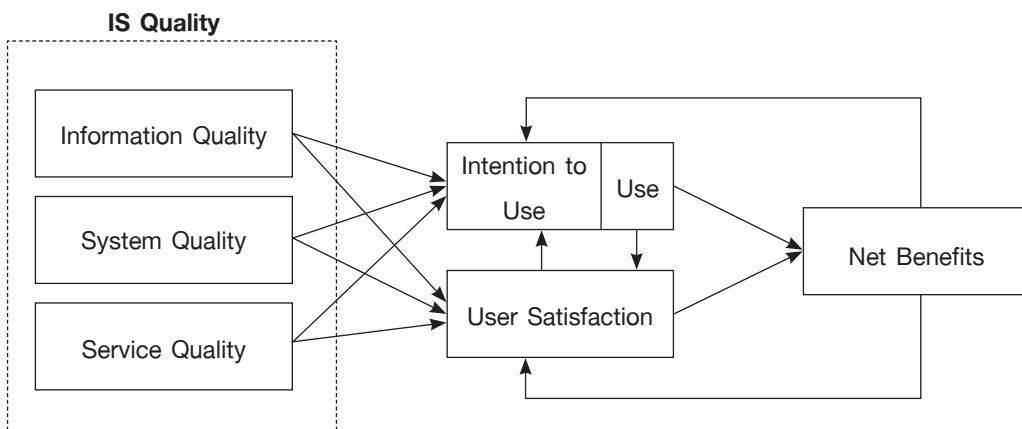


Figure 3 Employing IS Quality of Delone & McLean for CEL (Delone & McLean, 2003)

The measurement and evaluation of five learning outcomes of TQF at the Bachelor level using the “Information Technology for Life” course is shown in Table 3. Table 3 shows the examples of CEL measurement methods, e.g. e-Participation (P), e-Examination (E) and e-Assignment (A). Each learning outcome (i.e. moral and ethics, knowledge, cognitive skill, social skill, and information technology skill) can be measured by these three methods. The scores of each method and each learning outcome are shown in the below equations. The proportion of each measurement method can be adjusted lecturers. The total score of each student’s learning outcomes is the summation of e-Participation score (P), e-Examination score (E) and e-Assignment score (A).

$$P = \sum_{i=1}^5 P_i \quad (1)$$

$$E = \sum_{i=1}^5 E_i \quad (2)$$

$$A = \sum_{i=1}^5 A_i \quad (3)$$

$$\text{Total Score} = \sum_{i=1}^5 P_i + E_i + A_i \quad (4)$$

Where P = e-Participation score

P_i = e-Participation score on each learning outcome

E = e-Examination score

E_i = e-Examination score on each learning outcome

A = e-Assignment score

A_i = e-Assignment score on each learning outcome

$i = 1$: Moral & ethics; 2: Knowledge; 3: Cognitive skill; 4: Social skill; 5: IT Skill

Table 4 shows the students' score from each measurement method. This paper does not intent to illustrate the details of each measurement. We show the scores in order to giving a mathematical model for measuring each learning outcome. The score of each student's learning outcome (LO) is shown in equation-5.

$$LO_i = \frac{p * P_i}{P} + \frac{e * E_i}{E} + \frac{a * A_i}{A} \quad (5)$$

Where p = Score of student's participation

e = Score of student's examination

a = Score of student's assignment

Consider both Table 3 and Table 4, five expected learning outcomes of each student can be shown in Table 5. Hence, the scores of five learning outcomes are 18, 20, 30, 16 and 16, respectively. The result of each learning outcome is calculated by the proportion of three measurement methods, see Table 3. The total score of each student is calculated by summing up the score of each learning outcome as shown in the following equation.

$$\text{Student Score} = \sum_{i=1}^5 LO_i = \sum_{i=1}^5 \frac{p * P_i}{P} + \frac{e * E_i}{E} + \frac{a * A_i}{A} \quad (6)$$

This result allows lecturers to analyze the students' learning progress according to TQF's 5 LOs. For example, student #1 can view his/her learning competency and can compare his/her performance with the average score as shown in the radar chart, see Figure 4.

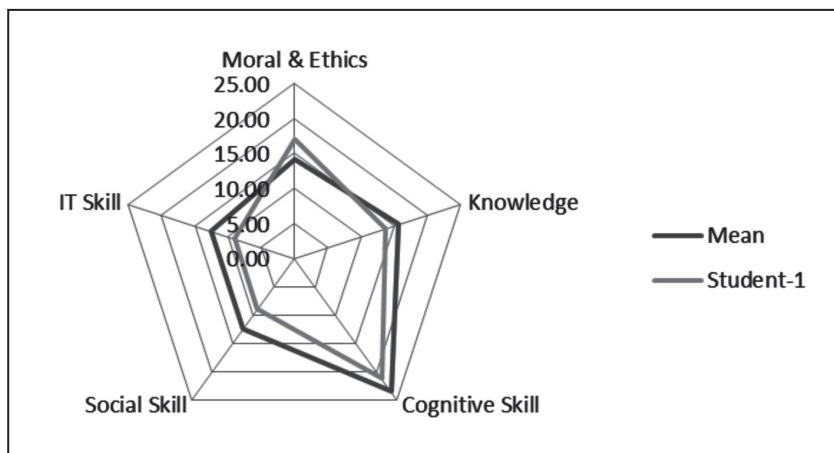


Figure 4 Radar Chart for Student-1's Learning Outcomes



From the above measurement and evaluation, we found that our students prefer to learn via CEL system, which aligns to the National Education Act in 1999 aiming to develop the learners with three goals: clever, good and happiness people. (The Office of Higher Education Commission, 2008) The learners can participate on the active learning, which is a way of supporting the life-long learning. Johnson & Johnson (2001) said that the learners should collaborate on learning with respect to competition. This is a two-way communication of learning process by using information technology.

Conclusion

Collaborative E-Learning (CEL) is the way of using information technology as a tool for supporting learning together. It is a modern learning method for 21st century. Students can learn at any place and any time. To achieve the success of learning, the learning outcomes of Thailand Qualification Framework (TQF) have been considered. CEL gives as a channel for students to learn and create new knowledge, and to solve the problem together. This research presents a mathematical model for measuring and evaluating students' learning outcomes (LOs) by giving an example of those attending the "Information Technology for Life" course at Phetchabun Rajabhat University. The methods of measuring the students' LOs are e-Participation on CEL, e-Examination and e-Assignment, which can support both generic and specific TQF's learning outcomes. The result of this work shows TQF's learning outcomes of individual students by using information technology, which shows the LOs result as a radar chart for easily analysis and using for the future students' LOs improvement.

The further work should compare the outcome from the traditional learning and CEL system. The use of CEL system on other courses should be considered. The statistics of TQF's learning outcomes at the program level is also interested. Finally, the research on e-Examination for measuring and evaluating should be found out.

Acknowledgment

Thank you to Rajabhat Phetchabun University for supporting me the study grant.

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