Mahidol University
Wisdom of the Land

Use of analytics systems to guide students in acquiring Information Literacy competencies

A Research and Practice approach

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INFORMATIC LITERACY

“a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.”

Association of College and Research Libraries (ACRL), 1989

Information Literacy Competency Standards for Higher Education (ACRL Standards)

Standard 1

The information literate student **determines** the nature and extent of the information needed.

Standard 2

The information literate student **accesses** needed information effectively and efficiently.

Standard 3

The information literate student **evaluates** information and its sources critically and **incorporates** selected information into his or her knowledge base and value system

Standard 4

The information literate student, individually or as a member of a group, **uses** information effectively to accomplish a specific purpose.

Standard 5

The information literate student **understands** many of the economic, legal, and social issues surrounding the use of information and **accesses** and uses information ethically and legally.

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1.To what extent have you incorporated IL in your course content?
2. How do you think your students can apply IL in your course?

Library instruction

Walker & Pearce, 2014

Curriculum-embedded instruction

Manus, 2009; Secker & Macrae Gibson, 2011

Games

Guo & Goh, 2016; Jere-Folotiya et al., 2014

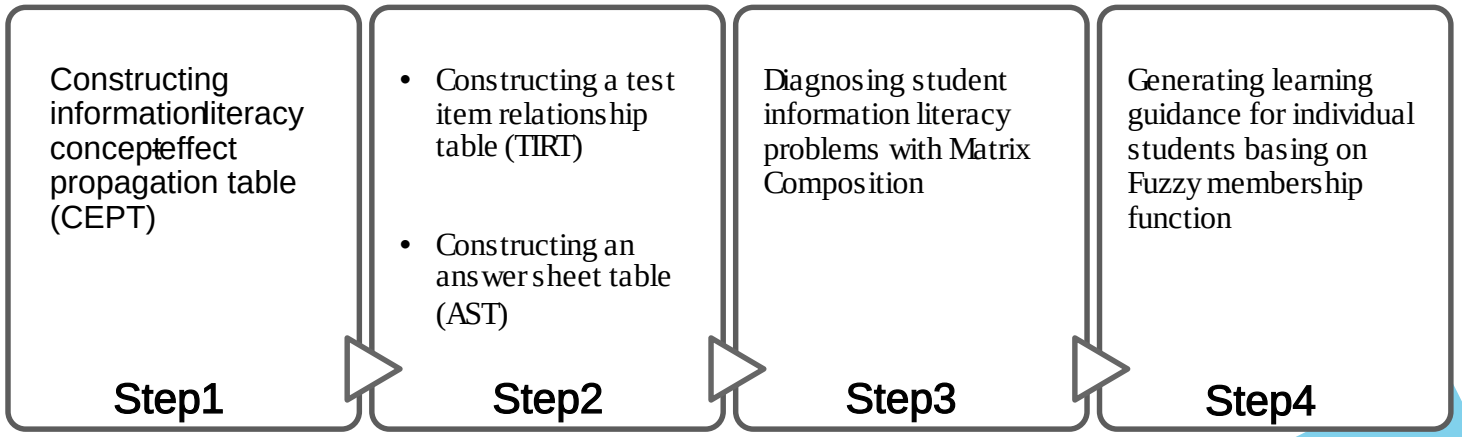
Online instruction

Su & Kuo, 2010; Yang, 2009; Lamb, 2017

Shortcoming >>>>

Students' prior experience of information literacy did not diagnosed in the existing systems.

PROCEDURE TO ANALYZE STUDENTS' INFORMAT



PROCEDURE TO ANALYZE STUDENTS' INFORMAT

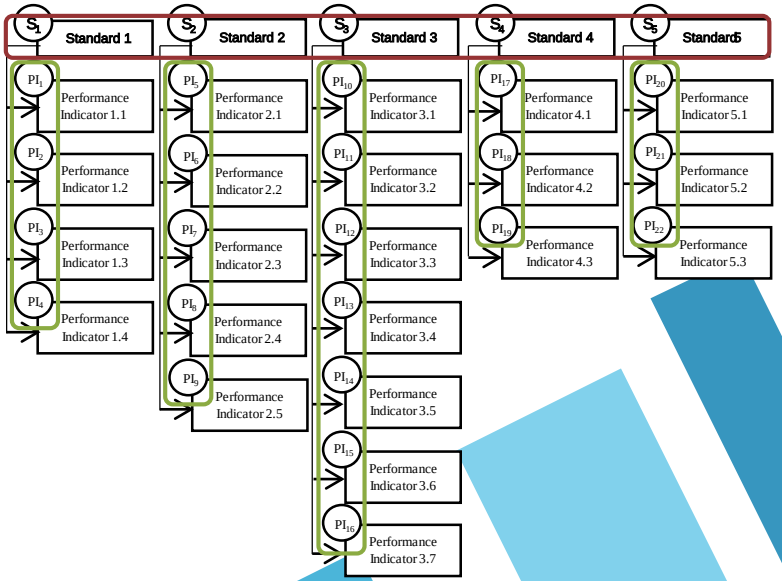
Constructing information literacy concept-effect propagation table (CEPT)

Step1

Concept-effect Propagation Table (CEPT)

Performance Indicator (PI_i)	Standard (S_j)				
	S_1	S_2	S_3	S_4	S_5
$PI_{1.1}$	1	0	0	0	0
$PI_{1.2}$	1	0	0	0	0
$PI_{1.3}$	1	0	0	0	0
$PI_{1.4}$	1	0	0	0	0
$PI_{2.1}$	0	1	0	0	0
$PI_{2.2}$	0	1	0	0	0
$PI_{2.3}$	0	1	0	0	0
$PI_{2.4}$	0	1	0	0	0
$PI_{2.5}$	0	1	0	0	0
$PI_{3.1}$	0	0	1	0	0
:	:	:	:	:	:
$PI_{5.3}$	0	0	0	0	1

Concept-Effect Relationship Diagram



PROCEDURE TO ANALYZE STUDENTS' INFORMAT

- Constructing a test item relationship table(TIRT)
- Constructing an answersheet table (AST)

Step2

Test Item Relationship Table (TIRT)

Test items (Q_n)	Performance Indication (PI_i)											
	$PI_{1.1}$	$PI_{1.2}$	$PI_{1.3}$	$PI_{1.4}$	$PI_{2.1}$	$PI_{2.2}$	$PI_{2.3}$	$PI_{2.4}$	$PI_{2.5}$	$PI_{3.1}$	..	$PI_{5.3}$
Q_1	0.8	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	..	0.0
Q_2	0.8	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	..	0.0
Q_3	0.6	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	..	0.0
Q_4	0.0	1.0	0.8	0.0	0.8	0.4	0.0	0.0	0.0	0.0	..	0.0
Q_5	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	..	0.0
Q_6	0.0	0.0	1.0	0.0	1.0	0.4	0.0	0.0	0.0	0.0	..	0.0
Q_7	0.0	0.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	..	0.0
Q_8	0.0	0.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	..	0.0
Q_9	0.0	0.8	0.8	0.0	0.8	0.0	0.0	0.0	0.0	0.0	..	0.0
Q_{10}	0.8	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.4	..	0.0
:	:	:	:	:	:	:	:	:	:	:	..	:
Q_{50}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	..	0.8

Answersheet Table (AST) 0 = Correct /1 = Incorrect

Student answer (St_x)	Test item (Q_n)											
	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9	Q_{10}	..	Q_{50}
St_1	1	0	0	0	0	1	0	0	1	1	..	1
St_2	1	0	1	0	1	1	1	0	0	0	..	1
St_3	0	0	0	1	0	0	0	1	0	0	..	0
St_4	1	0	1	1	1	1	1	1	1	1	..	1
St_5	1	0	1	1	0	1	1	1	1	1	..	1

Domain experts

PROCEDURE TO ANALYZE STUDENTS' INFORMAT

Diagnosing student information literacy problems with Matrix Composition

Step3

The max-min composition of R_1 and R_2

$$R_1 \circ R_2 = \{(x, z) | (x, z) = \text{Max}\{\text{Min}\{\mu_{R_1}(x, y), \mu_{R_2}(y, z)\}\}$$
$$\text{for } x \in X, y \in Y \text{ and } z \in Z \}$$

AST(St_k, Q_n) ∘ TIRT(Q_n, PI_j) ∘ CEPT(PI_j, S_i)

Student (St_k)	Test item (Q_n)				
	Q_1	Q_2	Q_3	Q_4	Q_5
St_1	1	0	0	0	0
St_2	1	1	1	1	1
St_3	0	0	0	1	0
St_4	0	0	0	0	0
St_5	1	0	1	1	0

Test item (Q_n)	Performance Indicator (PI_j)			
	$PI_{1.1}$	$PI_{1.2}$	$PI_{1.3}$	$PI_{1.4}$
Q_1	0.8	0	0	0.6
Q_2	0.8	0	0	0.6
Q_3	0.6	0	0	0.8
Q_4	0	1	0.8	0
Q_5	0	0	1	0

Performance Indicator (PI_j)	Standard (S_i)				
	S_1	S_2	S_3	S_4	S_5
$PI_{1.1}$	1	0	0	0	0
$PI_{1.2}$	1	0	0	0	0
$PI_{1.3}$	1	0	0	0	0
$PI_{1.4}$	1	0	0	0	0

Ex: The max-min composition of St_1 for $PI_{1.1\text{-}1.4}$ in S_1

		Q_1	Q_2	Q_3	Q_4	Q_5
AST	St_1	1	0	0	0	0
	$PI_{1.1}$	0.8	0.8	0.6	0	0
TIRT	$PI_{1.2}$	0	0	0	1	0
	$PI_{1.3}$	0	0	0	0.8	1
	$PI_{1.4}$	0.6	0.6	0.8	0	0

Min

	Q_1	Q_2	Q_3	Q_4	Q_5
$PI_{1.1}$	0.8	0	0	0	0
$PI_{1.2}$	0	0	0	0	0
$PI_{1.3}$	0	0	0	0	0
$PI_{1.4}$	0.6	0	0	0	0

Max

$PI_{1.1}$	0.8
$PI_{1.2}$	0
$PI_{1.3}$	0
$PI_{1.4}$	0.6

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$$R_1 \circ R_2 = \{(x, z) | (x, z) = \text{Max}\{\text{Min}\{\mu_{R_1}(x, y), \mu_{R_2}(y, z)\}\} \text{ for } x \in X, y \in Y \text{ and } z \in Z\}$$

AST(St_k, Q_n) ∘ TIRT(Q_n, PI_j) ∘ CEPT(PI_j, S_i)

Student (St_k)	Test item (Q_n)				
	Q_1	Q_2	Q_3	Q_4	Q_5
St_1	1	0	0	0	0
St_2	1	1	1	1	1
St_3	0	0	0	1	0
St_4	0	0	0	0	0
St_5	1	0	1	1	0

Test item (Q_n)	Performance Indicator (PI_j)			
	$PI_{1.1}$	$PI_{1.2}$	$PI_{1.3}$	$PI_{1.4}$
Q_1	0.8	0	0	0.6
Q_2	0.8	0	0	0.6
Q_3	0.6	0	0	0.8
Q_4	0	1	0.8	0
Q_5	0	0	1	0

Performance Indicator (PI_j)	Standard (S_i)				
	S_1	S_2	S_3	S_4	S_5
$PI_{1.1}$	1	0	0	0	0
$PI_{1.2}$	1	0	0	0	0
$PI_{1.3}$	1	0	0	0	0
$PI_{1.4}$	1	0	0	0	0

Ex: (Repeated) The max-min composition of St_1 for $PI_{1.1\text{-}1.4}$ in S_1

	$PI_{1.1}$	$PI_{1.2}$	$PI_{1.3}$	$PI_{1.4}$
$CEPTS_1$	1	1	1	1
Results of the max-min composition of AST and TIRT	0.8	0	0	0.6

Min: 0.8 | 0 | 0 | 0.6 → Max: 0.8

PROCEDURE TO ANALYZE STUDENTS' INFORMAT

Diagnosing student information literacy problems with Matrix Composition

Step3

The max-min composition of R_1 and R_2

$$R_1 \circ R_2 = \{(x, z) | (x, z) = \text{Max}\{\text{Min}\{\mu_{R_1}(x, y), \mu_{R_2}(y, z)\}\} \text{ for } x \in X, y \in Y \text{ and } z \in Z\}$$

AST(St_k, Q_n) ∘ TIRT(Q_n, PI_j) ∘ CEPT(PI_j, S_i)

Student (St_k)	Test item (Q_n)				
	Q_1	Q_2	Q_3	Q_4	Q_5
St_1	1	0	0	0	0
St_2	1	1	1	1	1
St_3	0	0	0	1	0
St_4	0	0	0	0	0
St_5	1	0	1	1	0

Test item (Q_n)	Performance Indicator (PI_j)			
	$PI_{1.1}$	$PI_{1.2}$	$PI_{1.3}$	$PI_{1.4}$
Q_1	0.8	0	0	0.6
Q_2	0.8	0	0	0.6
Q_3	0.6	0	0	0.8
Q_4	0	1	0.8	0
Q_5	0	0	1	0

Performance Indicator (PI_j)	Standard (S_i)				
	S_1	S_2	S_3	S_4	S_5
$PI_{1.1}$	1	0	0	0	0
$PI_{1.2}$	1	0	0	0	0
$PI_{1.3}$	1	0	0	0	0
$PI_{1.4}$	1	0	0	0	0

$$\text{error\_degree}(St_1, S_i) = \begin{array}{c} \\ St_1 \\ St_2 \\ St_3 \\ St_4 \\ St_5 \end{array} \begin{array}{c} \begin{array}{ccccc} S_1 & S_2 & S_3 & S_4 & S_5 \end{array} \\ \begin{pmatrix} 0.8 & 0.4 & 0 & 0 & 0.8 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 0.4 & 0 & 0 & 0.8 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0.8 & 1 \end{pmatrix} \end{array}$$

PROCEDURE TO ANALYZE STUDENTS' INFORMAT

Generating learning guidance for individual students basing on Fuzzy membership function

Step4

error_degree (St_1, S_1) = 0.8

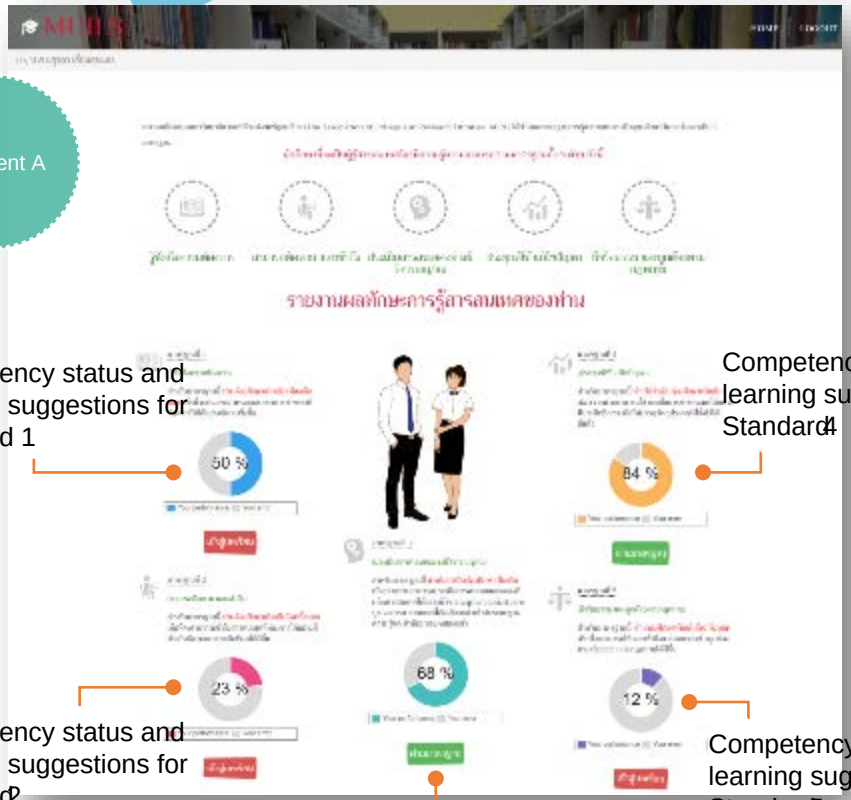
Fact 1 :error_degree (St_1, S_1) is HIGH with degree 0.92;
Fact 2 :error_degree (St_1, S_1) is AVERAGE with degree 0.32;
Fact 3 :error_degree (St_1, S_1) is LOW with degree 0.08.

Output 1 :competency_status (St_1, S_1) is novice with degree 0.92;
Output 2 :competency_status (St_1, S_1) is intermediate level with degree 0.32;
Output 3 :competency_status (St_1, S_1) is advanced level with degree 0.08.

IF competency_status is novice,
THEN it suggests student St_k to seriously learn the unit containing the standard S_i.
IF competency_status is intermediate level,
THEN it arranges more practice related to the standard S_i for student St_k.
IF competency_status is advanced level,
THEN it reports that student St_k has competent knowledge in the standard S_i.

Examples of Report for Individua

Student A



Competency status and learning suggestions for Standard 1

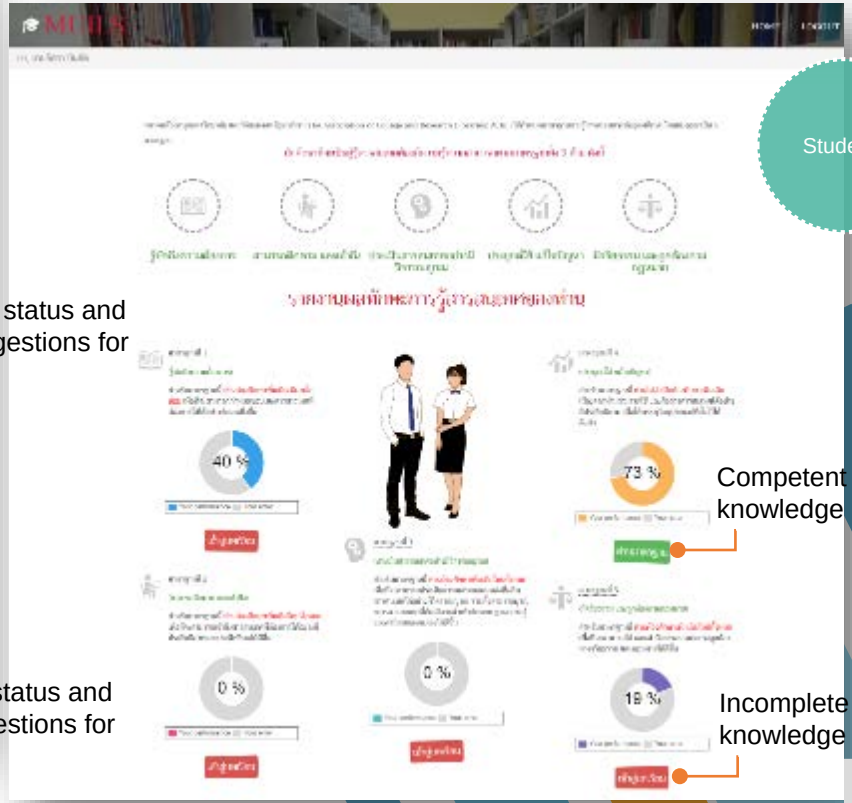
Competency status and learning suggestions for Standard 2

Competency status and learning suggestions for Standard 3

Competency status and learning suggestions for Standard 4

Competency status and learning suggestions for Standard 5

Student B

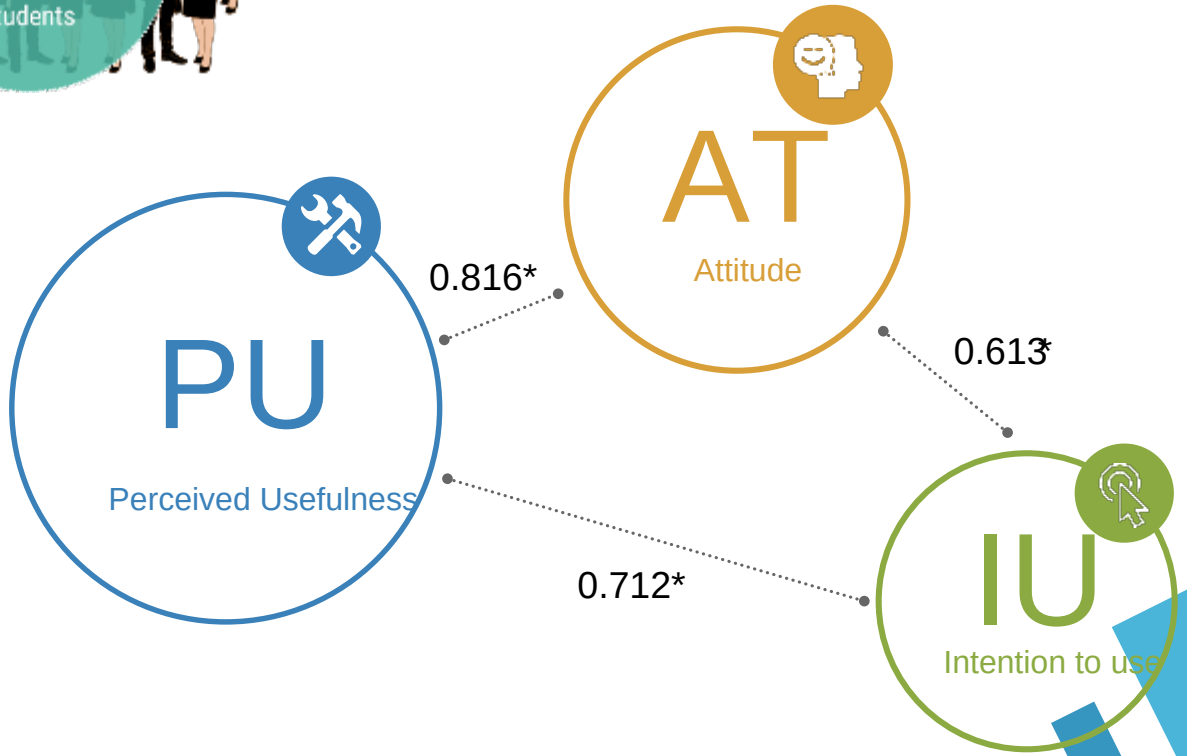


Competent knowledge

Incomplete knowledge

Survey Results

SPEARMAN'S CORRELATION COEFFICIENT BETWEEN FACTORS

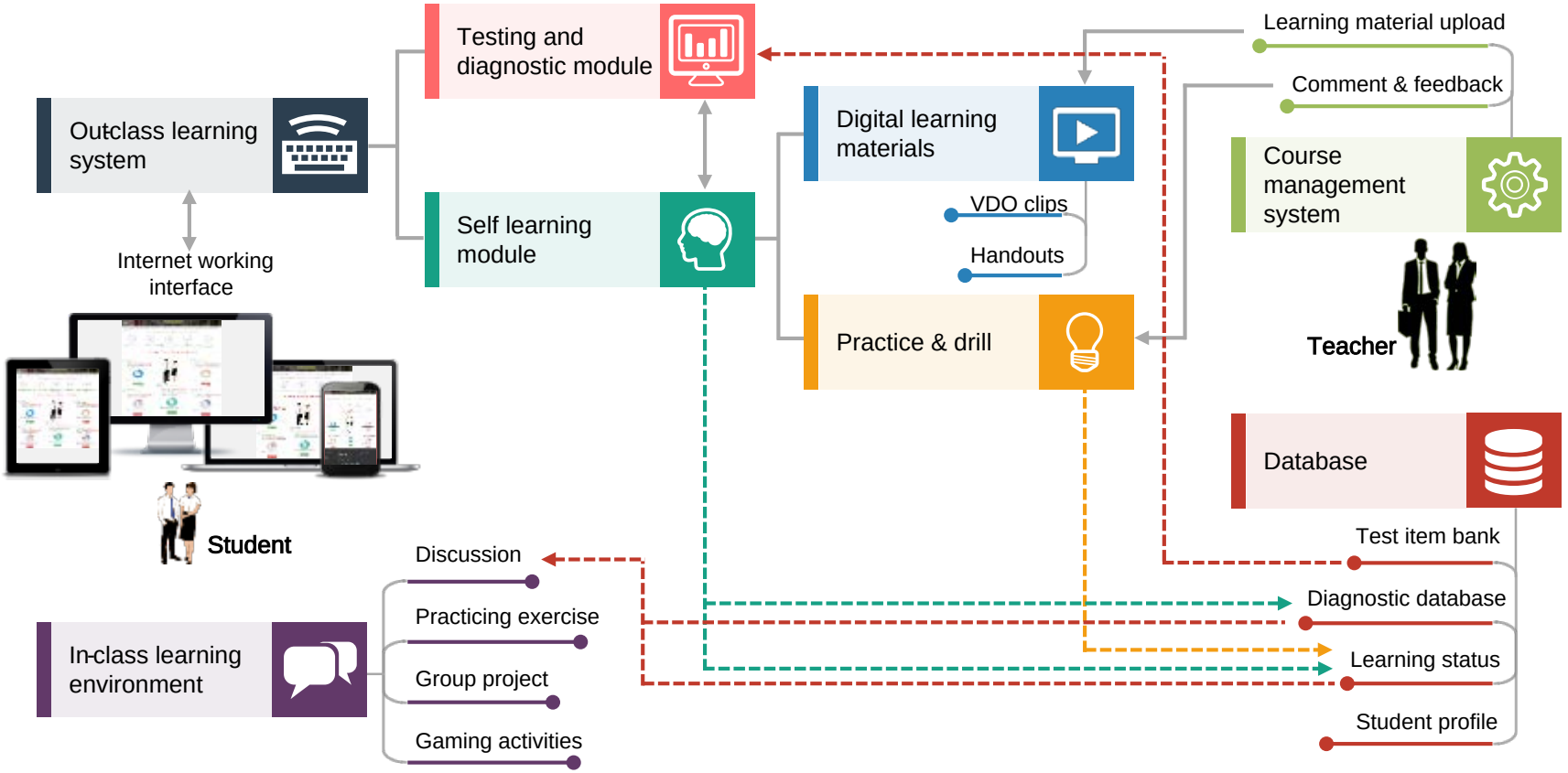


Note:* statistically significant at $p < .005$

Learning Environment

IMPLEMENTATION OF SELF-REGULATED FLIPPED CLASSROOM WITH INFORMATION LITERACY ANALYTIC SYSTEM TO PROMOTE THE UNIVERSITY STUDENT PERFORMANCE

ARCHITECTURE OF LEARNING ENVIRONMENT WITH INFORMATION LITERACY ANALYTIC SYSTEM



LEARNING FLOW OF THE SELF-REGULATED FLIPPED CLASSROOM WITH INFORMATION LITERACY ANALYTIC SYSTEM

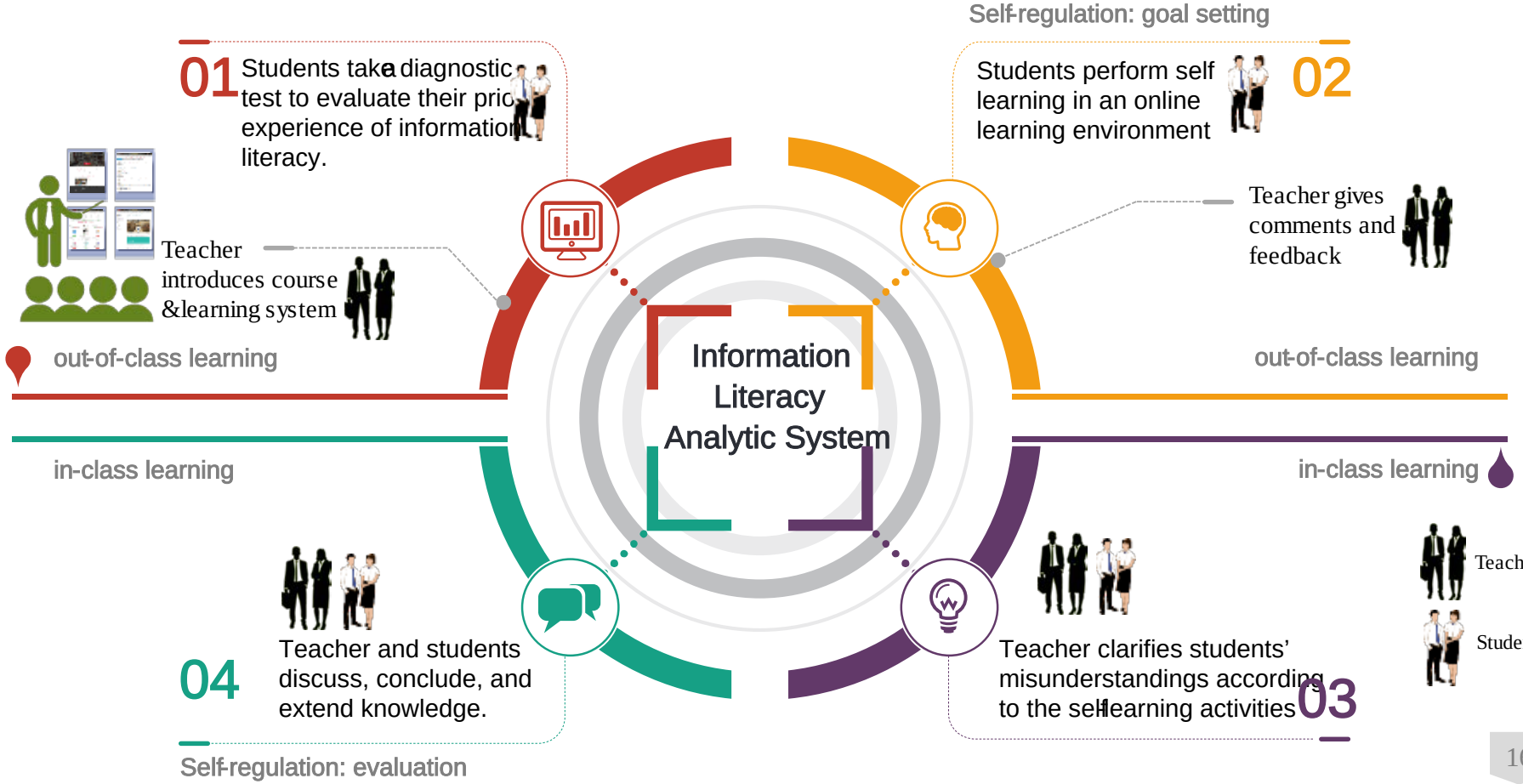
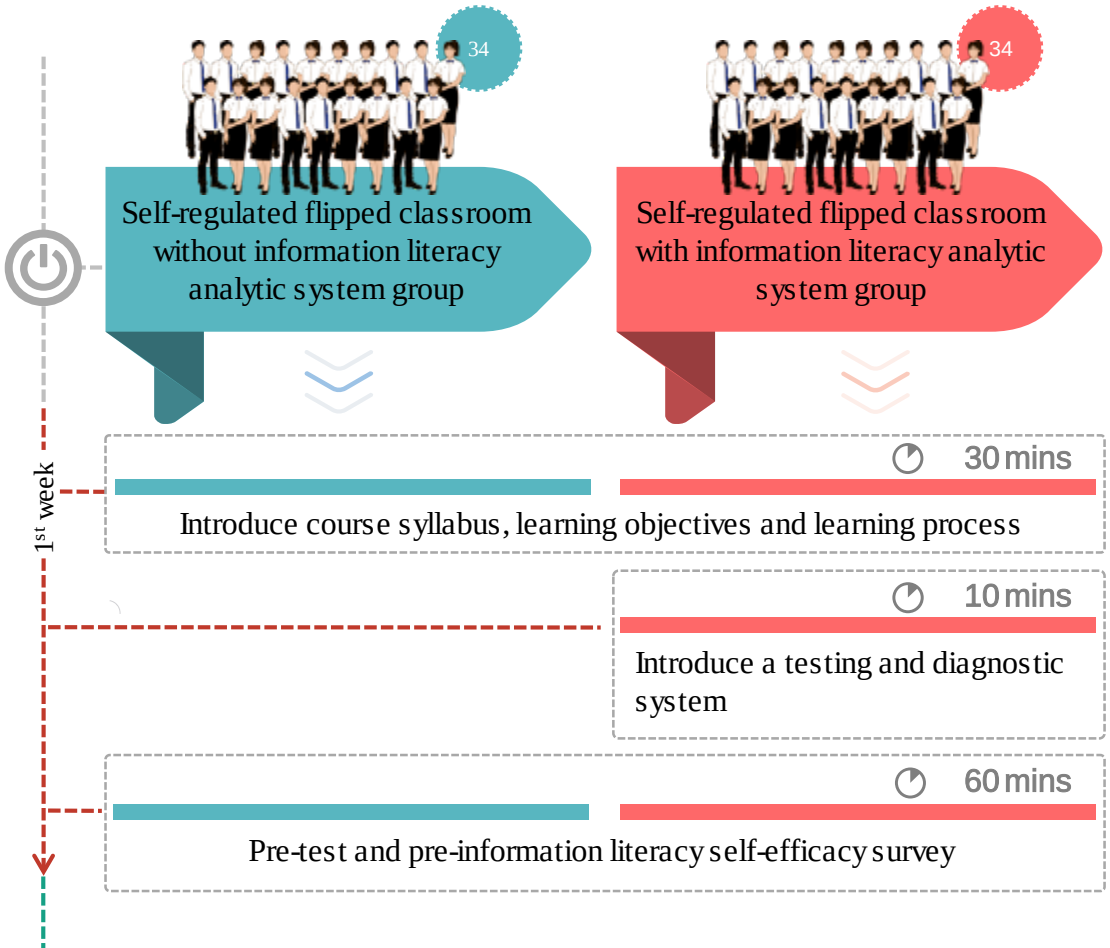


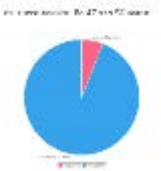
DIAGRAM OF EXPERIMENTAL PROCEDURE



2nd–6th week

Receive only pretest score after testing the information literacy performance

Receive pretest score, diagnose results, and learning guidance after testing the information literacy performance



Self-learning module with content-based arrangement

Self-learning module with learning-guidance based arrangement

170 mins

In-class learning activities

75 mins

Post-test, post-information literacy self-efficacy survey, and motivation questionnaire

7th week

* Out-of-class learning activities: students learn at wherever and whenever by personal devices

LEARNING PERFORMANCE OF THE INFORMATION LITERACY

Pre- and post-information literacy achievement tests

- Each test contained 50 multiple-choice questions associated with five standards of the information literacy.
- The total score of the tests was 50.
- Both tests are identical
- The Kuder-Richardson Formula 20 (KR-20) reliability coefficient values of the pre- and the post-tests are 0.60 and 0.64, respectively.

Pre- and post-information literacy scenario tests

- Both the pre- and the post-tests were adapted from Burgoyne and Chuppa Cornell (2015).
- Each test contained seven open-ended questions showing information literacy scenario in a hypothetical assignment format.
- Each test was scored by using a standards-based rubric in 3 levels of proficiency: Exemplary (3 scores), Competent (2 scores), and Developing (1 score).

LEARNING PERFORMANCE OF THE INFORMATION LITERACY

The t-test results of the pre information literacy achievement test scores in the two groups

- no significant difference between the pre-information literacy achievement test scores for self-regulated flipped classroom with information literacy analytic system students (M=28.44, SD=5.42) and self-regulated flipped classroom without information literacy analytic system students (M=28.12, SD=4.29), $t(66) = 0.27$, $p > 0.05$.

The one-way ANCOVA results of the post-information literacy achievement test scores in the two groups

Groups	Unadjusted		Adjusted		$F_{(1,65)}$	η^2
	Mean	SD	Mean	SE		
Self-regulated flipped classroom without information literacy analytic system	33.41	3.96	33.50	0.68	0.267	0.004
Self-regulated flipped classroom with information literacy analytic system	34.09	5.47	34.00	0.68		

LEARNING PERFORMANCE OF THE INFORMATION LITERACY

The t-test results of the pre-information literacy scenario test scores in the two groups

› no significant difference between the pre-information literacy scenario test scores for self-regulated flipped classroom with information literacy analytic system students ($M = 6.18$, $SD = 2.53$) and self-regulated flipped classroom without information literacy analytic system students ($M = 6.65$, $SD = 2.27$), $t(66) = 0.81$, $p > 0.05$.

Mann-Whitney U test results of the post-information literacy scenario test scores in the two groups

Groups	Mean	SD	z-value
Self-regulated flipped classroom without information literacy analytic system	12.94	3.49	2.198*
Self-regulated flipped classroom wit information literacy analytic system	14.97	2.39	

* $p < .05$

INFORMATION LITERACY SELF -EFFICACY

Pre- and postinformation literacy surveys

- The surveys were used to measure degrees of certainty that individuals can perform the given tasks before and after participating in the learning activities, respectively.
- The surveys were adapted from Kurbanoglu, Akkoyunlu, &Umay (2006).
- This questionnaire consists of 17 items scored on a 7-point Likert scales.
- It is classified the information literacy skill into 3 levels: Basic information literacy skill (5 items), Intermediate information literacy skill (8 items), and Advanced information literacy skill (4 items).
- The questionnaire's internal consistencies of the sublevels by Cronbach's alphas are 0.86, 0.91, and 0.85, respectively. The Cronbach's alpha value for the Thai version of the information literacy self-efficacy questionnaire is 0.95, implying a good level of internal consistency.

INFORMATION LITERACY SELF-EFFICACY

The ttest results of the pre-information literacy self-efficacy rating in the two groups

Sublevels	Groups	Mean	SD	*T*	*P*
Basic	(a)	22.47	5.02	1.910	0.060
	(b)	24.73	4.75		
Intermediate	(a)	33.71	7.92	1.694	0.095
	(b)	37.09	8.53		
Advanced	(a)	17.47	3.48	1.272	0.208
	(b)	18.71	4.46		

The ttest results of the post-information literacy self-efficacy ratings for the two groups

Sublevels	Groups	Mean	SD	*T*	*P*
Basic	(a)	27.18	3.86	1.339	0.185
	(b)	28.53	4.45		
Intermediate	(a)	42.44	5.78	0.721	0.473
	(b)	43.47	5.98		
Advanced	(a)	21.32	2.92	1.038	0.303
	(b)	22.15	3.59		

(a) Self-regulated flipped classroom without information literacy analysis system group

(b) Self-regulated flipped classroom with information literacy analysis system group

INFORMATION LITERACY SELF-EFFICACY

The *t*-test results of the post vs. pre- information literacy self-efficacy ratings for the two groups

Sublevels	Sources	Mean	SD	*t-value*	*p-value*
Basic level					
(a)	pre	4.49	1.00	6.727	<0.001
	post	5.43	0.77		
(b)	pre	4.95	0.95	4.569	<0.001
	post	5.71	0.89		
Intermediate level					
(a)	pre	4.22	0.99	6.856	<0.001
	post	5.31	0.72		
(b)	pre	4.64	1.07	3.636	<0.001
	post	5.44	0.75		
Advanced level					
(a)	pre	4.37	0.87	5.939	<0.001
	post	5.33	0.73		
(b)	pre	4.68	1.11	4.202	<0.001
	post	5.54	0.90		

(a) Self-regulated flipped classroom without information literacy analytic system group

(b) Self-regulated flipped classroom with information literacy analytic system group

LEARNING MOTIVATION

Learningmotivation survey

- The survey was used to measure students' motivation to learn information literacy after participating in the learning activities
- The Science Motivation Questionnaire II (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011) was revised by the researchers.
- This questionnaire consists of 25 items scored on a 5-point Likert scale.
- There are five dimensions of the questions: intrinsic motivation, career motivation, self-determination, self-efficacy, and grade motivation.
- The questionnaire's internal consistencies of the subscales by Cronbach's alphas are 0.90, 0.87, 0.90, 0.89, and 0.90, respectively. The Cronbach's alpha value for the Thai version of the motivation questionnaire is 0.94, implying a good level of internal consistency.

Outcomes

LEARNING MOTIVATION

The t-test results of the post-learning motivation rating for the two groups

Groups	Mean	SD	*t-value*	*p-value*
Intrinsic motivation				
(a)	19.94	3.07	1.022	0.310
(b)	20.76	3.55		
Career motivation				
(a)	19.94	3.08	2.859	0.006*
(b)	22.06	3.02		
Self-determination				
(a)	15.88	3.80	1.951	0.055
(b)	17.59	3.39		
Self-efficacy				
(a)	16.56	3.30	2.328	0.023*
(b)	18.41	3.26		
Grade motivation				
(a)	15.21	3.43	4.373	0.001*
(b)	19.29	4.24		

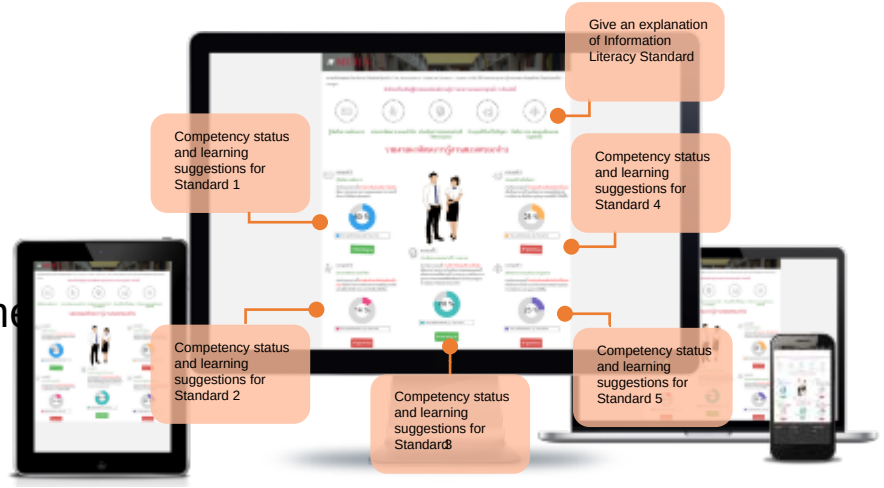
* $p<0.05$

(a) Self-regulated flipped classroom without information literacy analytic system group

(b) Self-regulated flipped classroom with information literacy analytic system group

DISCUSSIONS AND CONCLUSIONS

- The information literacy analytic system represents students' starting point of knowledge and shows how far to reach the goal.
- Students can set up their own learning strategies and prepare themselves at any time in any place by using personal computer device.
- This method allows students to identify their problems and focus their works on standards accurately and precisely.
- It assists teachers to prepare and adjust their instruction more fluently, in particular self regulation learning and flipped classroom.



PRACTITIONER NOTES

Teacher:

- Understand the nature of core contents they teach
- Prepare the test items for the exam and an educational expert
- Prepare the materials and conceptual contents in each topic through the system.
- Prepare the meaningful activities for the in-class phase.

Student:

- Study the content provided by the instructor in the system before attending the in-class learning activities.
- The students are able to access and take control of their own learning pace either in- or out-of-classroom by using their own devices in various forms.

Website developer:

- Design a database for receiving data from users, transmitting, and reporting them out to the users.
- The system should support multi-level user authentication.
- Designing the website responsive and user-friendly.
- The responsive design is the key enabling users to use their own device to learn through ubiquitous environment in anywhere and anytime.

References

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More About
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THANK YOU