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PROCEEDINGS OF
ICITEE 2021
THE 13th INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

14-15 OCTOBER 2021 | ONLINE VIRTUAL CONFERENCE

IEEE Computational Intelligence Society Thailand Chapter

Faculty of Information Technology, King Mongkut's Institute of Technology Ladkrabang, Thailand

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Welcome Messages

Message from Chair of IEEE CIS Thailand Chapter

Welcome everyone to the 13th edition of ICITEE and the 12th edition of CSBio. This is the first time IEEE-CIS Thailand Chapter is officially organizing conferences and happens to be the first time that these two conferences are collocating together. Traditionally, our Chapter has been technically sponsoring conferences, but as we grow, it's natural to extend our role. So, it gives me great pleasure to be able to bring our two collocated conferences to you online.

To provide you with a brief background, the IEEE Computational Intelligence Society (CIS) Thailand Chapter was formed back in 2015. Coincidently, our Chapter was initiated by the effort of Dr. Kitsuchart Pasupa and Dr. Kuntpong Woraratpanya who gathered sufficient support from IEEE-CIS members in the three King Mongkut's institutions (3K's). They are the General Co-Chairs of our two collocated conferences here. Of course, our membership has grown beyond 3K's with presence nationwide now. Our Chapter initiated the student-centric Joint Symposium on Computational Intelligence, or JSCI, back in 2016 and we have JSCI11 as a special session of ICITEE2021 here. JSCI has since grown to have international presence, including in JSCI11. We currently have the option to publish the preprints from JSCI on IEEE TechRxiv, with extended version submitting to collaborating international conferences.

As delegates to our collocated conferences, we will keep you informed of our activities such as Deep Learning and Artificial Intelligence (DLAI) Summer/Winter Schools. DLAI5 was officially endorsed by IEEE-CIS and we had over 200 registrants. Our partner may be offering DLAI6 in December this year; if not, surely, we will be doing so in the summer of 2022.

Let's keep in touch and we will keep you updated in the exciting and ever-evolving field of computational intelligence. Have a wonderful experience at our collocated conferences and feel free to reach out to us if you have any comments/suggestions or if there's anything you need.

Jonathan H. Chan
IEEE Computational Intelligence Society Thailand Chapter (2020-2021)

Message from General Chair

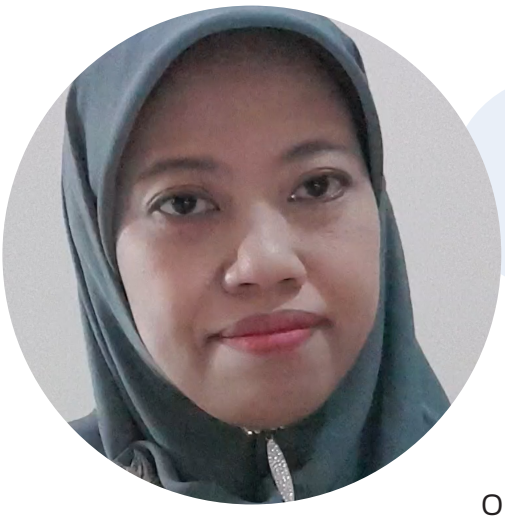
On behalf of the organizing committee, we are delighted to welcome all participants to the 13th International Conference on Information Technology and Electrical Engineering (ICITEE 2021) that takes place on 14–15 October 2021. Following the success of the previous twelve annual conferences of ICITEE, it is no exaggeration to say that this event is one of the forums that drives science and research of the following areas—including Information Technology, Signal Processing and Machine Intelligence, Communication and Network Technology, Electronics, Circuits, and Systems, Power Systems, and Control Systems—for the key technological trends which will shape the future. Unfortunately, we cannot hold the conference platform as usual, an onsite conference, due to the COVID-19 pandemic around the world. In this difficult situation, ICITEE 2021 must be held as an online virtual conference to move forward in providing a forum for academicians, professionals, and researchers to discuss and exchange their research results, innovative ideas, and experiences in all aspects of the key technological trends, as well as to identify emerging research topics and define future directions to achieve sustainable development.

Fortunately, this year we are pleased to have Prof. Dr. Masanori Sugimoto (Hokkaido University, Japan), Prof. Dr. Chu Kiong Loo (University of Malaya, Malaysia), Prof. Dr. Basabi Chakraborty (Iwate Prefectural University, Japan), Assoc. Prof. Dr. Sri Suning Kusumawardani (Gadjah Mada University, Indonesia), Assoc. Prof. Dr. Marco Anisetti (Università degli Studi di Milano, Italy) as the keynote speakers, and have Dr. Syukron Abu Ishaq Alfarozi (Gadjah Mada University, Indonesia), a young researcher, as the invited speaker.

All the members of the local organizing committee from IEEE CIS Thailand Chapter and King Mongkut's Institute of Technology Ladkrabang, and co-organizing committee from Gadjah Mada University would like to wish you a superb conference experience.

Lastly, we would like to thank our advisory board for supporting and guiding working teams, all committee members for working hard, and all participants for submitting their high-quality works to join the conference.

Sincerely,
Kuntpong Woraratpanya
General Chair of ICITEE 2021
Vice Chair of IEEE CIS Thailand Chapter (2020-2021)



Message from General Co-Chair

I would like to congratulate IEEE CIS Thailand Chapter and Faculty of Information Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), for organizing the 13th International Conference on Information Technology and Electrical Engineering (ICITEE 2021) scheduled for October 14-15, 2021, in Thailand.

On behalf of the Department of Electrical and Information Engineering, Universitas Gadjah Mada co-organizing committee, I am delighted to welcome all the experts and academics from around the world to ICITEE 2021.

The COVID-19 pandemic is still hitting around the world. The pandemic has forced us into a world only made possible through technology. While we regret that the COVID pandemic prevented us from holding the conference in Thailand, we are excited about the opportunities of holding an innovative virtual conference.

The conference will stimulate scientists worldwide to present innovative and culturally significant research in related areas. I sincerely hope that this conference will deliberate and discuss all the different facets of this exciting topic and come up with recommendations that

Sincerely,
Adhistya Erna Permanasari
Universitas Gadjah Mada

Message from Technical Program Chair

Welcome to ICITEE 2021, the 13th International Conference on Information Technology and Electrical Engineering. I am excited to be writing my first ICITEE welcome message as Technical Program Committee (TPC) Chairs of ICITEE 2021! Along with the Co-TPC Chair, Asst. Prof. Dr. Kanokwan Atchariyachanvanich - we would like to thank the Track Chairs, Asst. Prof. Dr. Sirion Vittayakorn, Asst. Prof. Dr. Bundit Thanasopon, Asst. Prof. Dr. Lapas Pradittasnee, Assoc. Prof. Dr. Vuttipon Tarateeraseth, and Asst. Prof. Dr. Itthisek Nilkhamhang, who have worked day and night to ensure a smooth delivery of the review process. Our thanks extend to the dedicated TPC members and all the reviewers who have delivered nearly 300 quality reviews within shortest time. It is thanks to the efforts of our community that we had delivered high quality reviews and the review results meeting the official deadlines.

We also want to extend sincere thanks to the authors of all submitted papers. We are pleased that you consider ICITEE to be a major conference and worthy of your time as an author and attendee. If you are attending this year, do enjoy the high quality presentations and do not forget to network! We are looking forward to an exciting conference with many stimulating discussions over keynotes, panels, and technical sessions.

The peer-review process and final paper selection is now complete! In this ICITEE, we received 103 paper submissions from several countries, out of which 45 papers were accepted for publication. The Technical Program Committee (TPC) had to make difficult decisions since many papers were of very high quality.

The resulting technical program represents a wide variety of topics organized into eleven oral presentation sessions over two days. The program also includes a special session from the 11th Joint Symposium on Computational Intelligence organized (JSCI11) organized by IEEE CIS Thailand Chapter. We hope that you will enjoy the entire program of ICITEE 2021.

Sincerely,
Teerapong Leelanupab
Technical Program Chair

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Competencies Measurement Framework Using Course Scoring Sheet (CSS) and Course Competencies Score (CCS)

Ellysa Tjandra
Department of Informatics Engineering
University of Surabaya
Surabaya, Indonesia
Department of Electrical and Information Engineering
Gadjah Mada University
Yogyakarta, Indonesia
ellysa@staff.ubaya.ac.id

Sri Suning Kusumawardani
Department of Electrical and Information Engineering
Gadjah Mada University
Yogyakarta, Indonesia
suning@ugm.ac.id

Ridi Ferdiana
Department of Electrical and Information Engineering
Gadjah Mada University
Yogyakarta, Indonesia
ridi@ugm.ac.id

***Abstract*— Academic performance is an essential focus in Higher Education. Outcome-Based Education (OBE) is recently used to measure the competencies achievements of the students in courses. In OBE, the curriculum is designed to measure students' competency achievement in each course. For this reason, it is necessary to measure course competencies achievement to provide information on whether the course learning outcome has already been fulfilled or not. This study aims to offer course competencies measurement framework and formulas using Course Scoring Sheet (CSS) at the course level.**

Keywords—competencies measurement, outcome-based education, scoring, higher education

I. INTRODUCTION

Academic performance is an essential focus in Higher Education. Outcome-Based Education (OBE), or what is also called an achievement-based curriculum, is an educational concept that emphasizes the abilities or competencies of students at the end of the learning process [1]. After students' competence is determined, the curriculum which contains the material and assessment standards is set. Currently, the educational paradigm in tertiary institutions is starting to use OBE, where curriculum designs are made by focusing on measuring students' competencies, not on the total credits taken by students [1]. Before OBE implementation in higher education institutions, the indicator used to measure student performance in the academic field was only the achievement index, which is calculated from the value of the courses that students have taken. Still, the achievement index is insufficient to measure student performance comprehensively because it does not reflect the specific competence of graduates. In this case, other indicators are needed as a compliment, which can measure graduate competencies in the Study Program.

Besides academic achievement and competence, the persistence factor also needs to be considered by universities. For this reason, efforts to monitor and evaluate student performance are necessary. By monitoring and assessing student performance regularly, the Study Program can find out student achievement and student competencies towards predetermined graduate competencies. It can make the right decisions to improve student performance.

Several previous studies have produced a competency measurement scheme within the OBE framework with conducted curriculum mapping [2]–[5]. There is also previous research using performance indicators based on three learning domains according to Bloom theory [6], and visual analytics to aid decision-making at Study Program level [7]. However, these studies did not include course competencies scoring steps and formulas to measure attainment of competence at the Study Program level.

This research proposes a competencies measurement framework and formulas using Course Scoring Sheet (CSS) and Course Competencies Score (CCS) to measure competencies achievement in a course based on Student Outcome-Learning Outcome (SO-LO) matrix. This framework can be used to measure the course competencies performance, whether it "fulfill" or "need improvement" by the Program Study.

II. PREVIOUS WORKS

Research of student competency has been carried out. The student performance measurement system in the form of competency-based Outcome-Based Education (OBE) is highly recommended because it can measure student performance more thoroughly [8]–[11]. Akir (2012) compared the impact of OBE-based educational structures and assisted technology-based education on student academic performance compared to conventional teaching-learning approaches [12]. Hammami (2020) has examined the effectiveness and efficiency of courses that implement an OBE-based assessment system [9]. Soh (2010), Ramchandra (2014), Arafeh (2015), Malagi (2016) have also established a learning outcomes measurement scheme within the OBE framework by mapping curriculum and have produced a competency measurement scheme [2]–[5]. Aziz (2005) created an outcome-based engineering education model in Malaysia [13], while Hussain (2016) adds performance indicators that are formed based on three learning domains according to Bloom's theory [6]. Lumius (2020) adds visual analytics to help decision-making at the Study Program level [7]. However, these studies did not include course competencies scoring steps and formulas to determine the level of competency attainment.

Previous researchers also have divided measurement competencies used in Study Programs into several domains. Easa (2013) has implemented a competency measurement model by dividing the stages of the assessment process into various steps based on the curriculum matrix that has been compiled [14]. Joyner (2016) also does not use the contribution level to the resulting matrix [15]. These two studies do not use the contribution level in the resulting matrix to measure the level of achievement, even though this contribution level is needed to ensure that the assessment

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scheme is appropriate [14], [15]. Basir (2019) measures competence on project subjects (capstones) by dividing competencies in a CO-PO matrix which is divided into several domains [16]. This study also does not use the level of contribution to the resulting matrix to measure the level of achievement. Bhuyan (2020) has also conducted research to evaluate OBE-based programming courses. This research produces a performance level or level of proficiency divided into six scales, namely excellent, very good, satisfactory, developing, and unsatisfactory, but the resulting mapping matrix also does not use the contribution level [17].

After that, Khan (2016) has also implemented a successful model of education programs related to competency measurement for ABET international accreditation in the Civil Engineering Study Program and also created a SO mapping matrix for the Educational Objective (PEO) Program [18]. In this study, five levels of contribution were used, where level 5 stated the strongest contribution and level 1 specified the weakest contribution, but these five levels are considered too complex/complicated based on the results of the initial needs analysis of teaching lecturers. Rajak (2018) has also conducted research to measure student competence, made a mapping matrix of PEO to PO, and then reduced it to CO [19]. Each question in the assessment is linked to the CO to measure each PO's achievement and then a survey of alumni, graduate users, curriculum teams, and exit surveys [19]. This study has used the achievement contribution level using three scales, namely low, medium, and strong, but did not report the results of measuring PO achievement in detail for each question for each student participating in the course.

III. Research Limitation

This research case studies use 16 selected mandatory subjects/courses as samples in current curriculum data of three programs at the University of Surabaya: Informatics Engineering, Information Systems, and Multimedia. These courses were selected as they represent the core knowledge areas in each program. This research provides the general representation of competencies measurement at the course level, and the subjectivity of the lecturers will be excluded.

IV. Research Methodology

The following will discuss the research methodology and the stages carried out in this study.

A. Curriculum Standards Gathering

To formulate the standardized Student Outcome of the Study Program, the Outcome-Based International Accreditation Standards for Engineering (IABEE), Indonesian Government Standards, and University Standards data will be considered.

B. Advisory Board

Universities' stakeholder feedback is mandatory for curriculum improvement to provide input to the current and future needs. Curriculum feedback is collected from the advisory board members, consisting of employers, alumni, and lecturers.

C. Focus Group Discussion

Focus group discussion will be performed to formulate the Student Outcome (SO) or Programme Educational Outcome (PEO) according to the standards and stakeholder feedback. This group consists of the university management level (university vice academic president, head of the curriculum department, and faculties members). The result from this focus group discussion is the student competencies measurement framework based on OBE. The framework will be used to measure the Student Outcome (SO) and Learning Outcome (LO) of the program.

V. Result and Discussion

This section will discuss the framework for assessing student performance based on Outcome-Based Education (OBE), including the results of the competency mapping of study programs against competency standards set by the government, the framework for assessing course academic performance. The course competencies measurement framework can be shown in Fig. 1.

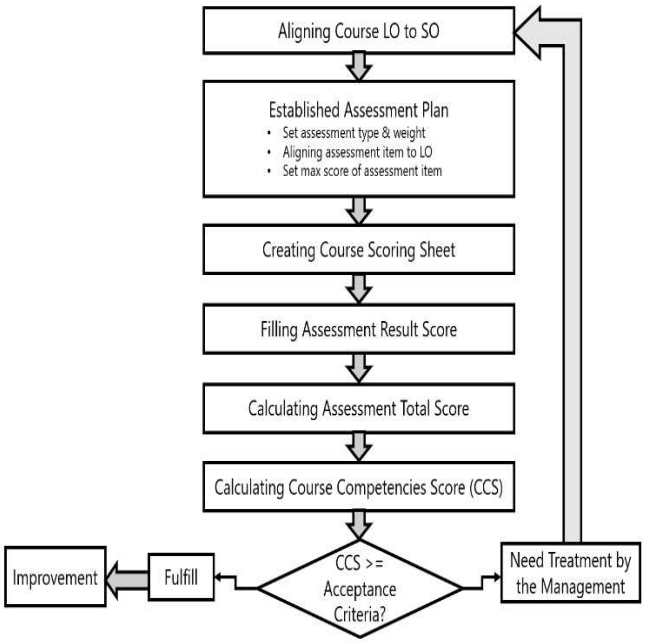

Fig. 1. Course Competencies Measurement Framework

A. Aligning Course LO to SO

In this step, Learning Outcome (LO) will be derived from Student Outcome (SO), resulting in a SO-LO matrix. Each SO must be fulfilled by one or more LO and vise versa using contribution weight three scales (low, medium, high) depending on the SO level of contribution. This matrix also defines the level of importance of the course competencies. Darker colors represent the higher contribution. The weight of competency of each course shows the importance level in achieving the competency. In this research, we only include compulsory or mandatory courses (subjects), which means elective subjects are not included in our model because the courses can vary for each specialization program taken by a student. An example of a complete SO-LO matrix can be seen in Fig. 2. In this step, a performance indicator – called Course Competencies Score (CCS) – and its acceptance criteria will also be established.

STUDENT OUTCOME MAPPING (TEMPLATE)

LEVEL OF CONTRIBUTION :
1 Low
2 Medium
3 High

NO	COURSE	STUDENT OUTCOME (SO)																	
		HARD SKILLS						Weight (%) :	x%	SOFTSKILLS						Weight (%) :	x%
		SO-1		SO-2		SO-3		SO-4		SO-5		SO-6		SO-7		SO-8		SO-9		SO-10	
1	COURSE-1	3	LO-1			3	LO-2							1	LO-3						
2	COURSE-2			1	LO-1			2	LO-2	3	LO-1							2	LO-3	2	LO-3
3	COURSE-3					3	LO-1							3	LO-2						
4	COURSE-4	2	LO-1							3	LO-2			2	LO-3	3	LO-4			1	LO-4
5	COURSE-5	1	LO-1	3	LO-2			2	LO-4			2	LO-4					2	LO-5		
6	COURSE-6			3	LO-1							3	LO-2	1	LO-3						
7	COURSE-7	3	LO-1	2	LO-1			2	LO-2							1	LO-3			2	LO-3
8	COURSE-8					3	LO-1							3	LO-2						
9	COURSE-9	2	LO-1							3	LO-2					3	LO-4			1	LO-4
10	COURSE-10			3	LO-1													3	LO-2		
11	COURSE-11					2	LO-1					3	LO-2					1	LO-3		
12	COURSE-12	1	LO-1					3	LO-2											2	LO-3
13	COURSE-13					3	LO-1									3	LO-2				
14	COURSE-14			2	LO-1															1	LO-2

Fig. 2. SO-LO Matrix Example

Course with CCS value above the acceptance criteria will be considered "fulfill" while others are considered "need treatment" – which must be explicitly treated by the management to fulfill the course competencies. Acceptance criteria, in this case, is set to 55%, so all courses with CCS<55% will be considered as "need treatment".

B. *Establish Assessment Plan*

In this step, the course assessment plan will be established by the lecturer. Course assessment type (e.g., tests, quizzes, assignments, projects, etc.) will be set with appropriate weight (0-100%), while the total weight of all assessments in a course must be 100%.

An assessment item will then be created based on the course assessment plan. All assessment items should be used to measure the appropriate SO in the SO-LO matrix. Each question of the assessment item must correspond to one or more LO(s) with a specific maximum score. The full score is set according to the level of contribution in the SO-LO matrix and the level of knowledge using Bloom's taxonomy. LO with a higher level of contribution and level of knowledge will lead to a higher maximum score. For quality control, each assessment item needs to be verified by the management.

C. *Creating Course Scoring Sheet*

Course Scoring Sheet (CSS) template is generated in this step. In the CSS, all assessments in a course must be included and weighted based on the course assessment plan. The CSS template example is shown in Fig. 3.

COURSE SCORING SHEET TEMPLATE

COURSE CODE : C-01 CREDIT : x
COURSE NAME : Course-1 SEMESTER : x

LEARNING OUTCOME (LO) :
LO-1 Learning Outcome 1 - supporting SO-1 (x%), SO-2 (x%), SO-3 (x%)
LO-2 Learning Outcome 2 - supporting SO-1 (x%), SO-2 (x%)

ASSESSMENT WEIGHT (%) :
Mid-Term Mark = x% Assessment1
Final-Term Mark = x% Assessment2
Final Mark = x% Mid-Term Mark + x% Final-Term Mark

SO : Student Outcome
LO : Learning Outcome
LSO : Lesson Student Outcome (SO achievement by specific course lesson/topic)
TS : Total Score for each assessment
ALSO : Assessment score of LSO
CCS : Course Competencies Score

NO	TERM	MID TERM									FINAL TERM									% STUDENT OUTCOME achieved by this course (CSO)						CCS	Result (fullfill/ need treatment)
		x%									x%																
	ASSESSMENT	ASSESSMENT 1									ASSESSMENT 2																
	WEIGHT (%)	x%									x%																
	ASSESSMENT ITEMS	1				2					1				2												
	LEARNING OUTCOME (LO)	LO-1			SCORE 1	LO-2			SCORE 2	TSA-1	LO-1			SCORE 1	LO-2			SCORE 2	TSA-2	ALSO-1	ALSO-2	CSO-1		CSO-2		CSO-3			
	STUDENT OUTCOME (SO)	LSO-1	LSO-2	LSO-3		LSO-1	LSO-2				LSO-1	LSO-2	LSO-3		LSO-1	LSO-2												
		x%	x%	x%		x%	x%				x%	x%	x%		x%	x%												
		MAX	MAX	MAX		MAX	MAX				MAX	MAX	MAX		MAX	MAX				MAX	MAX							
	MAX POINT	MAX				MAX				0	MAX				MAX				0			MAX	%	MAX	%	MAX	%	0	0
1	STUDENT 1																												
2	STUDENT 2																												
3	STUDENT 3																												
4	STUDENT 4																												
5	STUDENT 5																												
6	STUDENT 6																												
7	STUDENT 7																												
8	STUDENT 8																												
9	STUDENT 9																												
10	STUDENT 10																												

Fig. 3. CSS Template Example

TABLE I. ASSESSMENT PLAN EXAMPLE

No	Assessment	Weight		Assessment Items			SO Measurement	
		Mid-Term Mark	*Final Mark*	*No*	*Max Score*	*LO*	*LSO*	*LSOW*
		40%	*60%*					
1	Mid-Term Test	100%	40%	1	25	LO-1	LSO-1	50%
							LSO-2	50%
				2	25	LO-1	LSO-1	50%
							LSO-2	50%
				3	40	LO-2	LSO-1	100%
				4	10	LO-1	LSO-1	25%
							LSO-2	25%
						LO-2	LSO-1	50%
2	Class Assignment	20%	12%	1	100	LO-1	LSO-1	25%
							LSO-2	25%
						LO-2	LSO-1	50%
3	Final-Term Test	80%	48%	1-5	50	LO-1	LSO-1	50%
							LSO-2	50%
				6-10	50	LO-2	LSO-1	100%

D. Filling Assessment Result Score

After the CSS template has been generated, the lecturer will fill the template with the student score result for each assessment item.

E. Calculating Assessment Total Score

After each assessment has been conducted, the score for each student in the course will be inputted in the CSS, and the total score (TS) will be calculated using this formula:

$$TS = \sum_{i=1}^{m} scorei \quad (1)$$

where:

m = number of item in each assessment

score = item score achieved by the student in each assessment item.

F. Calculating Course Competencies Score (CCS)

For example, we use three assessments in the assessment plan, consists of Mid-Term Test, Class Assignment, and Final-Term Test. Mid-Term Mark consists of 100% Mid-Term Test score, while Final-Term Mark is calculated from 20% Class Assignment + 80% Final-Term Test. The course Final Mark is derived from 40% Mid-Term Mark + 60% Final-Term Mark. Each assessment consists of many items linked with the corresponding LO, then mapped to the suitable SO with a specific weight – called Lesson Student Outcome (LSO). This example can be seen in Table I. LSO is calculated by formula 2.

$$LSO = score\ x\ LSOW \quad (2)$$

where:

score = item score achieved by the student in each item

LSOW = Lesson Student Outcome Weight (assessment item weight, in %).

The next step is to formulate ALSO (Assessment score of Lesson Student Outcome), using this formula:

$$ALSO = \sum_{j=1}^{m} LSOj \quad (3)$$

where:

m = number of item in each assessment

LSO = Lesson Student Outcome.

Then we use formula 3 to formulate Course Student Outcome Score (CSO). CSO is total score for each SO corresponds to the LO(s) in a course (achievement of SO supported by a course) using this formula:

$$CSO = \sum_{k=1}^{n} ALSOk\ x\ AW\ x\ TW \quad (4)$$

where:

n = number of assessment in a course

ALSO = Assessment score of Lesson Student Outcome

AW = Assessment Weight for each term (mid/final term/etc., in %)

TW = term weight in a course (in %). If a course does not divided into any term then set the TW value to 100%.

Then CSO in formula 4 is used to calculate Course Competencies Score (CCS) as follows:

$$CCS = \frac{\sum_{q=1}^{p} CSOq\ x\ CSOW}{100} \quad (5)$$

where:

p = number of SO supported by a course

CSO = Course Student Outcome

CSOW = CSO Weight (weight for each SO supported by a course (in %).

G. Checking the CCS Based on Acceptance Criteria

In this step, CCS will be checked according to the acceptance criteria. Courses with CCS >= 55% will be considered "fulfill", while courses with CSS < 55% are considered "need treatment", which needs specific treatment by the management.

The final step is to determine whether a student is considered "fulfill" or "need treatment" according to the CCS value and acceptance criteria using formula 6. 55% is used for acceptance criteria based on international accreditation standards. CCS above 55% will be considered as "fulfill", while others will be considered as "need treatment" (see formula 6).

$$result = \begin{cases} fulfill, & CCS \geq 55\% \\ need\ treatment, & CCS < 55\% \end{cases} \quad (6)$$

For easier reading and to provide a better overview, the CSS results is shown in chart format in Fig. 4, showing the percentage of "fulfill" vs. "need treatment" students in the course. The university management can use this chart to monitor the competencies achievement in each course in the curriculum.

The detail calculation example of TS, LSO, ALSO, CSO, CCS, and recommendation results can be seen in Fig. 5. Students with CCS results < 55% are labeled as "need treatment", while others are labeled as "fulfill". For example, CCS of Student 5 = 56.04%, so the recommendation result is "fulfill" because the CCS value is above the acceptance criteria (55%). At the same time, Student 17 is labeled as "need treatment" because the CCS value is 47.28% (below the acceptance criteria).

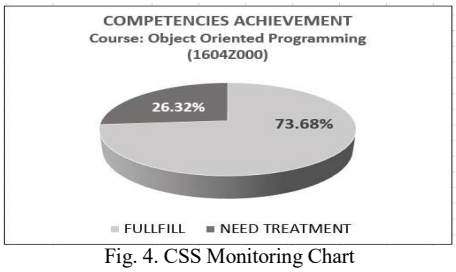

Fig. 4. CSS Monitoring Chart

This scheme has already tested on 10 respondents consisting of 10 courses coordinators who manage 16 subjects opened in three programs: Informatics Engineering, Information Systems, and Multimedia at the University of Surabaya. This scheme has also been validated in a focus group discussion (FGD) forum consisting of five members: university vice president, director of the curriculum and teaching department, dean, vice dean, and OBE practitioner. The scheme can provide the measurement results for all SO correspond to the subjects for each enrolled student. Still, the framework can not measure the real achievement for the student who does not complete any assessments in the course due to absence, plagiarism, or other reasons.

VI. Conclusion and Future Works

In this research, the competencies measurement framework has been obtained using CSS, and the recommendation result can be provided for the management. Since the CSS scheme can not measure the real achievement for the student who does not complete any assessments in the course, additional information for these cases is required in the management report. However, this framework works at the course level only, does not comply with all courses taken by the student, so we can not figure out the student competencies comprehensively. This framework also can not measure the competency of students who do not complete any course assessments due to absence, plagiarism, or other reasons because we do not include non-academic factors in our model. In further research, we will continue with a broader level with all courses taken by the student to obtain the complete student competencies measurement, including non-academic factors in our model.

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COURSE SCORING SHEET RESULT

COURSE CODE : 1604Z000 — CREDIT : 4 — SEMESTER : 2

COURSE NAME : Object Oriented Programming

LEARNING OUTCOME
- LO-1: The student will be able to analyze and design using object oriented concepts - supporting SO-1 and SO-2
- LO-2: The student will be able to create a modular program using object oriented concepts - supporting SO-1

ASSESSMENT : Final-Term Mark = 20% Class Assignment + 80% Final-Term Test, Final Mark = 40% Mid-Term Mark + 60% Final-Term Mark
Mid-Term Mark = 100% Mid-Term Test

SO : Student Outcome
LO : Learning Outcome
LSO : Lesson Student Outcome
TSA : Total Score for each assessment
ALSO : Assessment score of LSO
CCS : Course Competencies Score

NO	TERM	MID TERM 40%															CLASS ASSIGNMENT 20%						
	ASSESSMENT	MID SEMESTER TEST															8-14						
	WEIGHT (%)	100%																					
	ASSESSMENT ITEMS	1			2			3		4													
	LEARNING OUTCOME	LO-1			LO-1			LO-2		LO-1		LO-2					LO-1		LO-2				
	STUDENT OUTCOME (SO)	LSO-1	LSO-2	SCORE1	LSO-1	LSO-2	SCORE2	LSO-1	SCORE3	LSO-1	LSO-2	LSO-1	SCORE4	TSA-1	ALSO-1	ALSO-2	LSO-1	LSO-2	LSO-1	SCORE	TSA-2	ALSO-1	ALSO-2
		50%	50%		50%	50%		100%		25%	25%	50%					25%	25%	50%				
		12.5	12.5		12.5	12.5		40		2.5	2.5	5			72.5	27.5	25	25	50			75	25
	MAX POINT	25			25			40		10				100			100				100		
1	STUDENT 1	12.5	12.5	25	12.5	12.5	25	40	40	2.5	2.5	5	10	100	72.5	27.5	25	25	50	100	100	75	25
2	STUDENT 2	10	10	20	10	10	20	30	30	2.5	2.5	5	10	80	57.5	22.5	20	20	40	80	80	60	20
3	STUDENT 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	STUDENT 4	12.5	12.5	25	12.5	12.5	25	35	35	2.5	2.5	5	10	95	67.5	27.5	15	15	30	60	60	45	15
5	STUDENT 5	9	9	18	5	5	10	10	10	2.5	2.5	5	10	48	31.5	16.5	16.75	16.75	33.5	67	67	50.25	16.75
6	STUDENT 6	5	5	10	2.5	2.5	5	40	40	1.25	1.25	2.5	5	60	51.25	8.75	21.75	21.75	43.5	87	87	65.25	21.75
7	STUDENT 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	22	44	88	88	66	22
8	STUDENT 8	0	0	0	12.5	12.5	25	30	30	1.25	1.25	2.5	5	60	46.25	13.75	13.75	13.75	27.5	55	55	41.25	13.75
9	STUDENT 9	12.5	12.5	25	12.5	12.5	25	40	40	2.5	2.5	5	10	100	72.5	27.5	25	25	50	100	100	75	25
10	STUDENT 10	12.5	12.5	25	12.5	12.5	25	25	25	2.5	2.5	5	10	85	57.5	27.5	22.5	22.5	45	90	90	67.5	22.5
11	STUDENT 11	12.5	12.5	25	12.5	12.5	25	35	35	2.5	2.5	5	10	95	67.5	27.5	25	25	50	100	100	75	25
12	STUDENT 12	5	5	10	5	5	10	10	10	2.5	2.5	5	10	40	27.5	12.5	23.75	23.75	47.5	95	95	71.25	23.75
13	STUDENT 13	4	4	8	2.5	2.5	5	28	28	2.5	2.5	5	10	51	42	9	22	22	44	88	88	66	22
14	STUDENT 14	11	11	22	10	10	20	38	38	1.5	1.5	3	6	86	63.5	22.5	24.75	24.75	49.5	99	99	74.25	24.75
15	STUDENT 15	6	6	12	11	11	22	37	37	1.75	1.75	3.5	7	78	59.25	18.75	0	0	0	0	0	0	0
16	STUDENT 16	10.5	10.5	21	11.5	11.5	23	37	37	0.5	0.5	1	2	83	60.5	22.5	12.5	12.5	25	50	50	37.5	12.5
17	STUDENT 17	1	1	2	1.5	1.5	3	5	5	2.75	2.75	5.5	11	21	15.75	5.25	11	11	22	44	44	33	11
18	STUDENT 18	2.5	2.5	5	2.5	2.5	5	5	5	0	0	0	0	15	10	5	0	0	0	0	0	0	0
19	STUDENT 19	9	9	18	11.5	11.5	23	22	22	0	0	0	0	63	42.5	20.5	20.75	20.75	41.5	83	83	62.25	20.75

COURSE SCORING SHEET RESULT (continued)

NO	TERM	FINAL TERM 60%																												% STUDENT OUTCOME achieved by this course (CSO)				CCS	Result
	ASSESSMENT	FINAL SEMESTER TEST																																	
	WEIGHT (%)	80%																																	
	ASSESSMENT ITEMS	1			2			3		4			5			6		7		8		9		10						CSO-1		CSO-2			
	LEARNING	LO-1			LO-1			LO-1		LO-1			LO-1			LO-2		LO-2		LO-2		LO-2		LO-2			TSA-3	ALSO-1	ALSO-2						
	STUDENT OUTCOME (SO)	LSO-1	LSO-2	SCORE	LSO-1	LSO-2	SCORE	LSO-1	LSO-2	SCORE	LSO-1	LSO-2	SCORE	LSO-1	LSO-2	SCORE	LSO-1	SCORE	LSO-1	SCORE	LSO-1	SCORE	LSO-1	SCORE	LSO-1	SCORE									
		50%	50%		50%	50%		50%	50%		50%	50%		50%	50%		100%		100%		100%		100%		100%									
		5	5		5	5		5	5		5	5		5	5		10		10		10		10		10			75	25					
	MAX POINT	10			10			10		10			10			10		10		10		10		10		100			74	%	26	%	100	
1	STUDENT 1	5	5	10	5	5	10	5	5	10	5	5	10	5	5	10	10	10	10	10	10	10	10	10	10	10	100	75	25	74	100.00%	26	100.00%	100.00%	FULLFILL
2	STUDENT 2	2.5	2.5	5	2.5	2.5	5	2.5	2.5	5	2.5	2.5	5	5	5	10	10	10	10	10	10	10	10	10	10	10	80	65	15	61.4	82.97%	18.6	71.54%	80.00%	FULLFILL
3	STUDENT 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0.00%	0.00%	NEED TREATMENT
4	STUDENT 4	0	0	0	0	0	0	0	0	0	5	5	10	2.5	2.5	5	10	10	10	10	10	10	10	10	10	10	65	57.5	7.5	60	81.08%	16.4	63.08%	76.40%	FULLFILL
5	STUDENT 5	0	0	0	5	5	10	5	5	10	0	0	0	5	5	10	0	0	10	10	0	0	10	10	10	10	60	45	15	40.23	54.36%	15.81	60.81%	56.04%	FULLFILL
6	STUDENT 6	5	5	10	5	5	10	5	5	10	5	5	10	5	5	10	10	10	10	10	10	10	10	10	10	10	100	75	25	64.33	86.93%	18.11	69.65%	82.44%	FULLFILL
7	STUDENT 7	5	5	10	5	5	10	2.5	2.5	5	5	5	10	2.5	2.5	5	10	10	10	10	0	0	0	0	10	10	70	50	20	31.92	43.14%	12.24	47.08%	44.16%	NEED TREATMENT
8	STUDENT 8	5	5	10	5	5	10	2.5	2.5	5	5	5	10	5	5	10	10	10	10	10	10	10	0	0	10	10	85	62.5	22.5	53.45	72.23%	17.95	69.04%	71.40%	FULLFILL
9	STUDENT 9	5	5	10	5	5	10	5	5	10	5	5	10	5	5	10	10	10	10	10	10	10	10	10	10	10	100	75	25	74	100.00%	26	100.00%	100.00%	FULLFILL
10	STUDENT 10	2.5	2.5	5	0	0	0	0	0	0	5	5	10	5	5	10	10	10	10	10	10	10	10	10	10	10	75	62.5	12.5	61.1	82.57%	19.7	75.77%	80.80%	FULLFILL
11	STUDENT 11	0	0	0	0	0	0	5	5	10	0	0	0	5	5	10	10	10	10	10	10	10	10	10	10	10	70	60	10	64.8	87.57%	18.8	72.31%	83.60%	FULLFILL
12	STUDENT 12	5	5	10	5	5	10	5	5	10	5	5	10	5	5	10	10	10	10	10	10	10	10	10	10	10	100	75	25	55.55	75.07%	19.85	76.35%	75.40%	FULLFILL
13	STUDENT 13	0	0	0	5	5	10	5	5	10	0	0	0	5	5	10	10	10	0	0	5	5	10	10	10	10	65	50	15	48.72	65.84%	13.44	51.69%	62.16%	FULLFILL
14	STUDENT 14	5	5	10	5	5	10	0	0	0	5	5	10	0	0	0	10	10	10	10	10	10	10	10	10	10	80	65	15	65.51	88.53%	19.17	73.73%	84.68%	FULLFILL
15	STUDENT 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.7	32.03%	7.5	28.85%	31.20%	NEED TREATMENT
16	STUDENT 16	5	5	10	2.5	2.5	5	2.5	2.5	5	5	5	10	5	5	10	10	10	10	10	10	10	10	10	10	10	90	70	20	62.3	84.19%	20.1	77.31%	82.40%	FULLFILL
17	STUDENT 17	2.5	2.5	5	5	5	10	2.5	2.5	5	5	5	10	2.5	2.5	5	10	10	5	5	0	0	10	10	10	10	70	52.5	17.5	35.46	47.92%	11.82	45.46%	47.28%	NEED TREATMENT
18	STUDENT 18	0	0	0	2.5	2.5	5	5	5	10	2.5	2.5	5	2.5	2.5	5	5	5	5	5	5	5	0	0	0	0	40	27.5	12.5	17.2	23.24%	8	30.77%	25.20%	NEED TREATMENT
19	STUDENT 19	0	0	0	0	0	0	0	0	0	5	5	10	5	5	10	10	10	10	10	10	10	10	10	10	10	70	60	10	53.27	71.99%	15.49	59.58%	68.76%	FULLFILL

Fig. 5. CSS Calculation Example