CONSTRUCTIVE ALIGNMENT GUIDELINE IN PREPARING ASSESSMENT FOR TECHNOLOGY PROGRAM

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ABSTRACT

Accreditation serves to confirm that graduates adhere to the standards established by the Board of Engineers Malaysia (BEM) for engineering technologists. In outcome-based education, the teaching context must be created so that students may master the learning outcome, and each evaluation must be in line with the desired learning outcome (OBE). In order to assist in the process of constructing a rubric that is in line with learning outcomes, the purpose of this article was to develop constructive alignment guideline in preparing assessment for technology program. This study used document analysis to obtain data using a qualitative technique. All information was obtained from public records, such as on-going records of an organization's activities, policy manuals, Engineering Technology Accreditation Council (ETAC) guideline, strategic plans, and previous studies. From the document analysis, maps for all 12 Program Learning Outcome (PLO) and type of assessment were produced. Whilst, all 12 PLOs mapping with SP (Problem Solving) and SK (Knowledge Profiles) also been developed to eased the process of identifying the best SP and SK according to the depth of assessment and requirement by each PLO. Later, the rubrics for each assessment were developed to ensure all tasks given to student were being assessed. Finally, lecturers will have an option to choose the best mapped for their assessments according to the assessment guideline framework that has been developed. As a result, all assessment created by lecturers will be aligned with CLOs, PLOs and lastly PEO were measured correctly.

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1. Introduction

The body of information used in the TVET curriculum has changed as a result of many phases of change in the curriculum's growth. The adjustments are made in response to technology advancements, the Industrial Revolution 4.0, internet usage, and policies developed by institutions of higher learning (IHL). The creation of curricula must align with the standards set by the Engineering Technology Accreditation Council (ETAC), the sole accreditation body recognized in Malaysia for engineering technology bachelor's degrees, engineering diplomas, and engineering technology diplomas. ETAC, which is a division of the Board of Engineers Malaysia (BEM), aims to guarantee that the accredited programs meet the equivalent standards of engineering technology qualifications recognized by the signatories of the Sydney Accord and Dublin Accord. ETAC was established by the Board of Engineers Malaysia (BEM) to ensure the equivalent quality of the accredited engineering technology bachelor's degree, engineering diploma, and engineering technology diploma programs. Since it began offering certification in 2016, ETAC has approved 159 engineering diploma programs, delivered by 14 IHLs in Malaysia, and 50 engineering technology degree programs. Accreditation serves to guarantee that graduates meet the standards established by BEM for engineering technologists. Each assessment offered must be in line with the intended learning objective, and the teaching context must be created so that students may master the learning outcome (Biggs, 2012). Constructive alignment is a term used in the field of Outcome-Based Education (OBE) to describe the design and delivery of education programs. The concept of constructive alignment refers to the alignment of learning outcomes, assessment practices, and teaching methods, with the goal of ensuring that the students are able to achieve the desired learning outcomes.

The basic idea behind constructive alignment is that the educational process should be designed in a way that helps students to attain specific learning outcomes through a combination of instruction, practice, and feedback. To achieve this, teachers and educators must carefully design learning activities and assessments that align with the stated outcomes and provide students with the necessary opportunities to practice and demonstrate their understanding of the material. In practice, constructive alignment involves the following steps:

i. Identifying the desired learning outcomes
ii. Aligning instruction and assessment
iii. Using formative assessment
iv. Providing opportunities for practice and application

In conclusion, constructive alignment is a crucial component of Outcome-Based Education, as it helps to ensure that students are able to attain the desired learning outcomes in an efficient and effective manner. By aligning learning outcomes, assessment practices, and teaching methods, educators can create educational experiences that are tailored to the needs of their students and help them achieve their full potential.

Program Learning Outcome (PLO) refers to the knowledge, skills, and attitudes that students are expected to attain as a result of completing a particular program of study (Biggs & Tang, 2011). PLOs are used to define the expected outcomes of an educational program and provide a clear and measurable framework for assessing student performance. According to Biggs and Tang (2011), PLOs are "statements that describe what students are expected to know and be able to do at the end of a program of study". PLOs are typically developed at the program level and provide a roadmap for the design and delivery of educational programs. PLOs are an important component of Outcome-Based Education (OBE) and are used to align educational programs with the needs and expectations of students, employers, and other stakeholders. By defining clear and measurable PLOs, educators can ensure that their programs are relevant, effective, and meet the needs of their students. Constructive alignment in teaching and learning become vital in OBE curriculum whereby the implementation of OBE must be aligned with 12 Program Learning Outcome (PLO), Course Learning Outcome (CLO) and type of assessment produced. Whilst, all 12 PLOs mapping with SP (Problem Solving) and SK (Knowledge Profiles) also been developed to eased the process of identifying the best SP and SK according to the depth of assessment and requirement by each PLO. However, there were some issue highlighted by previous researchers regarding constructive alignment in OBE curriculum and the mismatch between assessment and program learning outcome as shown in Table 1.

Table 1: Issue in developing constructive alignment

Issue	Previous Studies
The importance of learning outcomes	Biggs, (1999); Adam, (2006); Biggs and Tang, (2007); Ali, (2019); Romero, M., & Kalmpourtzis, G. (2020); Noor Al-Huda & Khoo (2013); Rathy et al, (2020); Thian et al. (2018)
Learning outcome mismatch with tasks given	Alfauzan & Tarchouna (2017); Romero & Kalmpourtzis (2020).
A misalignment of learning outcome with teaching and learning approaches	Alfauzan & Tarchouna (2017) ; Abatihun, (2020); Sun & Lee (2020)
Assessment tasks are inadequately distributed to assess the intended knowledge	Genon & Torres (2020); Alfauzan & Tarchouna (2017); Abatihun, (2020); Zhang et. Al. (2022);
Constructive alignment was designed to promotes students' deep learning approach	Hailikari, et. al., (2021); Zhang et. Al. (2022); Jasmin, et al. (2018); Stamov Roßnagel, et al. (2021)
Challenge in establishing an OBE system	Spady & Marshall, (1991) ;Reich et al., (2019); Gunarathne et al., (2019);

Aligning assessment with learning outcomes is an important aspect of ensuring that students are effectively learning what they need to know in a course or program. However, this can be a complex and challenging process, and there are a number of issues that can arise when attempting to align assessment with learning outcomes. One issue is the lack of clear and well-defined learning outcomes. If learning outcomes are not clearly defined and communicated to both instructors and students, it can be difficult to develop assessments that effectively measure these outcomes. Additionally, if learning outcomes are not well defined, it can be difficult to determine what students should be able to know and do by the end of a course or program. Another issue is the lack of alignment between the assessment methods used and the learning outcomes being assessed. For example, if a learning outcome focuses on critical thinking skills, but the assessment only measures factual recall, it may not accurately assess student mastery of the learning outcome. A third issue is the lack of integration between assessment and instruction. In order to effectively align assessment with learning outcomes, it is important that assessments are integrated into the instructional process and used to inform and improve teaching and learning. Finally, there is often a lack of ongoing assessment improvement and revision. In order to effectively align assessment with learning outcomes, it is important to continuously evaluate and improve the assessments used, in order to ensure that they are accurately and effectively measuring student learning.

A recent study by Marzano and Pickering (2017) highlights these and other challenges in aligning assessment with learning outcomes, and provides recommendations for overcoming these challenges. The authors suggest that to effectively align assessment with learning outcomes, it is important to establish a clear and well-defined set of learning outcomes, to align assessment methods with these outcomes, to integrate assessment into the instructional process, and to continuously evaluate and improve assessments. Hence, every program developed by IHL must have a Program Education Outcome to determine the graduate has mastered all knowledge and skills required. The program also needs to be formulated based on the 12 learning outcome programs (PLO) listed by the Sydney Accord. The Sydney Accord is an international agreement between engineering accreditation bodies that was established in 2001. It provides a framework for the recognition of engineering qualifications across different countries, and is aimed at promoting the mobility of engineers and facilitating their international recognition.

The Sydney Accord has been widely adopted by engineering accreditation bodies around the world, and is considered an important step towards promoting the mobility and recognition of engineers in a global context. By providing a common framework for the recognition of engineering qualifications, the Accord helps to ensure that engineers have the skills and knowledge they need to meet the challenges of an increasingly interconnected world. Engineering technology graduates need to master the 12 PLOs. Whilst, Figure 1 shows how constructive alignment in curriculum whereby all rubrics and assessment given to students reflected back to PEO.

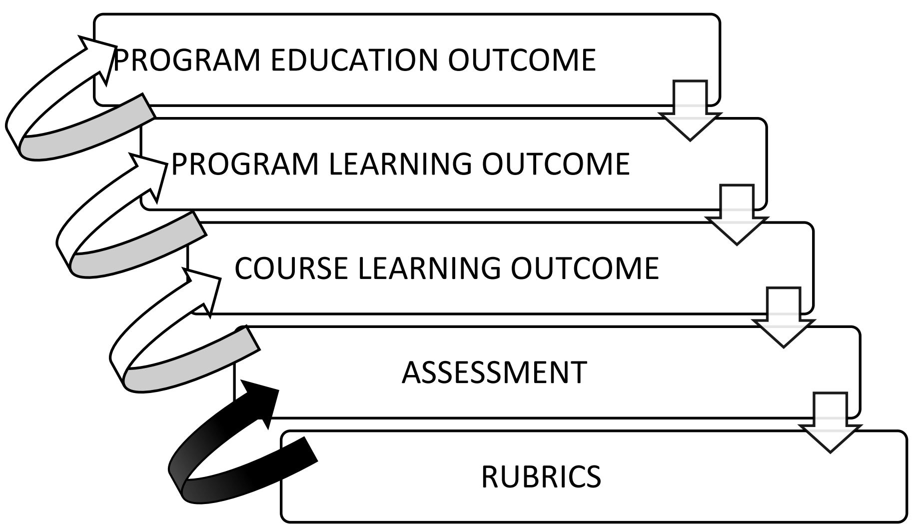

Figure 1: Constructive Alignment in Curriculum

Each program contained courses that will be offered to students. Each course offered must have a course learning outcome (CLO) for students to master. The planned CLO should be mapped with 12 PLOs designed under ETAC standard. Each CLO needs to be assessed to determine the graduate's achievement. Past studies have found that assessment needs to be done constructively aligned with CLO and PLO. PLO needs to map with knowledge profile (SK/DK) and problem solving (SP/DP). Table 2 shows 8 Knowledge Profile (SK/DK), 7 Problem Solving (SP/DP) & 5 Engineering Activities (NA/TA).

Table 2 Knowledge Profile (SK/DK), Problem Solving (SP/DP) & Engineering Activities (NA/TA)

Knowledge Profile (SK/DK)	**Problem Solving (SP/DP).**	**Engineering Activities (NA/TA)**
SK1-Natural sciences	SP1-Depth of knowledge required	TA1-Range of resources
SK2-Mathematics	SP2-Range of conflicting requirements	TA2-Level of interactions
SK3-Engineering fundamentals	SP3-Depth of analysis required	TA3-Innovation
SK4-Specialist Knowledge	SP4-Familiarity of issues	TA4-Consequences to society and the environment
SK5-Engineering Design	SP5-Extent of applicable codes	TA5-Familiarity of issues
SK6-Engineering Practice	SP6-Extent of stakeholder involvement & conflicting requirements	-
SK7-Comprehension	SP7-Interdependence	-
SK9-Research literature	-	-

Therefore, this paper aims to develop constructive alignment guideline in preparing assessment for technology program in assisting of rubric developing process that in line with learning outcome. All 12 PLOs under ETAC with knowledge profile (SK/DK) and problem solving (SP/DP) were mapped in order to create assessment rubrics for every PLOs.

2. Method

This study employs a qualitative methodology and document analysis. Comparative to quantitative research, qualitative studies use distinct types of data. Documents analysis is a widely used qualitative research method that involves the systematic examination and interpretation of written, visual, or audio material. This method can be used to gather data on a wide range of topics, including organizational processes, policies, and practices; cultural norms and beliefs; and historical events. According to Morse (1994), "document analysis is a social research method for studying written and printed texts that are relevant to the researcher's research questions. Morse goes on to explain that document analysis can involve the examination of a range of materials, including books, reports, memos, letters, journals, manuscripts, newspaper articles, government reports, organizational records, personal papers, audio-visual materials, and electronic data. In conducting document analysis, researchers often follow a systematic process, including: (1) selecting the documents to be analysed, (2) coding and categorizing the data, (3) identifying patterns and themes within the data, and (4) interpreting the findings in relation to the research questions. One of the strengths of document analysis is that it allows researchers to access a rich source of historical and contemporary data that may not be available through other methods, such as interviews or observation. Document analysis can also be less time-consuming and less expensive than other qualitative research methods, as the materials being analysed are often readily available and do not require the researcher to actively engage with participants. In conclusion, document analysis is a valuable qualitative research method that provides researchers with access to a rich source of data for understanding complex social and cultural phenomena.

A range of sources, including observations, interviews, and results from printed materials, can be used to gather data (Patton, 1990). Meanwhile, observations, interviews, and document analysis were the methods employed to collect data (Kamarul Azmi, 2012). Document analysis is a type of qualitative research in which the researcher interprets materials to give context and meaning to a topic under review (Bowen, 2009). Document analysis is a small part of the process of gathering information from written or spoken texts in order to conduct research. Information pertinent to the study's goals was gathered using this manner. Document sources inclusive of curriculum, syllabus, guidelines, circulars, minutes of meetings and many more. In this study, the documents analyzed are the curriculum documents of the Engineering Technology Program, Program Structure, ETAC standards as well as previous studies related to course assessment. Prior to conducting the analysis, O'Leary (2014) emphasized several steps in the planning process to be considered, including creating a list of texts to examine, addressing any linguistic or cultural barriers in accessing the texts, acknowledging and overcoming personal biases, acquiring relevant research skills, implementing strategies to maintain credibility, being aware of the desired data, and addressing ethical considerations. Figure 2 shows the research framework for this study.

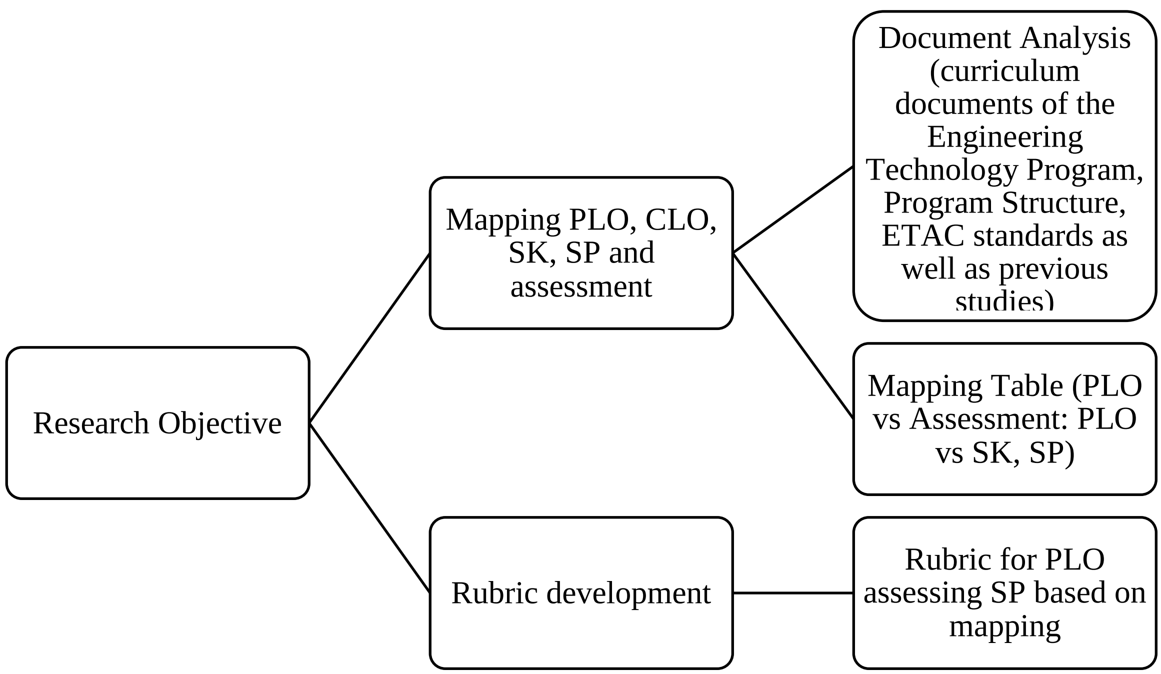

Figure 2: Research Framework

3. Result

The following section presents the results of a study that aimed to develop constructive alignment guideline in preparing assessment for technology program in assisting of rubric developing process that in line with learning outcome. After conducting a thorough review of existing literature and best practices in technology program assessment and rubric development, a draft assessment guideline was developed as it provided a clear and structured approach to aligning assessment practices with learning outcomes. Based on the analysis, the assessment constructive alignment guideline was refined and finalized. The final guideline consisted of five key components: (1) program learning outcome (PLO) identification and type of assessments, (2) PLO mapping with SP (Problem Solving) and SK (Knowledge Profiles), (3) PLO mapping with TA (Engineering Activities), (4) summary of PLOs, SPs and SKs Mapping, and (5) rubrics. Table 3 shows all 12 PLO and type of assessment suitable to assess the student competency in term of problem-solving skills and knowledge acquisition for each PLO. As for example, for PLO 1 (Knowledge), student attainment can be assessed using test, quiz and final examination whilst PLO5 (Modern Tools) can be assessed using Mini Project, Lab Report, Project Presentation and Capstone Project. Assessment is very important in determining student achievement as well as a key indicator of curriculum success. The developed curriculum should be able to be thought by the teaching staff and able to achieve the learning objectives by execution of assessment given to students.

Table 4 shows all 12 PLOs mapping with SP (Problem Solving) and SK (Knowledge Profiles). Each PLO has its owned mapping toward SP and SK according to the depth of assessment and requirement by each PLO. For example, PLO 1 (Knowledge) were mapped with 3 SP namely SP1, SP2 and SP3. PLO1 also were mapped with SP1, SP4 and SP5. Therefore, lecturers will have an option to choose the best mapped for their assessments. Later all assessment created by lecturers will aligned with this mapping to ensure all PLOs were measured correctly.

Table 3 : PLO Vs Assessment

No	***Program learning Outcome***	**SK/TA**	**SP**	**ASSESSMENT**
1	PLO1-Engineering Knowledge	SK1-SK4	SP1 and some or all of SP2 to SP7:	Test, Exam , Quiz
2	PLO1-Engineering Knowledge	SK1-SK4	SP1 and some or all of SP2 to SP7:	Test, Exam, Quiz, Case Study, Tutorial
3	PLO1-Engineering Knowledge	SK5	SP1 and some or all of SP2 to SP7:	Test, Exam, Quiz, Case Study, Mini Project, Captone Project
4	PLO2-Problem Analysis	SK8	SP1 and some or all of SP2 to SP7:	Case Study, Mini Project, Lab Report, Site Visit
5	PLO2-Problem Analysis	SK6	SP1 and some or all of SP2 to SP7:	Mini Project, Lab Report, Project Presentation, Captone Project
6	PLO2-Problem Analysis	SK7	SP1 and some or all of SP2 to SP7:	Case Study, Mini Project, Site Visit, Presentation, Appraisal, Reflective Journal, Captone Project
7	PLO3-Design/Development of Solutions	SK7	SP1 and some or all of SP2 to SP7	Case Study, Mini Project, Site Visit, Appraisal, Reflective Journal, Presentation, Captone Project
8	PLO4-Investigation	SK7		Case Study, Mini Project, Site Visit, Appraisal, Reflective Journal, Presentation, Captone Project
9	PLO5-Modern Tool Usage			Case Study, Mini Project, Site Visit, Appraisal, Reflective Journal, Presentation, Captone Project
10	PLO6-The Engineer and Society	TA1-TA5 (ANY 1 OR MORE)		Case Study, Mini Project, Site Visit, Appraisal, Reflective Journal, Presentation, Captone Project
11	PLO7-Environment and Sustainability			Case Study, Mini Project, Site Visit, Appraisal, Reflective Journal. Presentation, Captone Project
12	PLO8-Ethics			Case Study, Mini Project, Site Visit, Appraisal, Reflective Journal, Presentation, Captone Project

Table 4: PLO vs SK and SP

PLO	SP1								SP2	SP3	SP4	SP5	SP6	SP7
	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8						
PLO1-Engineering Knowledge	/	/	/	/					/	/				
PLO1-Engineering Knowledge	/	/	/	/							/	/		
PLO1-Engineering Knowledge	/	/	/	/									/	/
PLO2-Problem Analysis	/	/	/	/					/	/				
PLO2-Problem Analysis	/	/	/	/							/	/		
PLO2-Problem Analysis	/	/	/	/									/	/
PLO3-Design/Development of Solutions	/	/	/	/							/	/		
PLO4-Investigation				/				/				/	/	
PLO5-Modern Tool Usage				/		/					/	/		
PLO6-The Engineer and Society						/	/						/	/
PLO7-Environment and Sustainability				/			/		/	/				
PLO8-Ethics							/							

Table 5 show mapping of PLO without SP/SK but has engineering activities (TA). Out of 4 PLOs, only PLO10 has TA as shown in table 4. Whilst, Figure 3 show the summary of PLOs, SPs and SKs Mapping to ease lecturer understanding on selecting the perfect match in developing assessment and rubrics.

Table 5: PLO vs TA

PLO	TA1	TA2	TA3	TA4	TA5	
PLO9-Individual and Team work						
PLO10-Communication	/	/	/	/	/	Written Report, prototype, drawing, modelling Verbal Presentation, viva *Rubric need to be design according to TA1-TA5 depend on type of assessment taken.*
PLO11-Project Management and Finance						
PLO12-Lifelong learning						

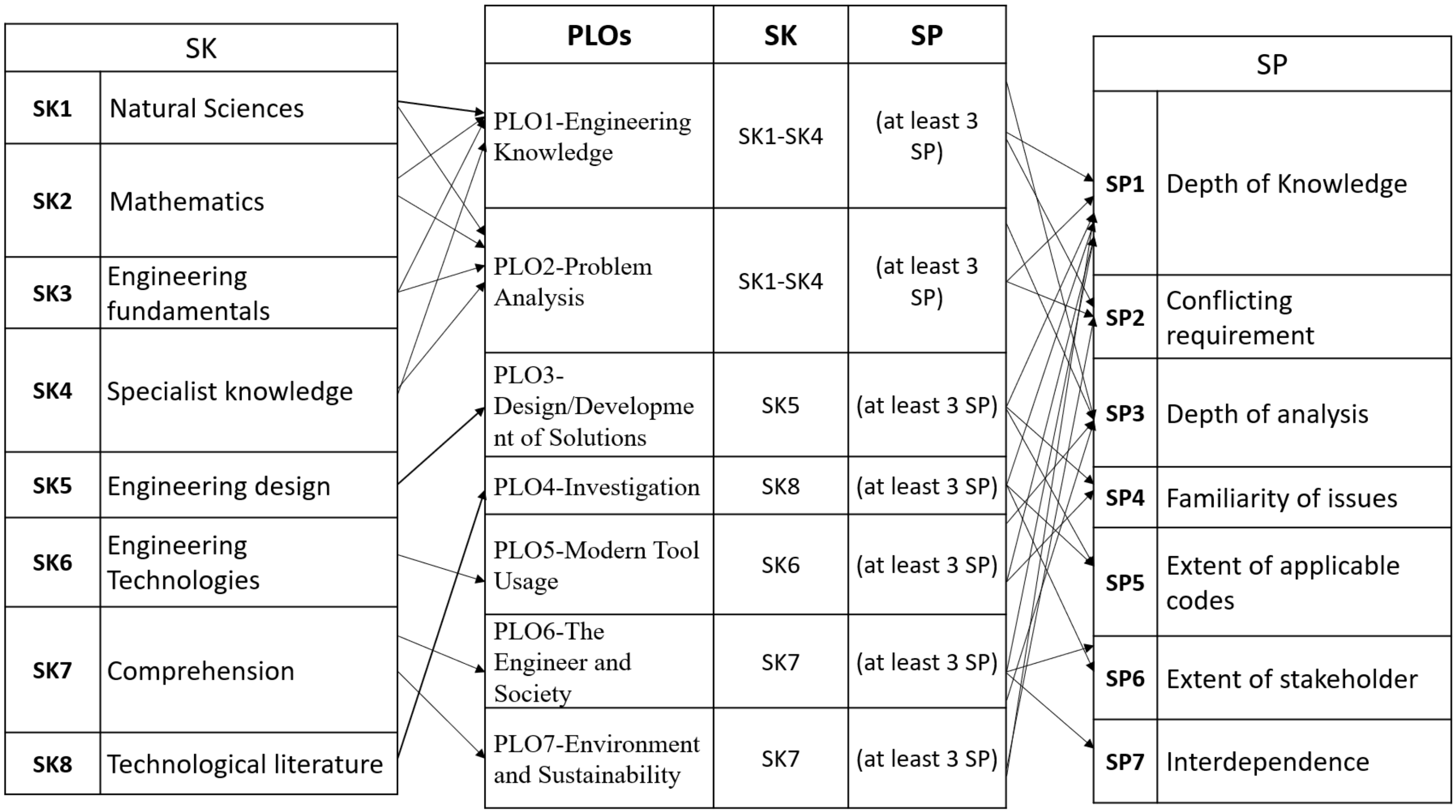

Figure 3: Summary of PLOs, SPs and SKs Mapping

Later, scoring rubric for the intended PLO was developed to assess a assignment for designated course. Example, a case study under this designated course were mapped with PLO5. Therefore, according to Figure 3, PLO5 were mapped with SP1, SP4 and SP5. Keep also in mind that PLO5 was compulsory mapped with SK6 (engineering technologies). Using the same method, rubrics for all PLOs has been developed and implemented for all courses for technology program. Therefore, each rubric was match with assessment given to student whereby each assessment tally with the intended course learning outcome. Whilst, the CLO was mapped with designated PLO and the PLO was mapped with PEO, meaning that the constructive alignment for the intended learning outcome was achieved.

4. Conclusions

This study has developed constructive alignment guideline in preparing assessment for technology program in assisting of rubric developing process that in line with learning outcome. This research applied qualitative approach for data collection using document analysis. All data were gathered through public records such as ongoing records of an organization’s activities, policy manuals, ETAC guideline, strategic plans, and previous studies. The finding from all information gathered enable to produce 1) guideline for 12 PLOs and type of assessment suitable to assess the student competency in term of problem-solving skills and knowledge acquisition for each PLO, 2) guideline for 12 PLOs mapping with SP (Problem Solving) and SK (Knowledge Profiles) whereby each PLO has its owned mapping toward SP and SK according to the depth of assessment and requirement by each PLO, 3) a mapping of PLO without SP/SK but has engineering activities (TA), and 4) scoring rubric for all the intended PLOs to assess an assessment for designated course. All of this assessment guideline was developed to ensure the constructive alignment of each designated course are achieved by following the guided template.

Constructive alignment plays a crucial role in student assessment as it provides a framework for designing and implementing assessment practices that are aligned with the learning outcomes. In the context of constructive alignment, assessment is not just a measure of student performance, but also an integral part of the learning process. When assessments are aligned with the learning outcomes, they help students to focus on the most important concepts and skills, and provide them with feedback on their progress. This, in turn, enables students to adjust their learning strategies and improve their overall performance. By integrating assessment into the learning process, constructive alignment helps to create a more meaningful and effective educational experience for students. It also enables educators to monitor student progress and adjust the instructional methods as needed, with the goal of ensuring that all students are able to attain the desired learning outcomes. Effective assessments that align with constructive alignment can enhance student performance and reflect the Program Learning Outcomes (PLOs) and Course Learning Outcomes (CLOs) of the course. The mapping carried out in this study provides a clear guideline for creating improved scoring rubrics that align with the PLOs. The assessment of each PLO will be based on the mapped knowledge and skills, thereby elevating student achievement and motivating them to focus on their learning activities. This approach serves as a useful guideline for instructors to design assessments that align with the intended PLOs.

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