

Integrated Project: Comparative Analysis of Lecturers' And Students' Assessment of Program Outcomes

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Abstract: The Department of Chemical and Process Engineering (JKKP) has taken an initiative to implement an Integrated Project (IP) for students in Year II and III since the 2006/2007 session. The IP combines three or four department courses offered at each semester. It is related to a problem in chemical or biochemical engineering that has open-ended solution. This approach allows the students to adopt generic skills of leadership, teamwork, oral and written communication and searching for the latest information through the process of lifelong learning. Student achievement in completing the IP has been measured and assessed through presentations and reports. At the end of each presentation, students were asked to fill out a questionnaire on the implementation of IP. The questionnaire has been modified and geared towards assessment of program outcomes (PO) set to be achieved from the IP, in line with the evaluation form filled by each lecturer in assessing each group in IP. A comparative analysis between the perception of students and evaluation performed by lecturers on the IP implementation was conducted to a batch of 60 third year students in Semester II Session 2009/2010. The results from these two aspects of the assessment score, given by the lecturer and student opinion from the survey on achievement of program outcomes through IP followed the same trend. This shows that not only students who felt that the IP was very useful to their learning process, but from the aspect of lecturer evaluation, the lecturers also found that students have benefited from the IP implementation.

Key-Words: Communication; generic skills; integrated project (IP); lifelong learning; programme outcomes

1 Introduction

Spurring on the Outcome-Based Education (OBE) [1] which had started in the Faculty of Engineering and Built Environment since Semester I Session 2005/2006 [2], the Department of Chemical and Process Engineering (JKKP) has started implementing the Integrated Project (IP) at the departmental level for Year II Session 2006/2007 [3], [4]. This OBE approach requires students to play an active role in the learning process and encourage each course lecturers adopting innovative delivery methods such as Project Based Learning (PBL), Project Oriented Problem Based Learning (POPBL), Active Learning (AL), Cooperative Learning (CL) and others [5],[6],[7]. The IP has been implemented with the aims to adopt skills of

lifelong learning [7], team work [8], communications [9] and sustainability concepts [10] among students. Up to Semester II Session 2009/2010, the IP implementation in JKKP has now been through two complete cycles in which there were two groups of students who have already completed their studies at the university by going through the outcome-based education. Takriff et al. [4] and Abdullah et al. [11], [12] have explained in details about the implementation of IP and process enhancements to the IP since it was implemented in Semester I 2006/2007 Session. Basically, an IP is a group project that integrates three or four departmental courses at each semester. Instead of having to perform a project for each departmental course, each group of students has to complete only

one project, known as Integrated Project (IP), for each semester; hence reducing their burden. In any chemical engineering degree course, it is traditionally ended up with a chemical plant design project in the final year of study. The final year plant design project is fundamentally a project that integrates all the elements covered from the beginning of the degree course. It blends the issues of designing a plant producing a chemical product by having to consider all the chemical engineering theories without neglecting the aspects of economy, society, safety and sustainable environments. Principally, the implemented IP imitates the final year design project and the only difference is the IP only integrates the theories covered in each semester. A questionnaire was distributed to the first graduates that have faced the full cycle of IP in Semester II Session 2008/2009 to assess the effectiveness of the IP [13]. The analysis results of the effectiveness of the IP implementation has shown increasing confidence in students in generic skills such as oral and written communication, teamwork, lifelong learning and the identification of current issues since it was introduced. Positive feedback was also sought from students and they think IP should be continued in the future because it really helped them in completing design projects in their final year.

In the implementation of outcome-based education, each course or activity must be based on the program outcomes set by the program. Program outcomes are statements about things that every student should know, understand and be able to do so after the completion of a learning process [14], [15]. The Department of Chemical and Process Engineering (JKKP), which offers two programs of Chemical and Biochemical Engineering Program outlines 12 learning outcomes (PO) for the two programs [12]. For the IP implementation, six POs are considered and must be achieved at the end of an IP implementation (Abdullah et al. 2007), namely the students should be able to:

- apply the basic knowledge (PO1).
- communicate effectively in oral conversation and in writing (PO2).
- work in a team with the ability to manage (PO6).
- adopt lifelong learning skills (PO8).
- identify current issues (PO11).
- use modern engineering tools such as iCON®, HYSYS®, SUPERPRO®, AUTOCAD® and others in solving problems (PO12).

During the implementation of IP, the lecturers at JKKP are always trying to improve its implementation, including in terms of assessment

and measurement even though it has been implemented for nearly five years since Semester II 2006/2007. In the department, the implementation of IP has been one of the main agenda in Teaching, Learning and Improvement (UP3) Meeting Unit. The committee meets every two months to discuss all issues related to undergraduate programmes, including IP, research projects, final year design project, industrial visits and talks, and laboratory implementation. On the assessment of IP, all the involved lecturers will evaluate each group based on oral presentations and written reports at the end of the semester. Assessment of lecturers has already been outlined based on the POs (PO1, PO2, PO6, PO8, PO11 and PO12). In addition, questionnaire is distributed to students to obtain their feedback on the IP implementation in which they have gone through in each semester during an overview and comment session conducted by the IP coordinator. Originally the questionnaire distributed to students is not based on the outlined POs. Thus, starting Semester II 2009/2010, the JKKP UP3 meeting has improved the student questionnaires to incorporate statement towards the outlined PO achievement. Hence, this paper aims to compare analytically the assessment and evaluation done by the lecturers with the assessment made by students through a questionnaire on the implementation of IP for third year students in Semester II Session 2009/2010.

2 Research Methodology

Effectiveness of the IP through the achievement of the program outcomes (PO) was assessed by comparing the evaluation of lecturers and students. The IP assessment by lecturers is done through oral presentations and also written reports submitted by each group. It is being considered as a direct measurement of the targeted PO achievement. Meanwhile, student assessment is conducted through questionnaires distributed to students at the end of an IP implementation during an overview and comment session conducted by the IP coordinator. Assessment through questionnaire is regarded as an indirect measurement for the IP since it is based on students' perception. This comparative analysis was performed on the Year II IP of Semester II 2009/2010, which had combined three courses in the semester. For the Chemical Engineering Program, the IP integrates KKKR3633 Particle Technology, KKKR3653 Mechanical Design of Process Equipment and KKKR3673 Utility Design, while the IP for Biochemical Engineering Program integrates courses of KKKB3643 Bioseparation

Process, KKKR3653 Mechanical Design of Process Equipment Design and KKKR3673 Utility Design.

2.1 Direct measurement (Lecturer Evaluation)

A sample evaluation form by lecturers is illustrated in Fig. 1. The form is divided into two parts: evaluation on the written report and other part is on the student oral presentation of an IP group. Each criterion measured in each section was tailored towards the targeted PO. The first part (Part I) of the evaluation form is on PO1 (basic knowledge of the

technical aspects), PO2 (communication), PO8 (lifelong learning), PO11 (current issues) and PO12 (modern engineering tools). For the evaluation of basic technical knowledge (PO1), each lecturer involved has its own evaluation criteria based on the courses taught. The form shown in Fig. 1 is an example of assessment for the course KKKR3653 Mechanical Design of Process Equipment. Therefore, the PO1 criteria set out by each course will be different criteria from other courses. However, the criteria for PO2, PO8, PO11 and PO12 are the same for all courses.

PO	KI	SCOPE	Score					MARKS
PART I: REPORT (70%)								
Technical (40%)								
1	FK1, FK2	Understanding of process and operation units	1	2	3	4	5	
		Production rate based on the current product demand and supply	1	2	3	4	5	
		Proper material and energy balance	1	2	3	4	5	
		Measurement of diameter and height for the pressure vessel based on material balance	1	2	3	4	5	
		Description and justification on process, construction material and corrosion allowance	1	2	3	4	5	
		Proper determination of MAWP and wall thickness after undergoing the process of thickness uniformity	1	2	3	4	5	
		Consideration of combined loadings and stress analysis	1	2	3	4	5	
		Determination of vessel support and flanged joints	1	2	3	4	5	
		Understandings of process and process unit	1	2	3	4	5	
12	ICT	Utilisation of iCON® / SUPERPRO® / Autocad / GUI in problem solving	1	2	3	4	5	
Current issues (10%)								
11	CI1	Awareness on current issues related to the project	1	2	3	4	5	
	CI2	Identification of current issues related to the project	1	2	3	4	5	
Lifelong learning (10%)								
8	LL1	Able to plan strategically to obtain reliable and good references	1	2	3	4	5	
	LL2	Able to explore the issues / problems that need solutions independently	1	2	3	4	5	
	LL3	Able to link information needs with resources	1	2	3	4	5	
	LL4	Able to select quality resources / references efficiently	1	2	3	4	5	
Written communication (10%)								
2		Ability to communicate ideas in writing with a clear, structured, fluent and appropriate way	1	2	3	4	5	
	CS8	Ability to make solid, precise and robust conclusions	1	2	3	4	5	
PART II: ORAL PRESENTATION (30%)								
2	CS2	Good response to comments and questions	1	2	3	4	5	
	CS3	Ability to convey ideas clearly and in a structured, fluent and appropriate tone	1	2	3	4	5	
	CS5	Slides are simple and attractive	1	2	3	4	5	
	CS7	Use standard and clear language	1	2	3	4	5	
	CS8	Ability to make solid and precise conclusions orally	1	2	3	4	5	
			Ability to present ideas in a logical d clear way.	1	2	3	4	
TOTAL MARKS								

Fig. 1 An example of lecturer evaluation form on IP

For the oral presentation in Part II, the lecturers can assess the students' ability to communicate (PO2) based on the given presentation and also through question and answer session at the end of the presentation. This assessment is to evaluate how each group present their ideas and also the presentation slides. All PO (PO1, PO2, PO8, PO11 and PO12) were taken into account in this evaluation form except PO6 which is a measure of cooperation and team work within each group with the ability to manage. To measure PO6, a peer evaluation form (Fig. 2) has been distributed to students themselves to evaluate their colleagues. Student is the best assessor for this category because they have been working together in a group at the beginning stage for completing all tasks in the IP. They are advised to assess their colleagues with fairness because these marks contribute 20% of the total IP scores. In fact, these scores will be different between one student to another in the same group. Another 80% marks are contributed from the team work which are directly assessed by lecturers.

2.2 Indirect measurement (Student Evaluation)

At the end of each IP implementation, the IP coordinator will hold a review session with students who have completed their IP. The purpose of this review session was to provide appropriate overview and comments on student performance in IP through

the eyes of the lecturers. Coordinator will consult each lecturer involved in the IP to get feedback on the performance of students during IP. Students will be clarified on their mistakes and improvements that they need to do on their final report and in next IP presentation. In this occasion, a questionnaire (Fig. 3) will be distributed to students to get student feedback on the implementation of IP. For the purpose of this manuscript, a questionnaire was circulated in the last week of Semester II 2009/2010 for third year students. This questionnaire is divided into two main parts. The first section asks students' background in terms of gender, race, and programs of students. While the second part of this questionnaire contains a statement which has led to the evaluation of the performance of each PO (PO1, PO2, PO6, PO8, PO11 and PO12) throughout the IP implementation. It includes basic knowledge (PO1), lifelong learning (PO8), teamwork (PO6), communications (PO2), the identification of current issues (PO11) and use software such as ICON® and SUPERPRO® (PO12) to reflect the their agreement to the relevant statement. In addition, students' views on whether sufficient time was given to students to complete their IP tasks and whether it should be continued or not are also taken into account. Finally, students were also asked to provide any recommendations for improvement or any comment on the implementation of IP as a whole.

PO	KI	NAME OF EVALUATOR :	MATRIC NO.:	GROUP		
EVALUATION SCORING SCALE:		STRONGLY AGREE 5 4 3 2 1 DISAGREE				
(Please provide an appropriate assessment score in the dedicated box)						
KRITERIA			Name of students (Team Members)			
6	TS1	Ability to build teamwork to achieve the same objectives				
	TS2	Ability to be leaders and followers				
	TS3	Ability to respect and accept the opinions of other individuals				
	TS4	Ability to accept the diversity that exists within the group				
	TS5	Ability to demonstrate involvement and contribution to the planning and coordinating of the group work				
	TS6	Responsible for the decision made by the group				
	TS7	Ability to assist other members proactively				
TOTAL						

Fig. 2 Peer evaluation form to be filled by each student for the PO6 assessment

**QUESTIONNAIRE ON YEAR III INTEGRATED IMPLEMENTATION
SEMESTER II 2009/2010
(KK: KKKR3633, KKKR3653, KKKR3673, KKKR3693)
(KB: KKKB3633, KKKB3643, KKKR3653, KKKR3673)
DEPARTMENT OF CHEMICAL AND PROCESS ENGINEERING**

**PART A**

Arahan: Sila tandakan [√] pada kotak-kotak yang disediakan atau berikan maklumat yang diketahui.

- | | | | | |
|-------------|--------------------------|-------------|--------------------------|---------------------------|
| 1. Gender: | <input type="checkbox"/> | a. Male | <input type="checkbox"/> | b. Female |
| 2. Race: | <input type="checkbox"/> | a. Malay | <input type="checkbox"/> | b. Chinese |
| | <input type="checkbox"/> | c. India | <input type="checkbox"/> | d. Others (Please state): |
| 3. Program: | <input type="checkbox"/> | a. Chemical | <input type="checkbox"/> | b. Biochemical |

PART B

Instructions: Please tick (√) in the scale of your choice in this inventory (1 = Strongly disagree, 2 = Disagree, 3 = Neutral / Neutral (no opinion), 4 = Agree, 5 = Strongly agree)

1. APPLICATION OF BASIC KNOWLEDGE (PO1)

No.	Item	1	2	3	4	5
1.	I can apply the basic knowledge that I got from KKKR3633/KKKB3633, KKKR3653, KKKR3673 and KKKR3693/KKKB3643 courses in completing IP.					
2.	Integrated Project helps me to further understand basic chemical engineering courses (KKKR3633/KKKB3633, KKKR3653, KKKR3673 and KKKR3693/KKKB3643).					
3.	Integration Project shows the inter relationship among the basic chemical engineering courses (KKKR3633/KKKB3633, KKKR3653, KKKR3673 and KKKR3693/KKKB3643).					
4.	Integrated Project relates the courses taught in the previous semester.					
5.	Integrated Projects requires me to understand and apply basic knowledge of courses taught in the previous semester.					

2. IDENTIFICATION OF CURRENT ISSUES (PO11)

No.	Item	1	2	3	4	5
1.	I am able to identify safety issues of exposure limit on workers and environment, safety precautions if there is occasion of plant fire and explosion.					
2.	I am able to identify environmental issues and acts that are related to the integrated project.					
3.	I was able to identify issues related to products such as its use, sources of raw materials, price and market, and demand and supply					
4.	I was able to identify the processes involved in the production of the dedicated product.					

3. UTILISATION OF iCON® / SUPERPRO® IN PROBLEM SOLVING (PO12)

No.	Item	1	2	3	4	5
1.	Exposure on the software application of iCON® / SUPERPRO® was beneficial to students.					
2.	The use of iCON® / SUPERPRO® software has helped the understandings of course topics.					
3.	The application of iCON® / SUPERPRO® software has enabled me to understand the influence of operational parameters for an operating unit (such as reactors, pumps, compressors, distillation column).					
4.	The application of iCON® / SUPERPRO® software has integrated the learning process of lecture topics in different courses.					
5.	The application iCON® / SUPERPRO® software in integrated projects requires me to learn more and explore on the software.					
6.	Exposure on iCON® / SUPERPRO® software is sufficient.					

4. COMMUNICATION (PO2)

No.	Item	1	2	3	4	5
1.	I was given the opportunity to make presentations in this course.					
2.	I am very confident to make a presentation.					
3.	I do preparation for the presentation.					
4.	I can write a report according to the appropriate format (Gaya UKM).					
5.	I am able to relate from one chapter to another chapter in report writing.					

5. TEAM WORK (PO6)

No.	Item	1	2	3	4	5
1.	I always contribute ideas towards completing the Integrated Project.					
2.	I am always willing to assist other members in completing the Integrated Project.					
3.	My group conducts discussions during the Integrated Project and report writing.					
4.	I just keep quiet during the implementation of Integrated Project.					
5.	There are members in my group who did not do any work.					

6. LIFELONG LEARNING (PO8)

No.	Item	1	2	3	4	5
1.	I need to make appropriate references in the understanding of the Integrated Project carried out.					
2.	I was able to get the latest data and analyze it properly.					
3.	I always go to library to obtain a quality source of reference.					
4.	Integrated project taught me to refer to the quality references.					
5.	I only get references from the internet.					

7. IMPLEMENTATION OF INTEGRATED PROJECT

No.	Item	1	2	3	4	5
1.	I understand the purpose of Integrated Project held.					
2.	Integrated Project tasks relevant to the courses offered.					
3.	I have benefited from the Integrated Project implementation.					
4.	Integrated Project questions that have been given at the beginning of the semester help my team to plan ahead.					
5.	Cooperation of the lecturers involved in each course is helping me in carrying out the assigned Integrated Project.					
6.	The period given to complete the Integrated Project was adequate.					
7.	I find the implementation of the Integrated Project occurs smoothly.					

8. COMMENTS (Please state other than the above comments):

Fig. 3 An example of questionnaire distributed to students during review and comment session at the end of semester in JKKP

3 Results and Discussions

This part will divide the discussion into two main sections. First, it will focus on the direct measurement of the lecturers on students' performance through the implementation of IP, and then, followed by discussions on the perception of students through a questionnaire as an indirect method of measurement. All results of data analysis will be separated based on the Chemical and Biochemical Engineering Programs. This is because any curriculum that incorporates the outcome-based education requires each program stands alone without relying on one another. Therefore, every program will be seen in isolation. At the end of the results and discussion section, a comparative

analysis was conducted between the two types of measurements (direct assessment by the lecturers and indirect assessment through student questionnaires).

3.1 Direct measurement (Lecturer Evaluation)

In Semester II 20092010, there were 60 third year students for Chemical Engineering Programme (KK) and 28 students for Biochemical Engineering Programme (KB). All the KK students were divided into 15 groups (Group 1-15) and the KB students into 7 groups (Group 16-22), in which each group consisted of 4 students. Four courses involved in the

IP implementation during that semester, meaning that four lecturers had involved in the project for each program. Due to some technical faults, the evaluation from only three courses were considered in the comparative analysis of the data.

Fig. 4 illustrates the scores given by lecturers towards PO1 that measure the effectiveness of students applying basic knowledge obtained from each involved course into IP. As previously discussed, each course had different criteria in evaluating PO1. Therefore, the PO1 assessment on

each group cannot be compared from one lecturer to another. On overall, for KK programme, lecturer P1 gave score between 70-90%, lecturer P2 between 69-75% and lecturer P3 between 35-95%. For KB programme as well, the PO1 assessment by the lecturers was different from each other since the evaluation criteria set in each course was different. Lecturer P1 gave scores to all involved KB groups between 35-65%, lecturer P2 between 75-90% and lecturer P3 between 40-90%.

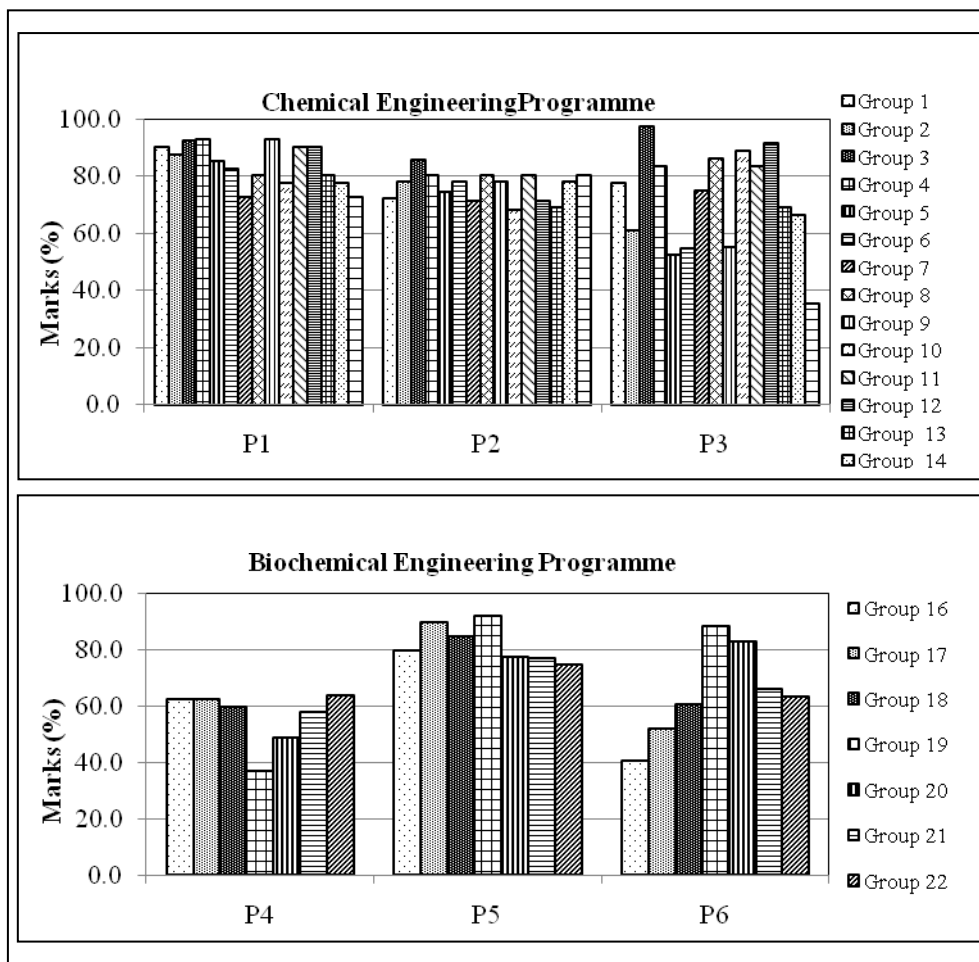


Fig. 4 Scores on the application of basic knowledge in IP (PO1) given by lecturers to all groups of Chemical and Biochemical Engineering Programmes

For the evaluation of PO2 on communication, both oral and written communication (reports) are measured by the lecturers. For report communication, among the criteria considered is the ability of students to disseminate their ideas in writing clearly, coherently and fluently, and end up with concrete and compact conclusions. Whereas for oral communication, each lecturer will assess

students in terms of effective response to comments and questions, the ability to convey ideas clearly and fluently with appropriate tone, using simple and attractive presentation slides, standard language, and the ability to conclude precisely. KK lecturer gave overall rating between 60-90% to all the group involved (Fig. 5). It shows that all the lecturers were satisfied with the performance of the students in the

aspect of oral and written communication. All the lecturers were satisfied and found that the students on overall had performed well on this aspect. In contrast to KB groups, the PO2 performance was quite low which was between 40-80%. Although the criteria in the evaluation form to assess the

performance of PO2 by lecturers are the same for all courses, however the lectures judged from the point of whether or not the student is able to convey their ideas in writing or orally in different aspects of the courses they teach. Therefore, this evaluation is also different from one lecturer to another lecturer.

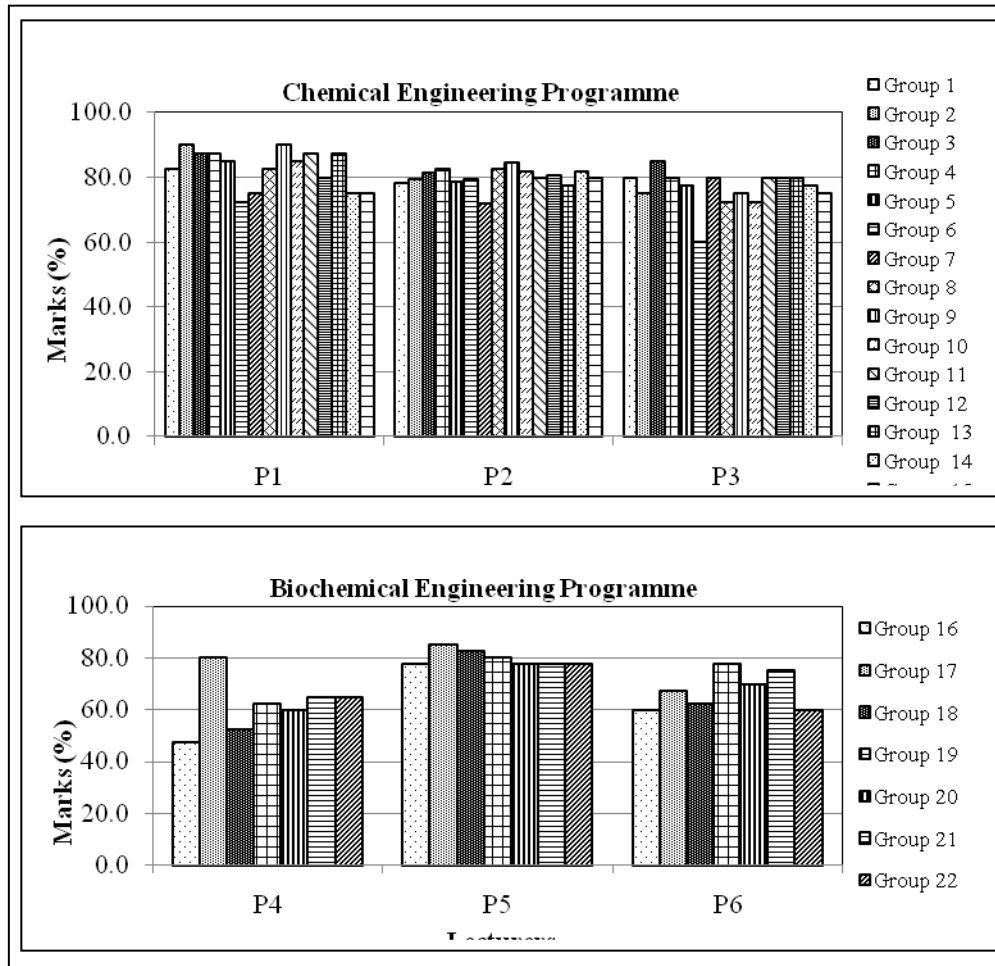


Fig. 5 Scores on communication (PO2) given by lecturers for each group of Chemical and Biochemical Engineering Programmes

For the evaluation of lifelong learning (PO8), the criteria evaluated were the ability of each group to plan strategically for obtaining reliable and quality reference materials, exploring the issues or problems that require solutions independently,

relating the needs of resources and information on selecting quality resources efficiently. For this category, lecturers of both KK and KB programmes had given average scores of 60-90% (Fig. 6).

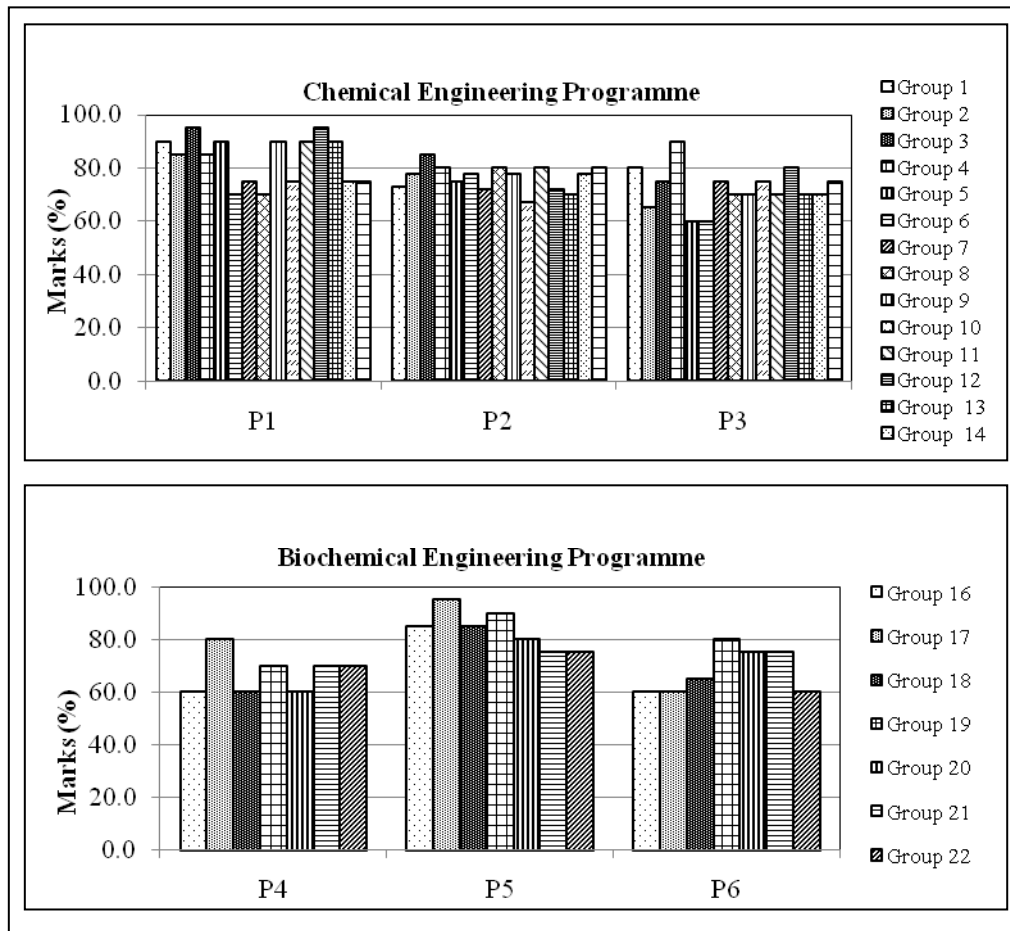


Fig. 6 Scores on lifelong learning (PO8) given by lecturers for all groups of Chemical and Biochemical Engineering Programmes

Assessment of PO11 on current issues measures students' general knowledge on the topic conducted for each IP such as market and economic information on the products to be produced, environmental issues such as pollution or safety that may arise during production. Students should be aware of the current issues related to the projects

they run and should be able to identify the current issues. Fig. 7 shows the evaluation of PO11 for both programmes. Both KK and KB lecturers gave satisfactory scores for most of the groups with an average score of 60-90%, meaning that the students had successfully demonstrated their ability to identify current issues related to their projects.

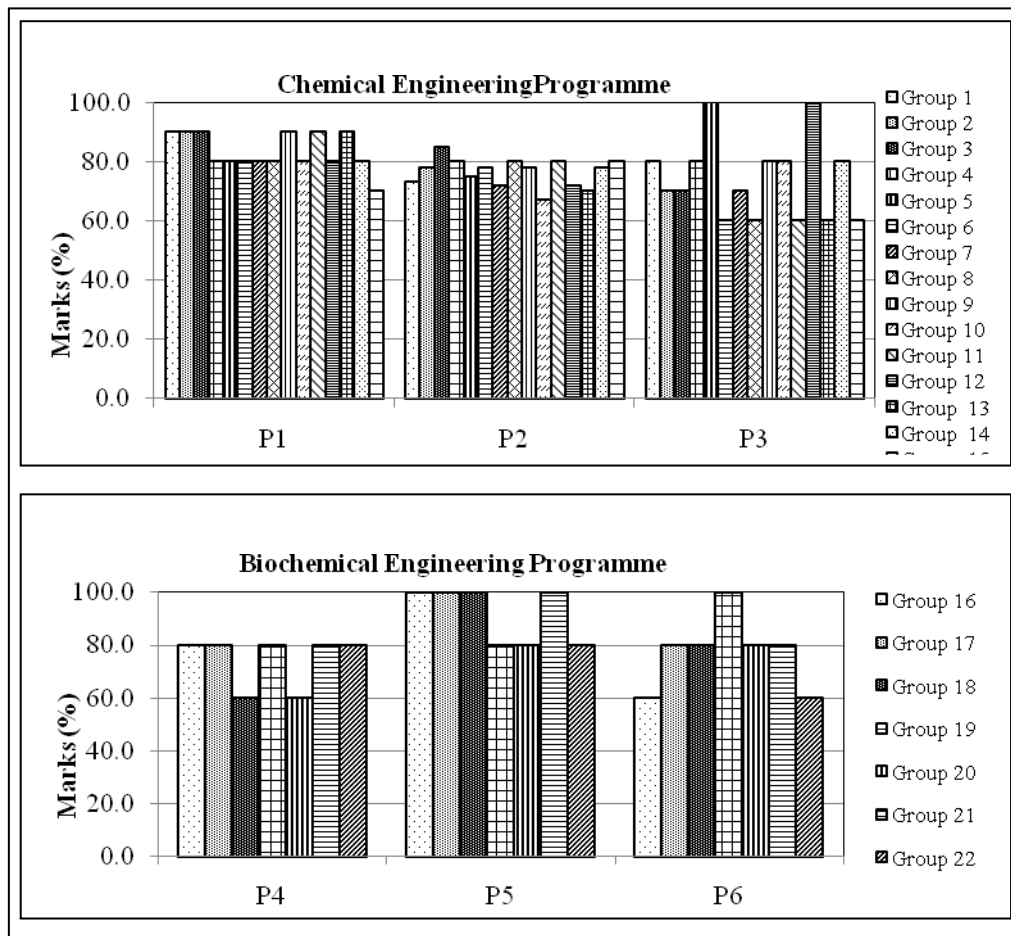


Fig. 7 Scores on identification of current issues (PO 11) given by lecturers to all groups of Chemical and Biochemical Engineering Programmes

The ability of students to use modern tools such as engineering software of iCON® / SUPERPRO® / Autocad® / GUI® in solving their projects is evaluated through PO12 programme outcomes. In most software applications, students are only exposed minimally to the use of relevant software. Students are asked to show their own efforts and initiative to explore more on the software application without expecting to get full guidance from the involved lecturers. The assessment of lecturers on PO12 varied from one lecturer to another lecturer. This may be due to the lecturers

who have their own software that requires students to use. For example, KKKR3653 course requires students to produce advanced engineering drawings of their designed pressure vessels, while KKKR3673 course requires students to solve problems through design utility software of GUI®. Although the criteria measured in the evaluation form are the same, but the lecturers see different aspects of software. The KK lecturers rated PO12 achievement between 60-100% for 11 groups. However the marks given by KB lecturers to the KB groups were quite low, between 20-100% (Fig. 8).

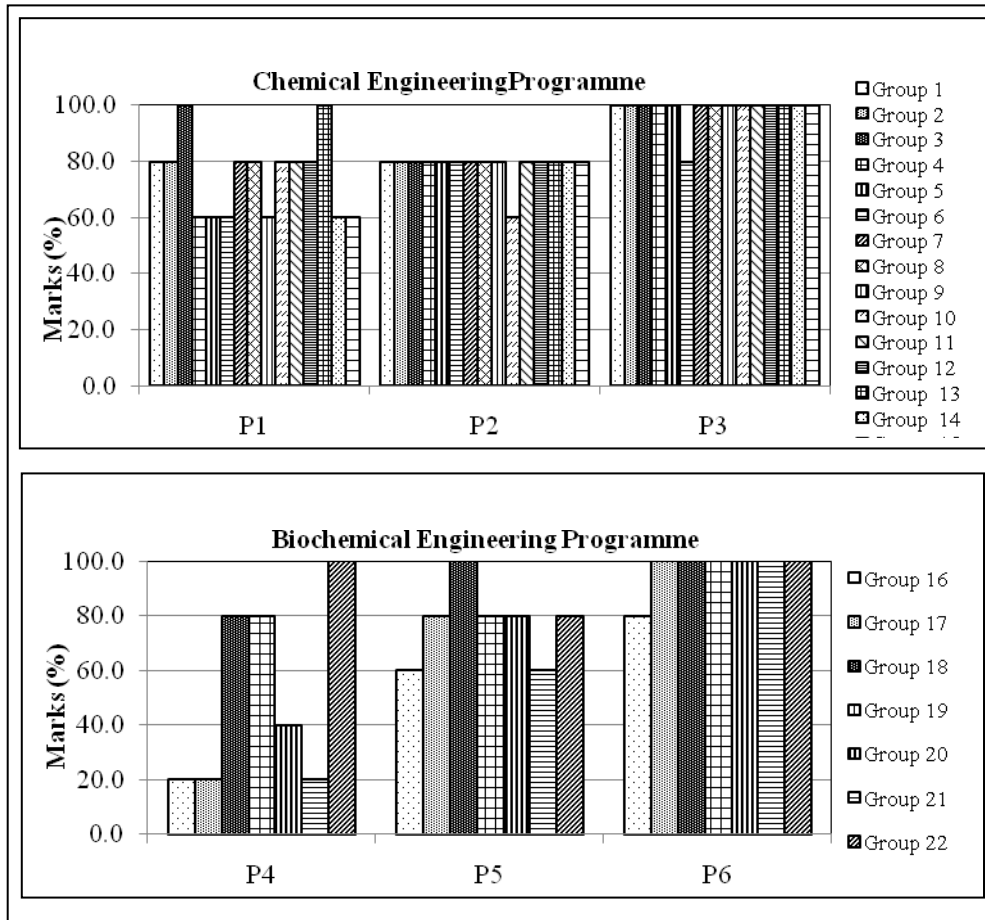


Fig. 8 Scores on the application of iCON® / SUPERPRO® / Autocad® / GUI® software in solving IP (PO 12) given by lecturers to all groups of Chemical and Biochemical Engineering Programmes

Peer assessment through PO6 program outcome was done by students and not lecturers. Students are the most qualified person to evaluate the cooperation received from their group members while completing the IP task. Assessment made by every student in a group on all of his or her colleagues to measure the ability to perform teamwork in order to achieve the same objectives, to be leaders and followers, demonstrate their capability to respect and accept others' opinions and

diversity that exists within the group, demonstrate the involvement and contribution to the planning and group decisions, and the ability to help other partners proactively. On overall, all the KK groups had given full marks to their colleagues in their IP assignments, indicating high satisfaction through group work (Fig. 9). The KB groups also showed a high level of cooperation obtained through group work, except one group gave only 80% for this program outcome.

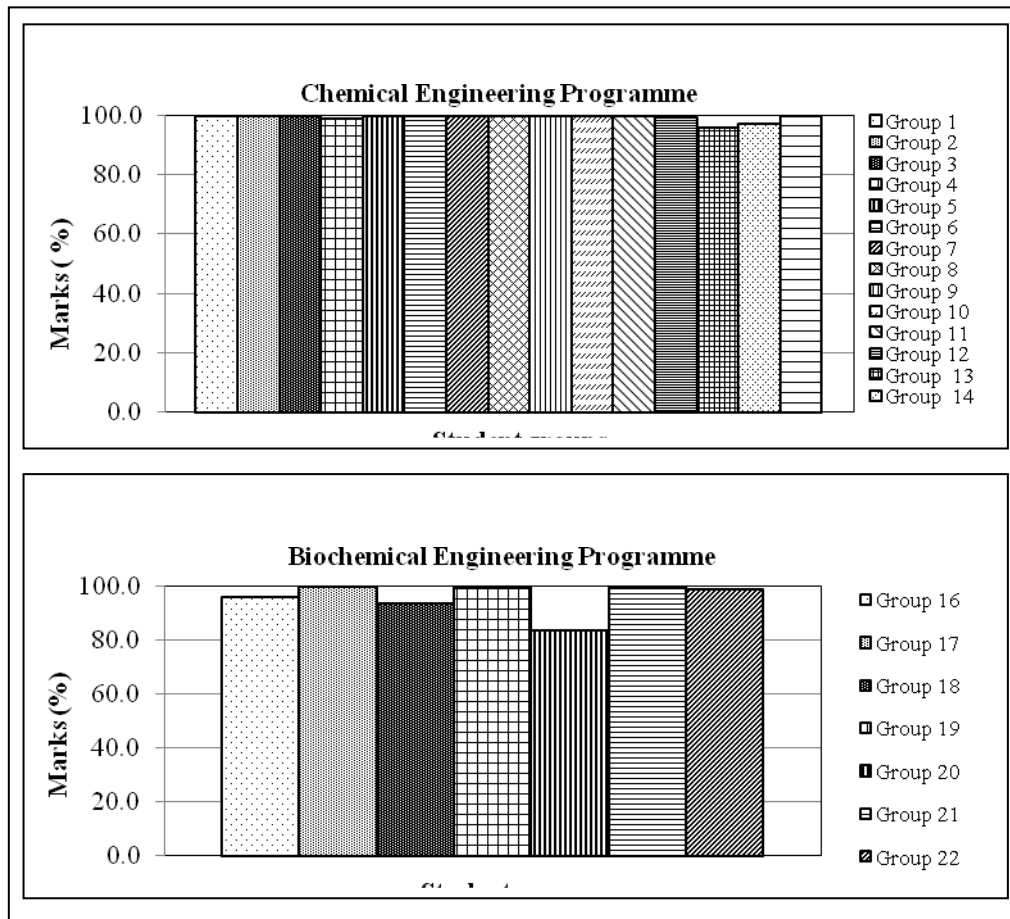


FIG. 9 Scores on peer assessment (PO6) given by students on their team members for all groups of Chemical and Biochemical Engineering Programmes

3.2 Indirect measurement (Student Evaluation)

Students' feedback through questionnaires distributed to them during the review session at the end of an IP implementation contributes to the indirect assessment of IP effectiveness. There were respective 60 and 28 students for Chemical and Biochemical Engineering Programmes, as shown in

Fig. 10. For the Chemical Engineering Programme, a total of 55 (91.7%) students had responded in the questionnaire and all 28 KB students (100%) students involved in the IP survey. Based on the obtained respondents, the racial demographics and gender of the two programmes are as depicted in Fig. 11 and 12.

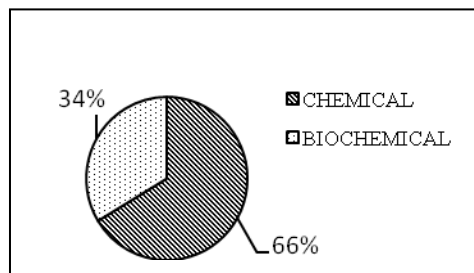


Fig. 10 Percentage of students under Chemical and Biochemical Programmes in the Department of Chemical and Process Engineering

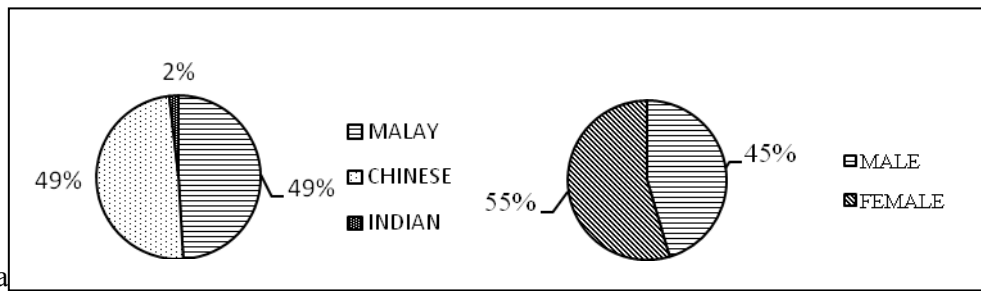


Fig. 11 Racial and gender demographics of students involved in the questionnaire

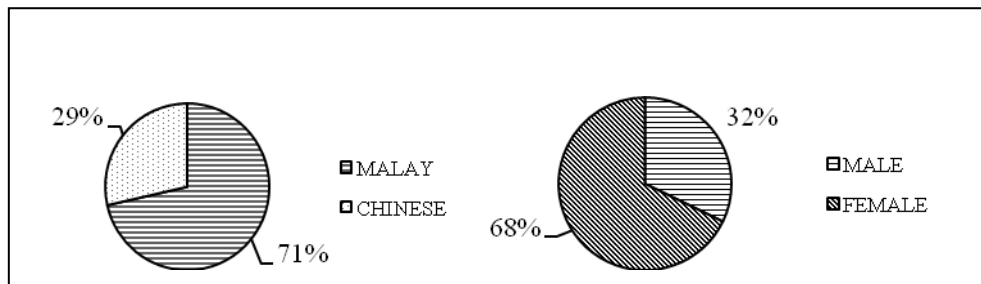


Fig. 12 Racial and gender demographics of Biochemical Engineering students involved in the questionnaire

As mentioned earlier, the questionnaire was designed to cater student achievement on dedicated program outcomes (PO) in line with the assessment made by the lecturers on the IP. For each PO, there are some statements which are included to assess PO based on the respondent's agreement. Details of the statement asked for each PO are listed in Fig. 3.

Based on the analysis results shown in Fig. 13, approximately 80-90% chose "Strongly Agree" and "Agree" to all categories of the PO1 statements for

both KB and KK students. This proves that the students were able to use the basic knowledge of KKKR3633/KKKB3633, KKKR3653, KKKR3673 and KKKR3693/KKKB3643 courses in completing the Integrated Project task. They also believed that the IP has helped them to understand the basic courses of KKKR3633/KKKB3633, KKKR3653, KKKR3673 and KKKR3693/KKKB3643, to integrate the related basic courses in chemical engineering, and also link courses that has been studied in previous semesters.

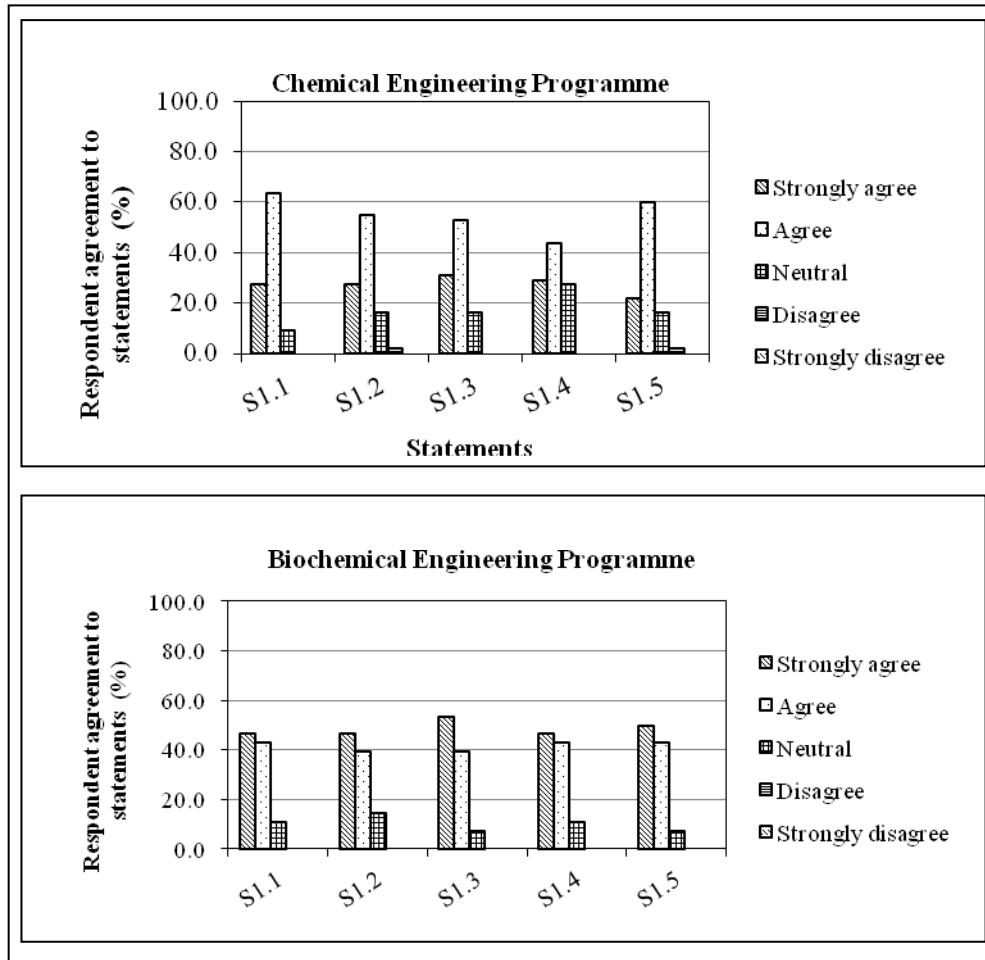


Fig. 13 Respondent agreement on statements of basic knowledge application (PO1) given by both Chemical and Biochemical Engineering students

Evaluation by students on the achievement of PO11 in the identification of current issues shows [10] about 60-80% chose "Strongly Agree" and "Agree" to all categories of the statements for both Chemical and Biochemical Engineering Programmes (Fig. 14). Students thought that they were capable to identify safety issues, such as exposure limits for workers and the environment, safety measures in case of fire or explosions in the plant, environmental issues and relevant legislation and also issues associated with products such as its usage, sources of raw materials, price and market, demand and supply, and finally the processes used to produce the specified product.

In implementing the IP, all the JKKP students have been exposed to simulator software of

SUPERPRO®, iCON ® as well as other software such as Visio ®, and also AUTOCAD ® as early as Year II of study. They were given a short exposure during the first year of their IP in Year II with the hope that they can grab and expand the skills of using them from year to year until they do a final year design project. During Year IV, they will take a special course to use this software. With the exposure given, students are also expected to take their own initiative to explore the use of this software. Students are also reminded that they are not expected to have 100% skills on how to use the software because there are many theories that have not been covered in the earlier courses such as functions of unit operations of distillation columns and absorber.

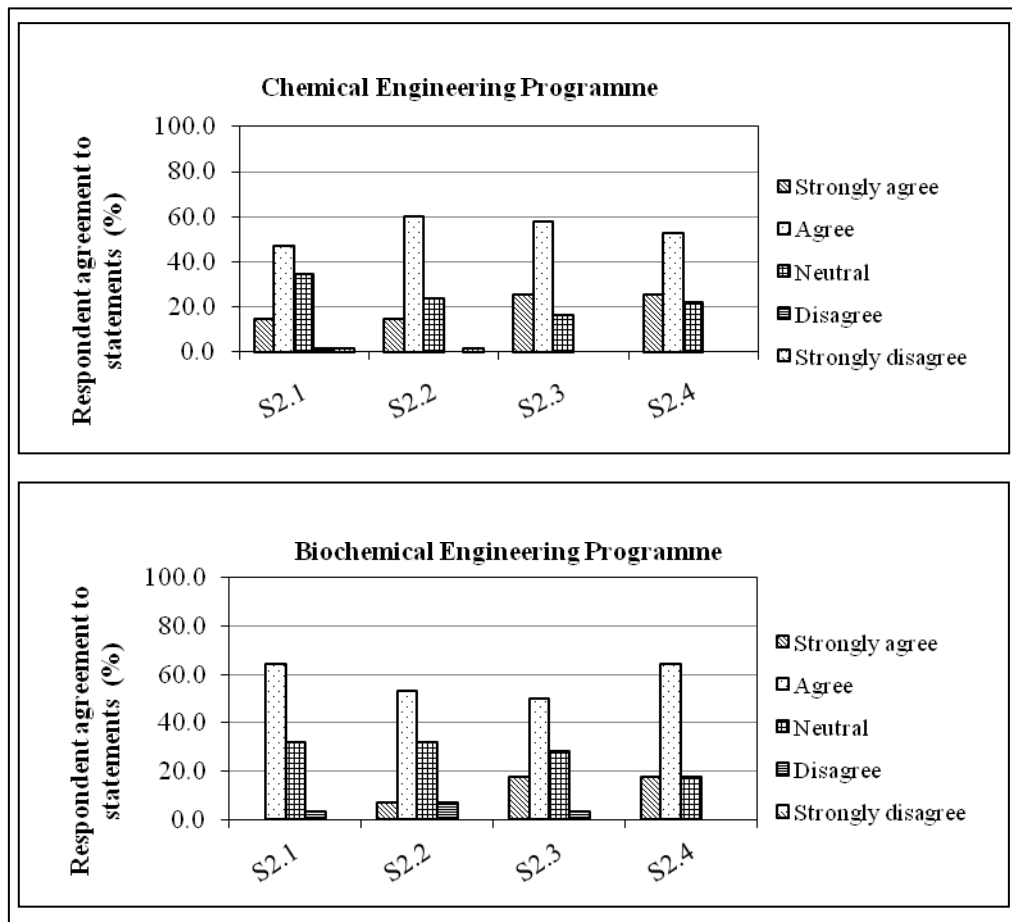


Fig. 14 Respondent agreement on statements of current issue identification (PO11) given by both Chemical and Biochemical Engineering students

According to Fig. 15, a total of 50-70% and 50-90% of respective KK and KB students had expressed their agreement (“Agree” and “Strongly agree”) on all of the PO12 statements except for the sixth statement that requires students to give feedback whether exposure to iCON® / SUPERPRO® software was adequate or otherwise. They agreed on the statement that the introduction and application of iCON® / SUPERPRO® software had been beneficial to them, helped them in understanding the lecture topics and integrate the learning of lecture topics from different courses. They also believed the software applications on of the project require them to learn more details on the

software. The software application also tests students' critical thinking in assessing the results given by the software compared with their manual calculations. For the sixth statement, both KK and KB students felt that the exposure to the software was inadequate with the students' disagreement of more than 50% (“Neutral”, “Disagree” and “Strongly disagree”). Similar trend for this statement was found with other batches of students from different year of study as reported in Abdullah et al. 2009. This might due to the attitude of "spoon feed" still veiled students who are still hoping for 100% guidance from lecturers to use the software.

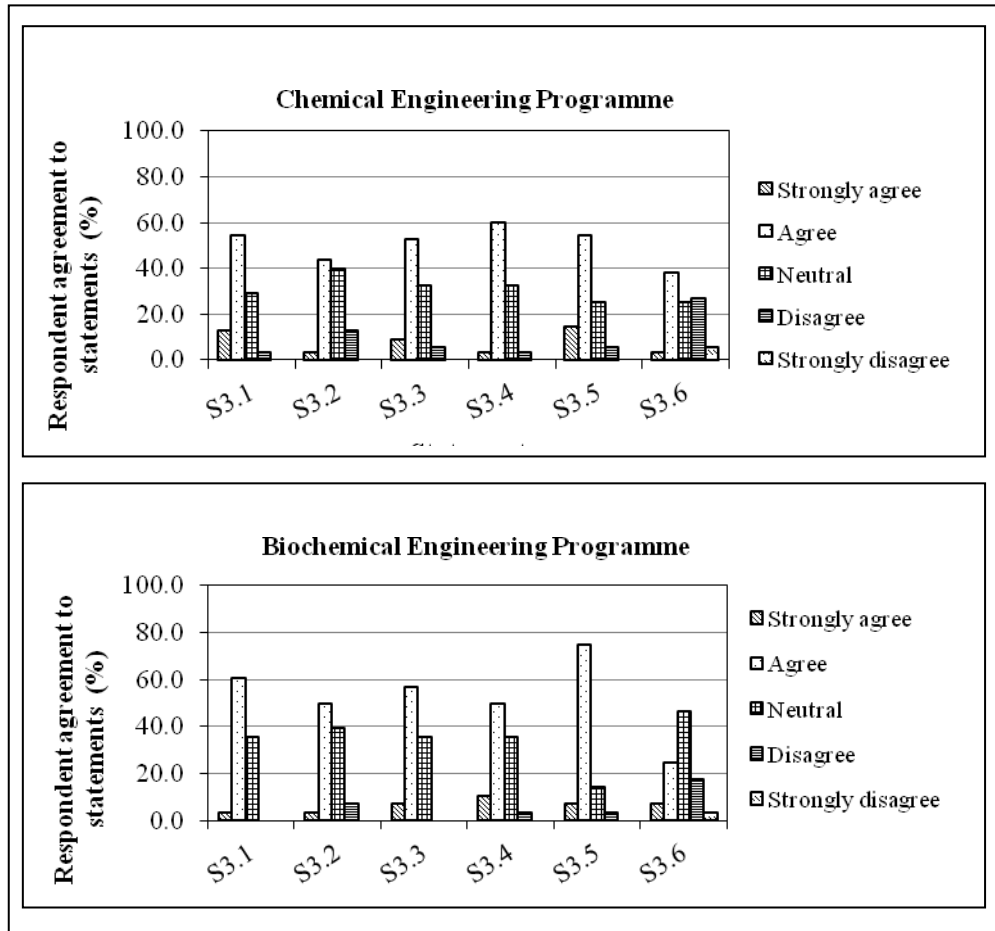


Fig. 15 Respondent agreement on statements of software application of iCON® / SUPERPRO® (PO12) in problem solving given by both Chemical and Biochemical Engineering students

For the assessment of communication (PO2) [9], the students were asked whether they are given any opportunity to do oral presentation in IP, feel confidence to present, do any preparation for the presentation and can write the IP report according to the format of Gaya UKM. Based on the analysis

results shown in Fig. 16, approximately 80-95% of students chose "Strongly Agree" and "Agree" to all the statements given for both programmes. This is a very positive results, indicating that the students had adopted communication skills either verbally or in writing very well.

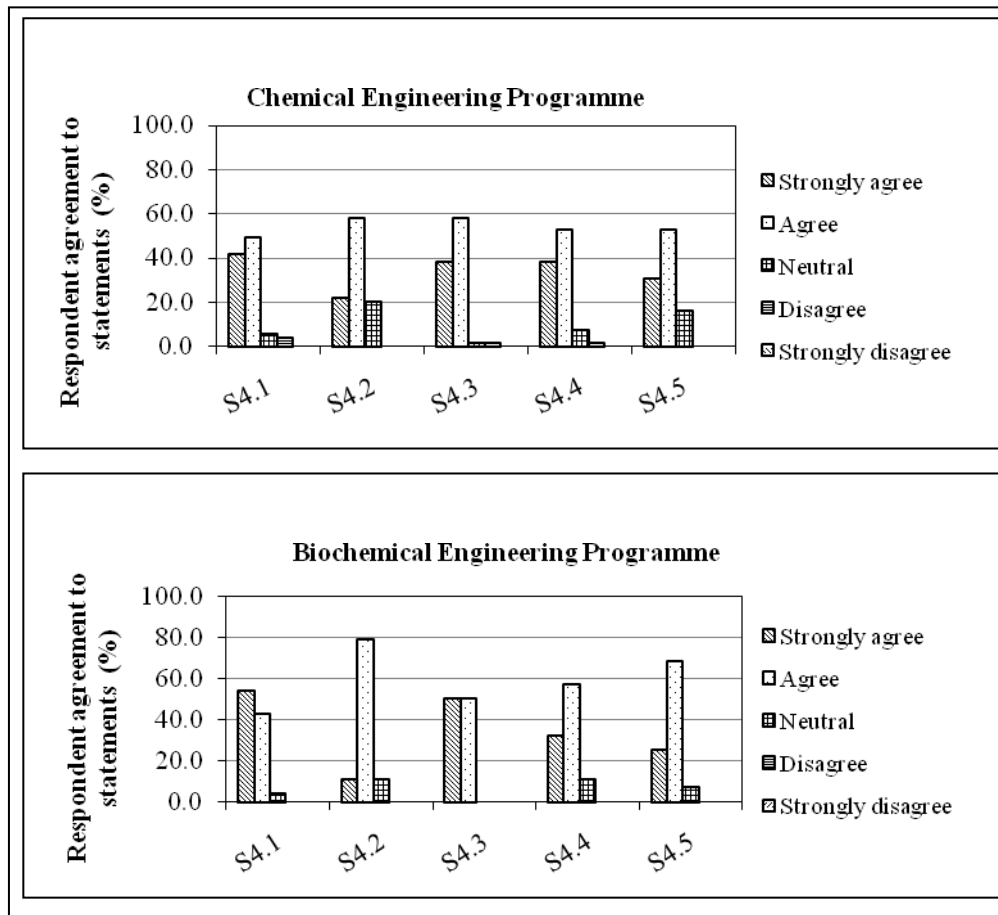


Fig. 16 Respondent agreement on statements of communication (PO2) given by both Chemical and Biochemical Engineering students

The ability to work in groups [8] is one of the outcomes (PO6) to be achieved by students through the IP implementation. In assessing students' performance in PO6, they were asked whether they always contribute ideas, are willing to help other members and conduct discussions during completing IP and writing the report. The feedback obtained shows that majority of students with more than 70% for both the Chemical and Biochemical Engineering Programmes believed that the IP had

trained them to work as a team in carrying out the assignment (Fig. 17). When posed with negative statements of just keeping quiet and doing nothing during completing IP task, more than 60% and 50% of respective KK and KB had chosen "Strongly disagree" and "Disagree" for the negative statements, proving that the students had actively participated in group discussion, contributed ideas and energy in the IP.

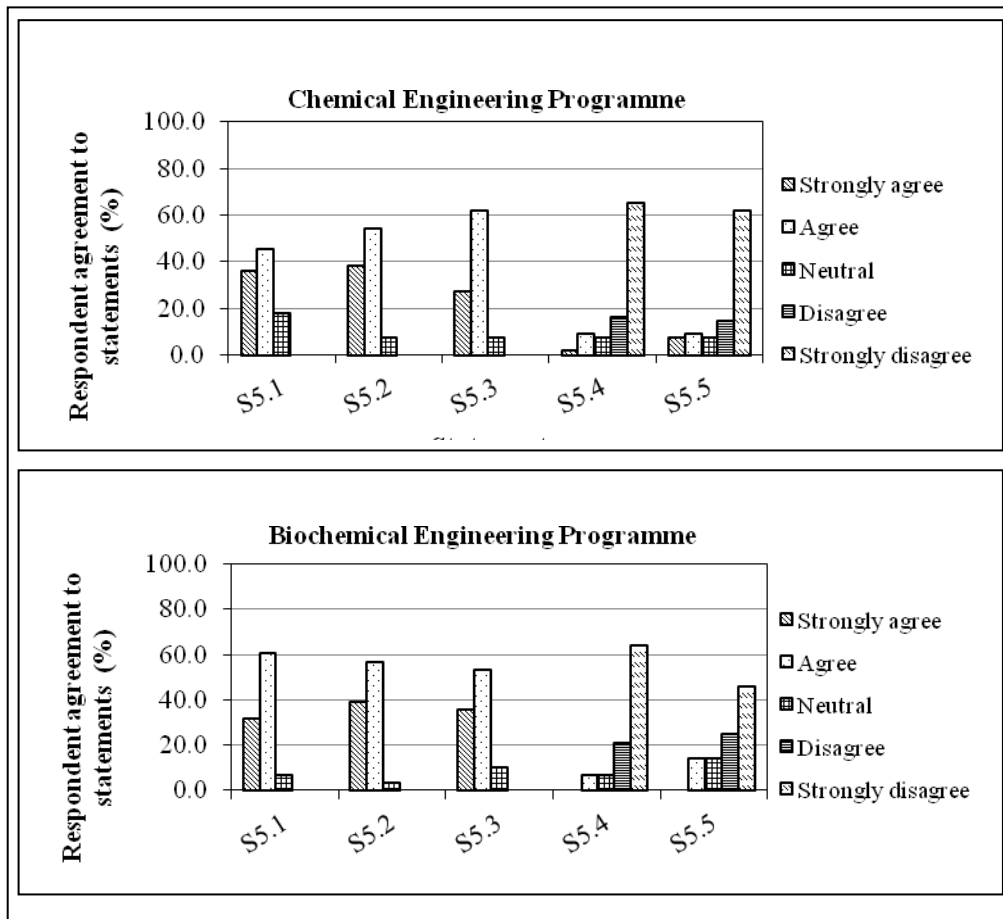


Fig. 17 Respondent agreement on statements of team work (PO6) given by both Chemical and Biochemical Engineering students

Lifelong learning (PO8) [7] is another programme outcome to be achieved through IP. It assesses students' ability to obtain information from relevant and quality sources and have critical view in interpreting the obtained data. They are also asked whether they frequently go to the library to get current sources, and whether the IP has taught them to refer the quality source. The feedback obtained in this category (Fig. 18) of generic skills is very positive, because between 70-90% and 50-

90% of KK and KB students respectively gave the agreement ("Agree" and "Strongly disagree") with these statements, except for the negative statement of the dependency on the internet only to obtain information. As much as 60% for both Chemical and Biochemical Engineering Programme students stated "Strongly Disagree" and "Disagree" to this last statement, implying that the IP implementation had trained them to come out with a good report based on quality references.

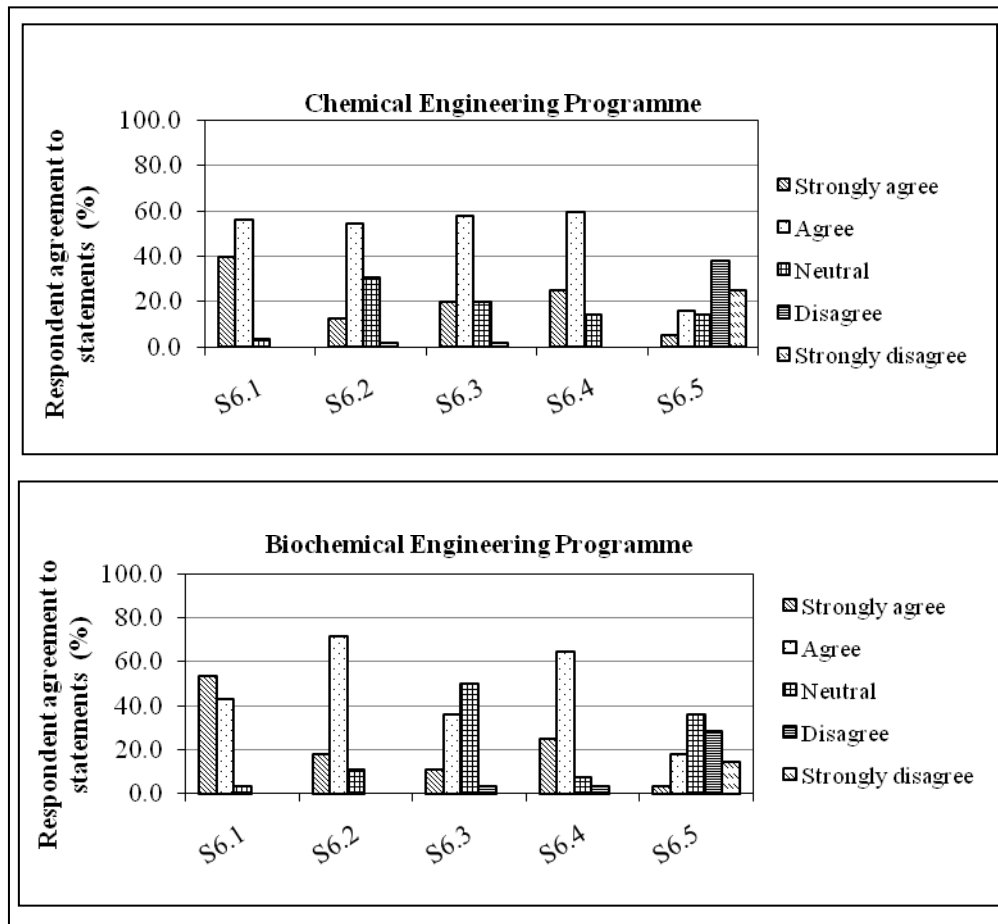


Fig. 18 Respondent agreement on statements of lifelong (PO8) given by both Chemical and Biochemical Engineering students

3.3 Comparison between direct and indirect measurement

After evaluation of lecturers and student questionnaires being analyzed separately, the section will try to compare the results obtained from both types of measurement. In the direct measurement, the results are shown in the form of mark percentage. While the results from the student questionnaires are shown in the percentage of students who had agreed on any statement in relating to the PO. For the purposes of this comparison, the results from the questionnaires were converted into scores or percentage of marks as being done in the direct measurement. In converting the results from the questionnaires into scoring values, score-5 as shown in the questionnaire (Fig. 3) will be the maximum mark of 5 while score-1 indicates 1 mark. For the negative statements, 5 marks will be given to score-1 and vice versa. The comparative results are shown in Fig. 19. For KK programme, no significant differences were observed for the achievement of all

PO (PO1, PO2, PO8, PO11), except in PO6 and PO12. For all PO (PO1, PO2, PO8, PO11), both direct and indirect measurement reaches about 80% of the scores, indicating that the achievement of these POs through the IP is valid. As for the PO6 (team work), basically both direct and indirect measurement were done by students. The students directly measure their team members right after the oral presentations of IP, in which this marks will contribute 20% of the total IP marks. A score of 80% was obtained through the questionnaires, but almost 100% scores from the direct measurement of peer assessment. The feeling of consciousness and generosity of students were more significant the time of evaluating their colleagues since the marks will contribute 20% to the individual, resulting most of students had given their colleagues full marks for the peer assessment. Meanwhile, the distributed has nothing to do with the scoring, so feedback obtained from the questionnaire is more sincere. This explains why the marks from the indirect measurement are lower than that of the direct

measurement. The same trend was also found for PO12 achievement (70% of the indirect measurement, 82% of the direct measurement) in relating to the use of engineering software in problem solving. Lecturers gave higher scores than the student assessment through questionnaires, due to different expectations. Lecturer assessment was more on the given efforts and positive attitude towards the use of modern software such as iCON ® / SUPERPRO ®, but students were always in the opinion of insufficient exposure of the software, and always expected full guidance from the lecturers on the software application.

For KB students, a slightly different trend is obtained. For the achievement of PO1 (application of basic knowledge) and PO2 (communication

skills), assessment of students through questionnaires (90%) is higher than the assessment of lecturers (70%). For PO6, the same trend as obtained with the KK program for the same reason. As for the PO8, PO11 and PO12, there are no significant differences between direct and indirect measurement. For all three categories, the scores were between 70-80%.

On overall, for both programmes, although there are differences between the direct and indirect measurements, however the difference scores as shown in Fig. 19 are not too significant. This demonstrates that the specified programme outcomes were achieved with an average percentage score between 75-85% for KK programme and 70-85% for KB programme.

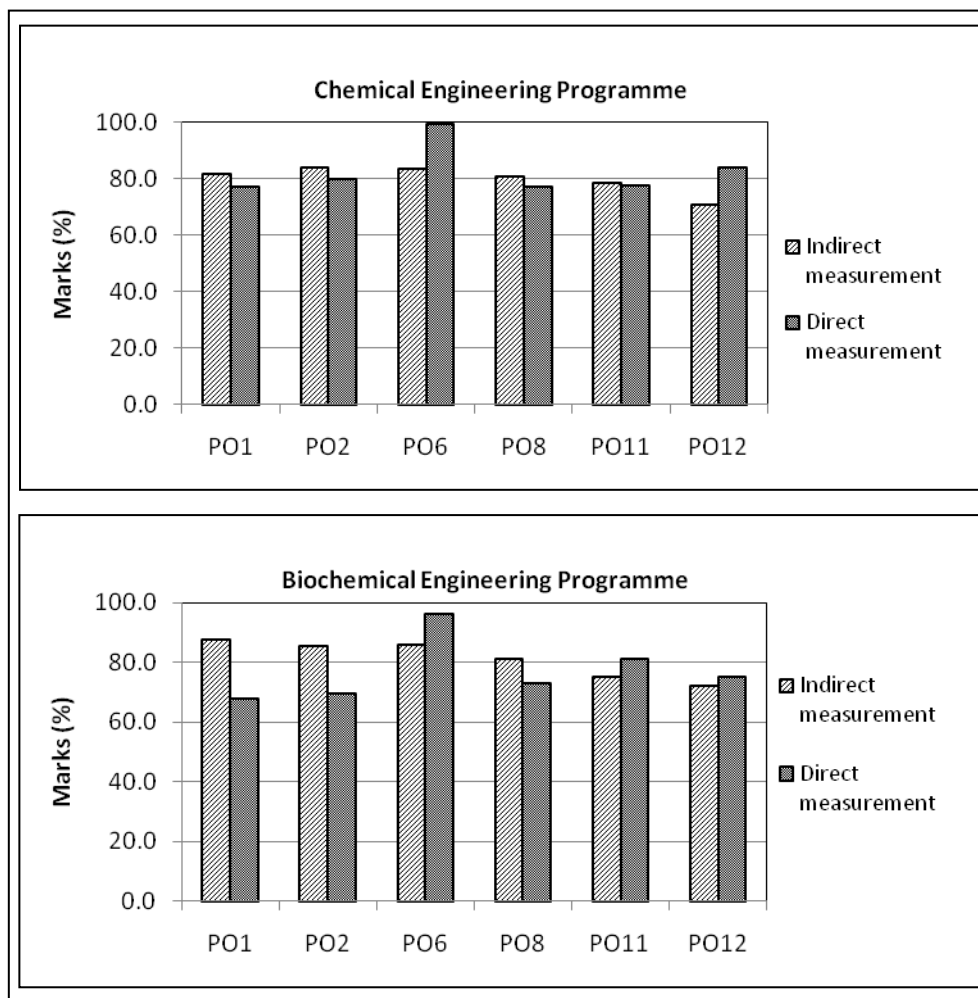


Fig. 19 Comparative results between direct measurement by lecturers and indirect measurement by students for both Chemical and Biochemical Engineering Programmes

3.4 Suggestions for Improvement

In the final section of the questionnaire distributed to students (Fig. 3), there is a section asking students to fill in any constructive comments on the implementation of IP. Table 2 lists all the comments given by the third year students from both program in Semester II 2009/2010. By referring to Table 2, most of the given views asked for a more detailed explanation of the problem task. However, IP as firstly introduced in the Semester I 2006/2007, is a project designed in such a way that it has an open-ended and not a specific solution (Abdullah et al. 2007) so that students will always try, have open minded and give proactive effort and have their own initiative steps to solve the IP. JKPP lecturers expect their students not being too rigid to obtain accurate or precise solutions, but more towards how the students can learn and find the right information, and then use and digest them to fulfill the requirement of their IP task.

4 Conclusions

The results from both direct and indirect measurement comprising marks given by the lecturers and scores obtained from students perception through questionnaire on the achievement of program outcomes (PO) via the IP implementation follows similar trend. This shows that not only students who believed that IP was very useful to their learning process, but also based on the lecturer evaluation, it indicates that students have benefited from the IP implementation. The IP implementation in JKPP, as a method of innovative teaching and learning has already entered the age of 5 years, however the JKPP academic staff will always strive to improve their implementation based on the comments of students and also through their experience in handling it.

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