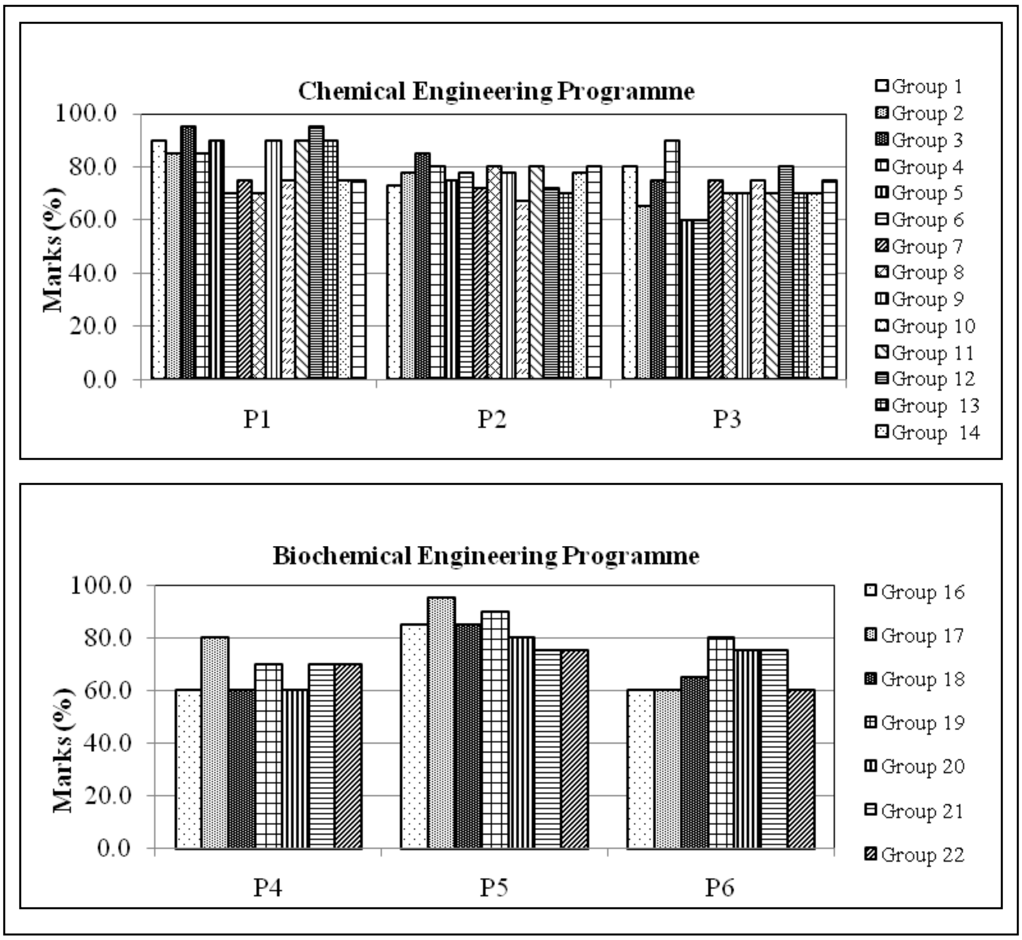

Fig. 6 Scores on lifelong learning (PO8) given by lecturers for all groups of Chemical and Biochemical Engineering Programmes

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.

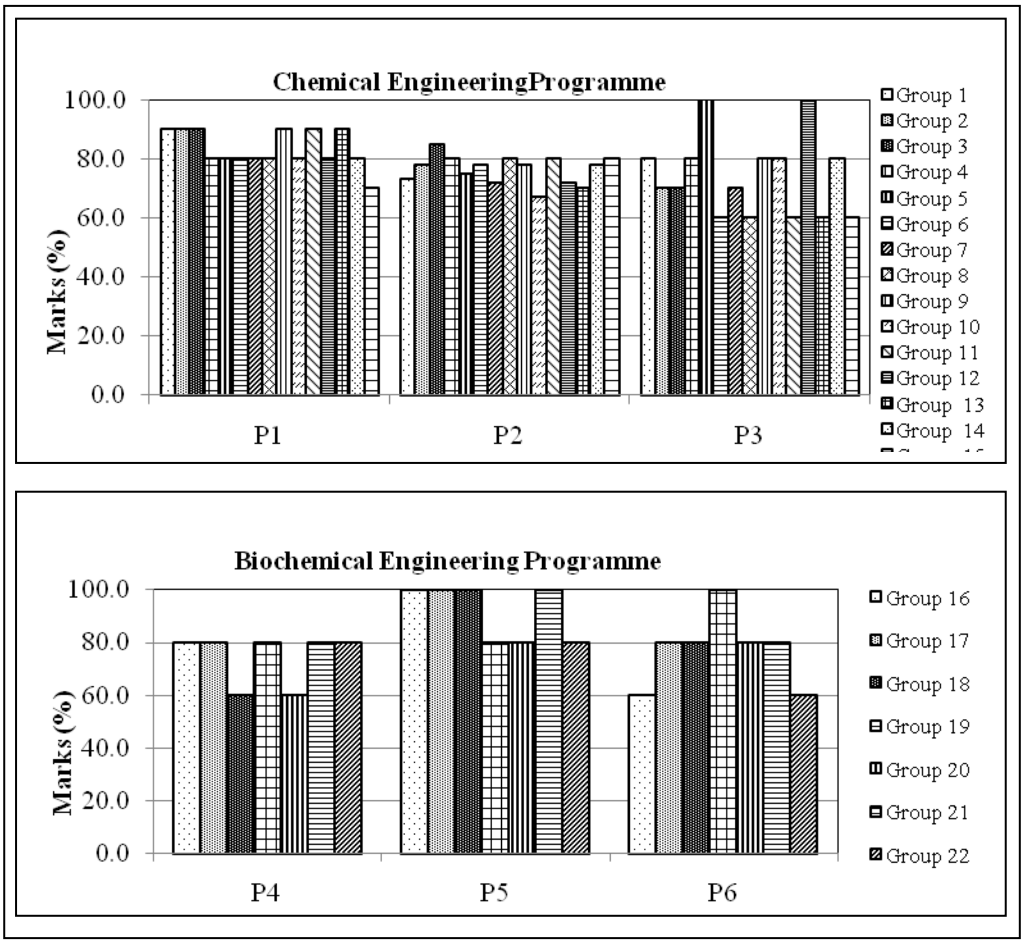

Fig. 7 Scores on identification of current issues (PO 11) given by lecturers to all groups of Chemical and Biochemical Engineering Programmes

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 ll groups. However the marks given by KB lecturers to the KB groups were quite low, between 20-100% (Fig. 8).

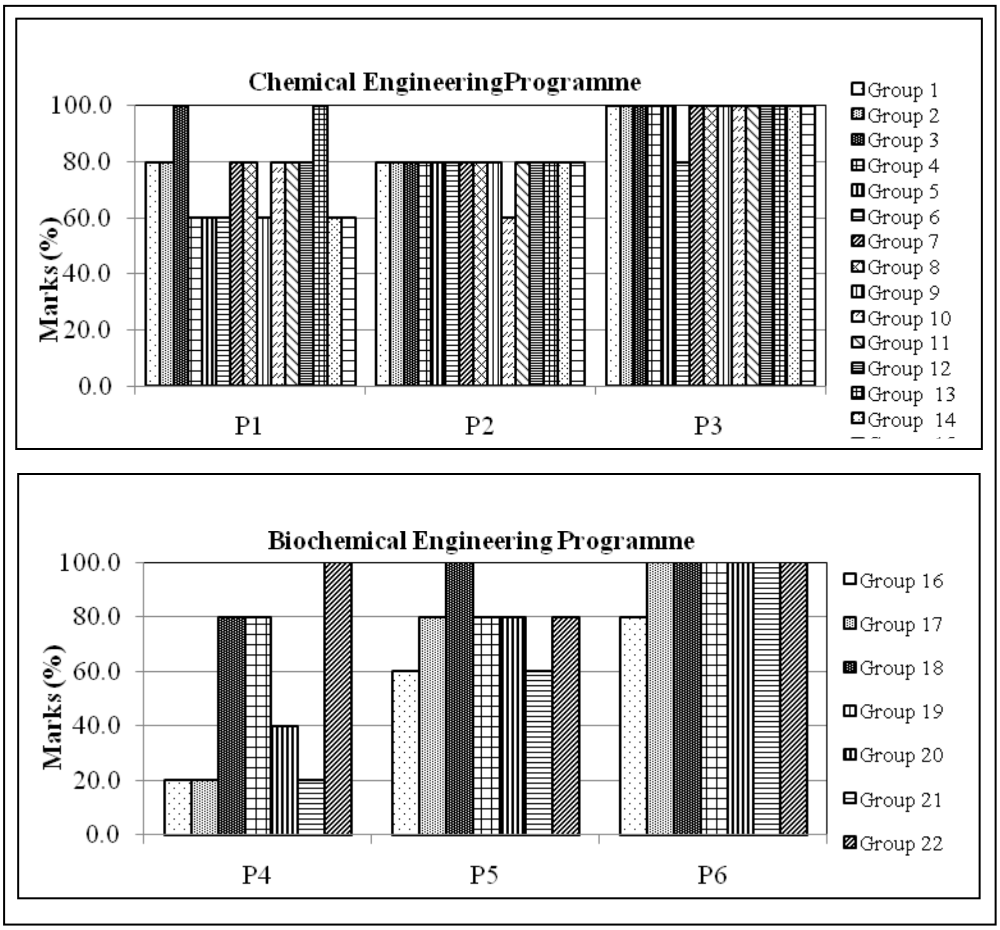

Fig. 8 Scores on the application of iCON® / SUPERPRO® / Autocad® / GUI® software in solving IP (PO 12) given by lecturers to all groups of Chemical and Biochemical Engineering Programmes

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.

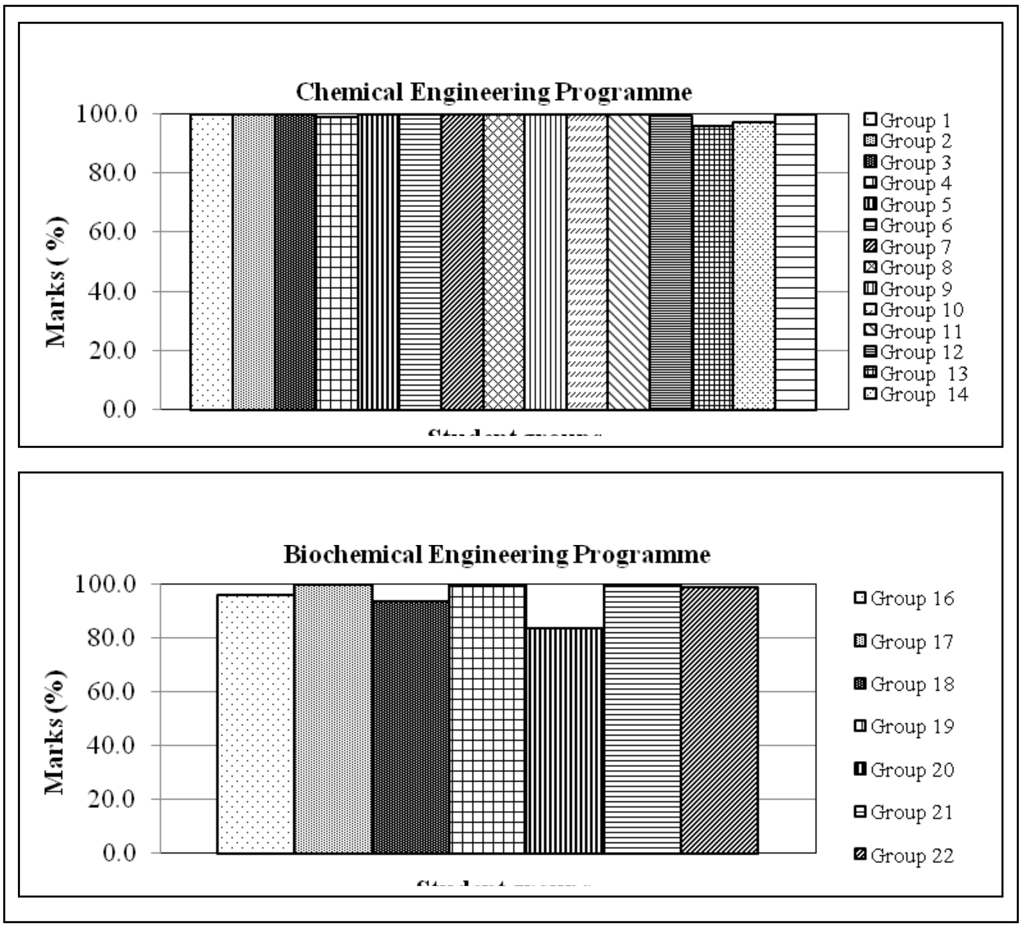

FIG. 9 Scores on peer assessment (PO6) given by students on their team members for all groups of Chemical and Biochemical Engineering Programmes

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.

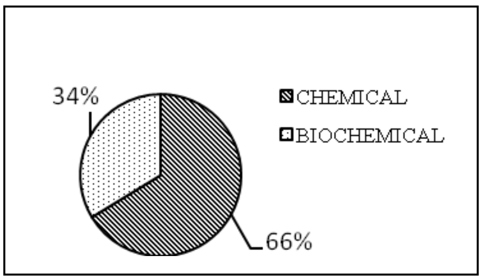

Fig. 10 Percentage of students under Chemical and Biochemical Programmes in the Department of Chemical and Process Engineering

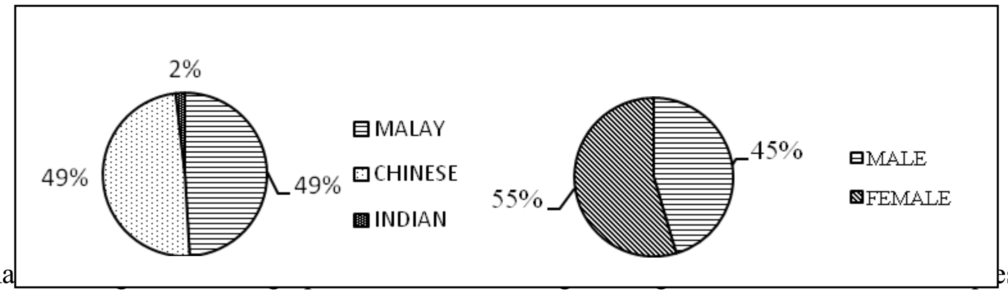

Fig. 11 Ra [illegible] estionnaire

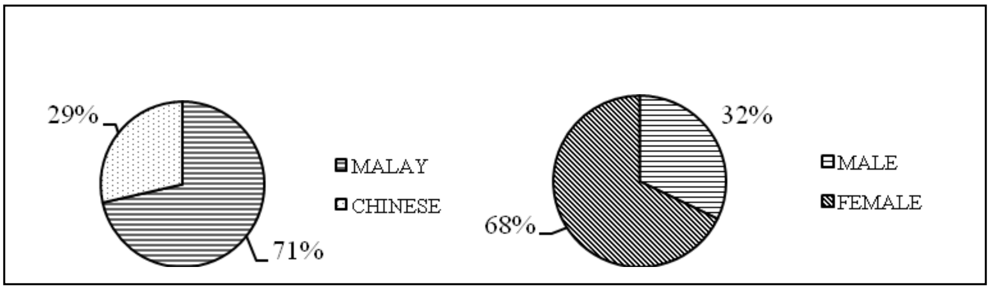

Fig. 12 Racial and gender demographics of Biochemical Engineering students involved in the questionnaire

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.

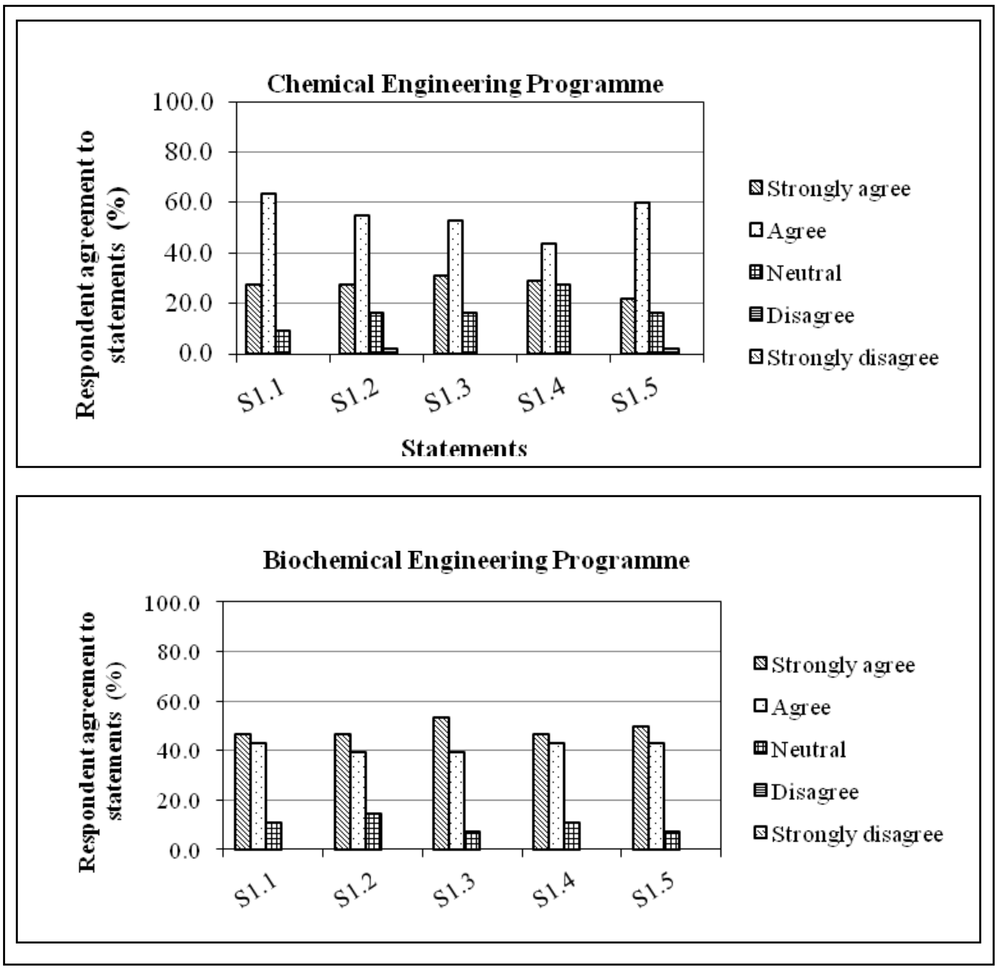

Fig. 13 Respondent agreement on statements of basic knowledge application (PO1) given by both Chemical and Biochemical Engineering students

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.

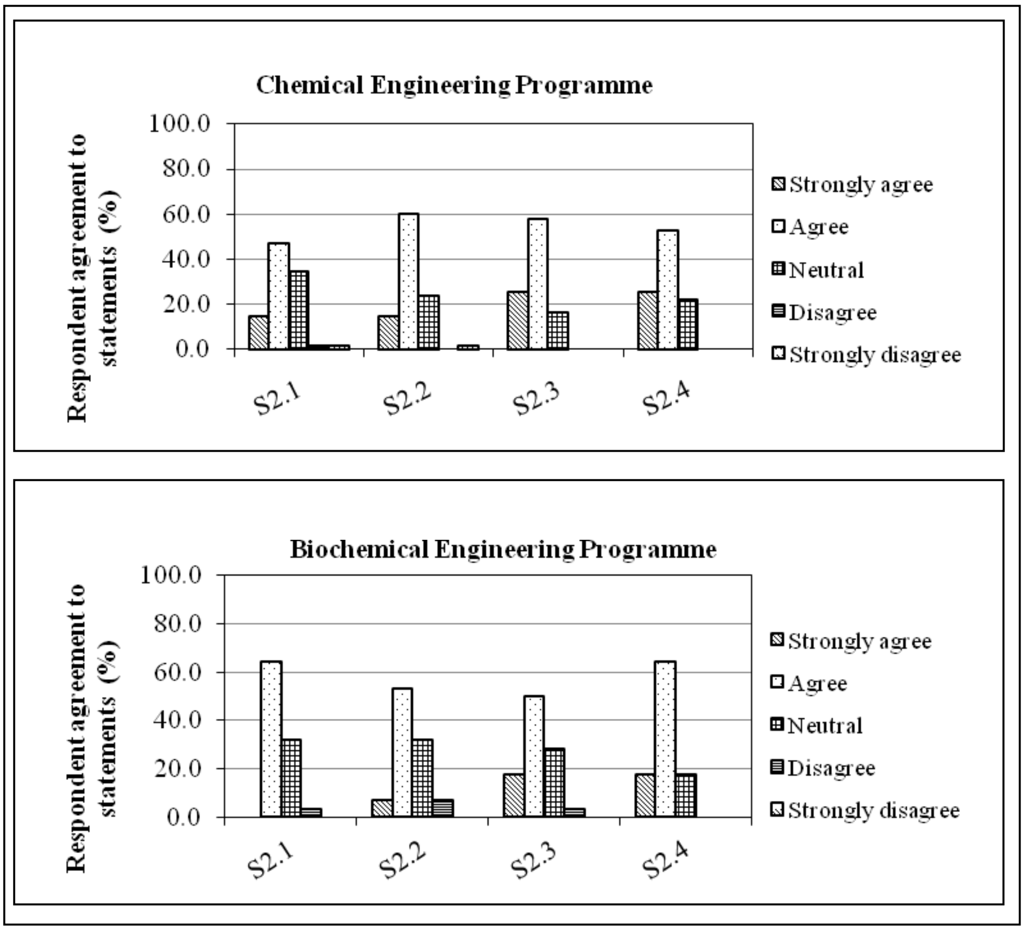

Fig. 14 Respondent agreement on statements of current issue identification (PO11) given by both Chemical and Biochemical Engineering students

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.

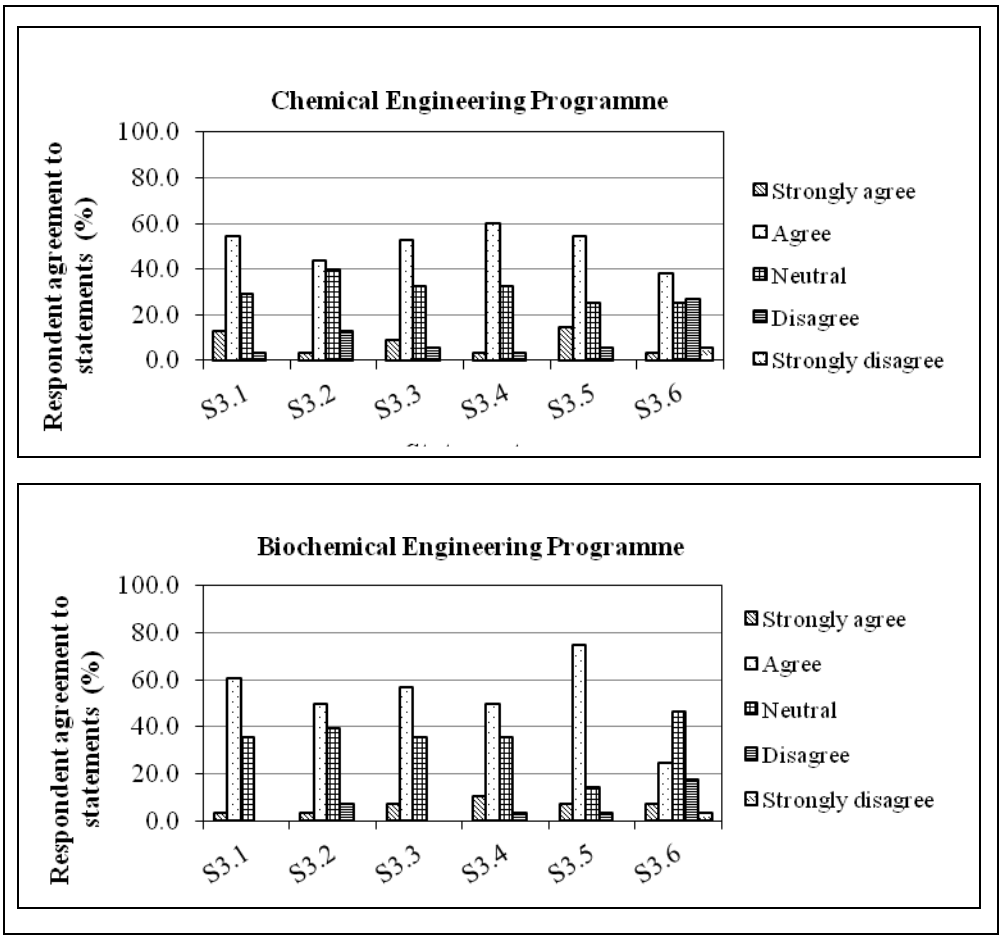

Fig. 15 Respondent agreement on statements of software application of iCON® / SUPERPRO® (PO12) in problem solving given by both Chemical and Biochemical Engineering students

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.

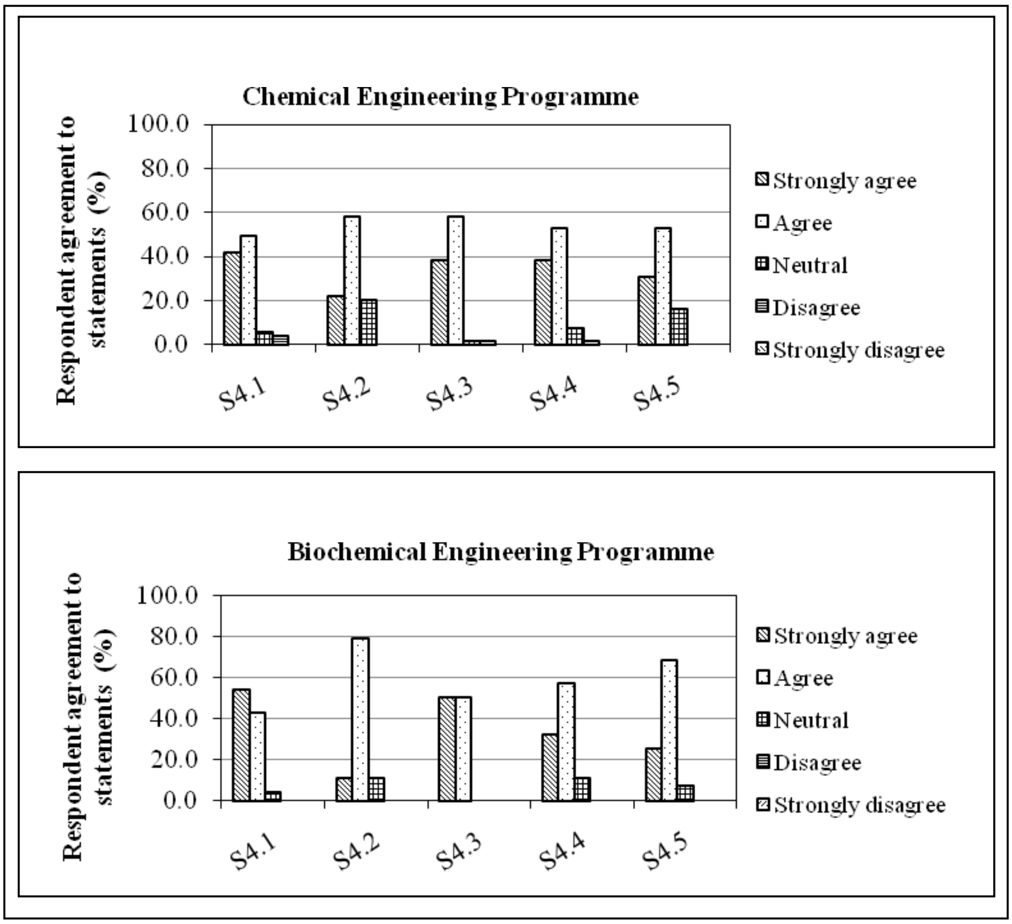

Fig. 16 Respondent agreement on statements of communication (PO2) given by both Chemical and Biochemical Engineering students

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.

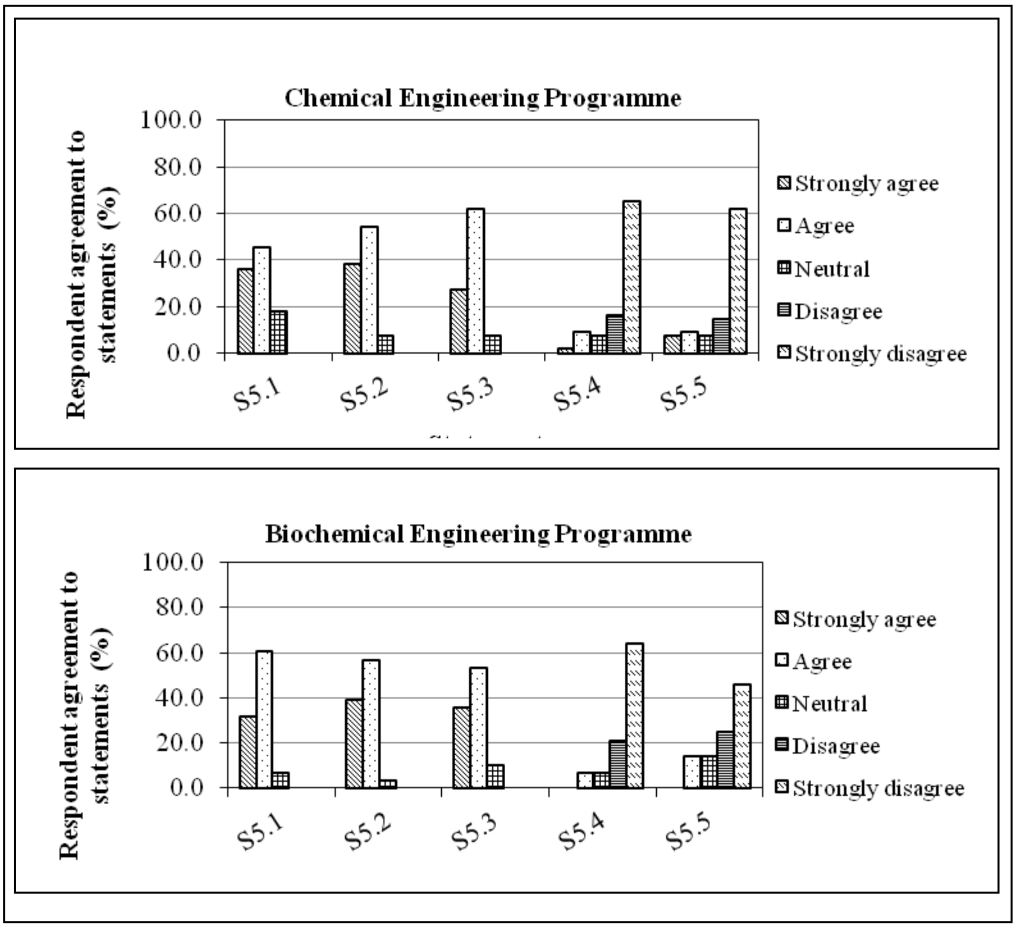

Fig. 17 Respondent agreement on statements of team work (PO6) given by both Chemical and Biochemical Engineering students

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.

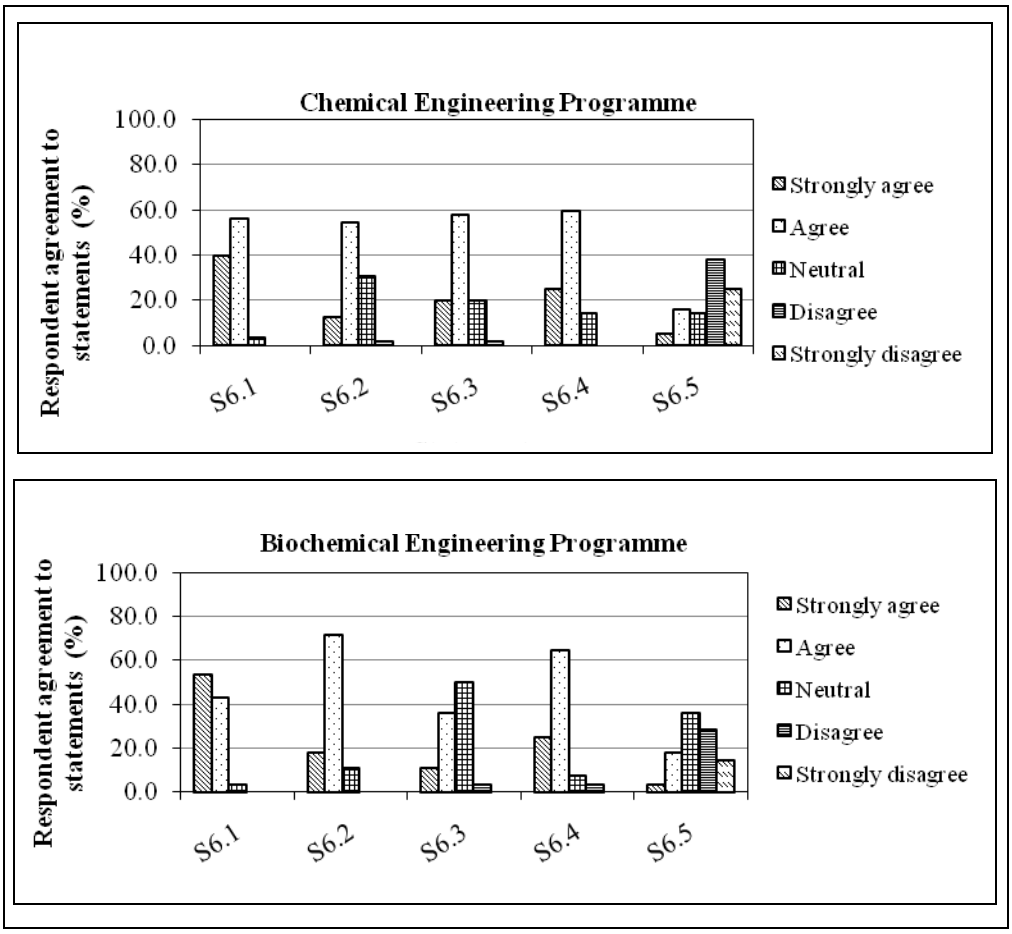

Fig. 18 Respondent agreement on statements of lifelong (PO8) given by both Chemical and Biochemical Engineering students

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.

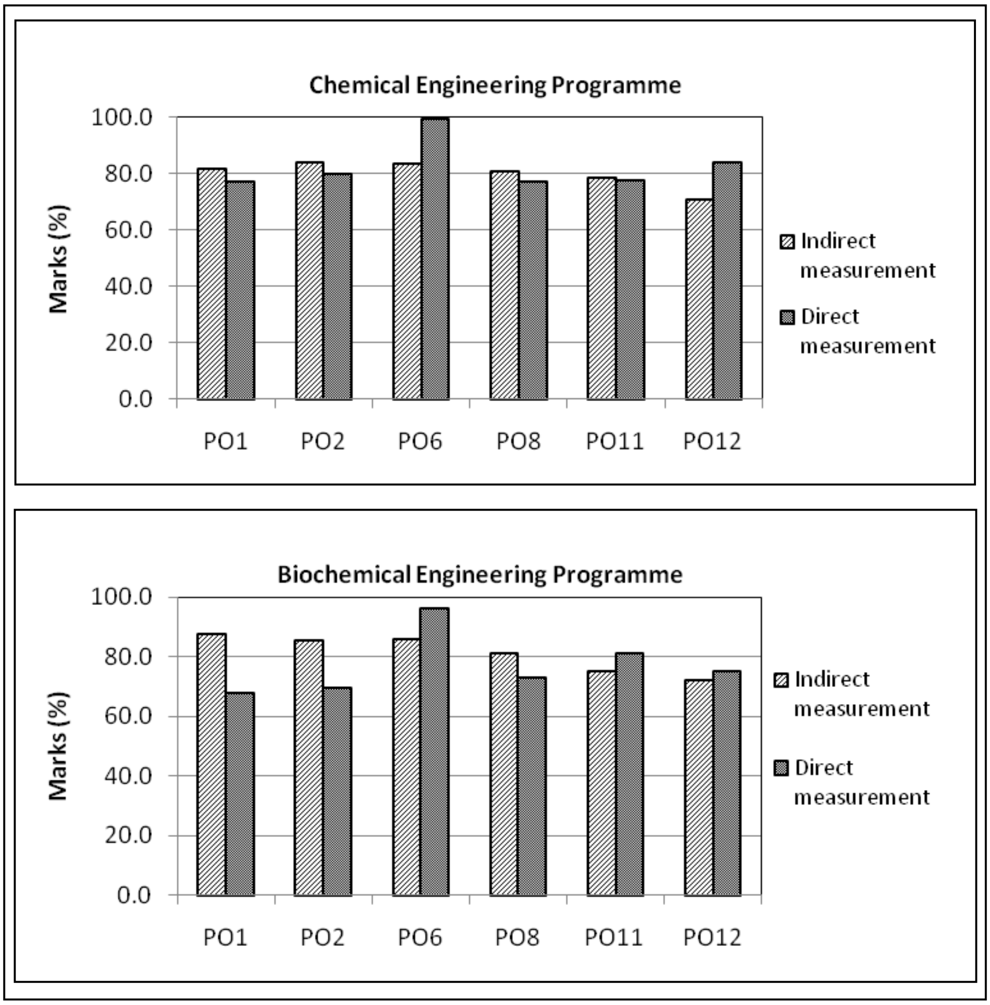

Fig. 19 Comparative results between direct measurement by lecturers and indirect measurement by students for both Chemical and Biochemical Engineering Programmes

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 20092010. 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 20062007, 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. JKKP 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 JKKP, as a method of innovative teaching and learning has already entered the age of 5 years, however the JKKP 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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