

Global Journal of Engineering Education

Assessment of student outcomes of the *Industrial and Management Systems Engineering* programme at Kuwait University

Ali Allahverdi & Tariq Aldowaisan

Kuwait University
Kuwait

ABSTRACT: The Industrial and Management Systems Engineering (IMSE) programme at Kuwait University has been accredited by ABET since 2001. This article describes the assessment of student outcomes of the programme. A framework model is developed where the assessment process and tools are shown to drive improvement in student outcomes. Student outcomes describe what students are expected to know and be able to do by the time of graduation in terms of knowledge, skills and behaviours. Four different tools, both direct and indirect, are used to assess student outcomes. The results from assessment indicate that the target levels are attained for each of the eleven student outcomes.

Keywords: ABET, student outcomes, assessment, industrial engineering programme

INTRODUCTION

Quality plays a pivotal role in all improvement systems and programmes across all types of organisations; e.g. manufacture, finance, service, healthcare, and education. Examples of such programmes and systems include the Baldrige National Quality Programme (BNQP) [1]; European Foundation for Quality Model (EFQM) [2]; Six Sigma [3]; ISO 9000 Quality Management System [4]; Balanced Scorecard (BSC) [5] and Customer Service Excellence (CSE) programme [6].

The interest of employing quality in engineering education has increased over recent years. Global competitiveness has intensified with the mind boggling advent of communication and free-trade alliances. Expectations relating to superior graduates have been ever-increasing. The emergence of cultural diversity in the workplace and other significant changes have had an impact on almost every aspect of life [7][8].

Credentialing agencies have been established to ensure the quality of engineering education through accrediting engineering and other related programmes. Examples are the Accreditation Board for Engineering and Technology (ABET) of the USA, Japan Accreditation Board of Engineering Education (JABEE), the Accreditation Board for Engineering Education of Korea (ABEEK) and the Engineering Accreditation Council of Malaysia (EAC).

The Bologna Process has been instrumental in developing a mutual accreditation framework [9], which has led to the establishment of a non-profit organisation, the European Network for Accreditation of Engineering Education (ENAEE) [10]. The quality of engineering education has also been discussed in other countries, such as Jordan [11] and Nigeria [12].

Engineering programmes in the USA and worldwide sought to apply the ABET criteria in order to assure and improve the quality of their programmes, e.g. improving mechanical engineering education at Kuwait University [8], improving electrical engineering education at American University of Sharjah [13], improving petroleum engineering education at the United Arab Emirates University at Al-Ain [14], improving biomedical engineering education at Johns Hopkins University [15] and improving chemical engineering education at Columbia University [16].

An engineering programme seeking to be accredited by the Engineering Accreditation Commission of ABET must demonstrate that it satisfies all of the general criteria in addition to the specific programme criteria. One of the eight general criteria of ABET is student outcomes (SOs). Student outcomes describe what students are expected to know and be able to do by the time of graduation.

The Industrial and Management Systems Engineering (IMSE) programme at Kuwait University (KU) has been accredited by ABET since 2001. This article describes the design and implementation of a systematic process for the development and assessment of SOs. Four different assessment tools are used to measure performance against specified attainment levels for each student outcome. The findings are positive since the results show that all attainment levels have been met.

It is important to note that the SOs marked for each course/syllabi are directly related to the learning objectives of that course/syllabi. Therefore, the chosen assessment methods to measure the realisation of SOs in essence lead to the assessment of learning objectives.

STUDENT OUTCOMES (SOs)

The Department of Industrial and Management Systems Engineering (IMSE) has developed its student outcomes (SOs) based on ABET student outcomes (a-k). SOs describe what students are expected to know and be able to do by the time of graduation (skills, knowledge and behaviours). The developed SOs are:

a. Ability to apply knowledge of mathematics, science and engineering.
b. Ability to design and conduct experiments related to deterministic or stochastic systems, as well as to analyse and interpret data.
c. Ability to design a system, component or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
d. Ability to function on multidisciplinary teams.
e. Ability to identify, formulate and solve industrial and management systems engineering problems.
f. Understanding of professional and ethical responsibility.
g. Ability to communicate effectively.
h. Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.
i. Ability to engage in life-long learning and appreciate the need for continual self-development.
j. Knowledge of contemporary issues.
k. Ability to use the techniques, skills, and the modern engineering tools necessary for industrial and management systems engineering practice.

Table 1 shows the mapping of the IMSE SOs to courses in the IMSE curriculum, which are classified as general, engineering, programme compulsory and programme electives. The symbol *R* (relevant) is used to denote significant relevance between the course and the SO. However, the absence of the symbol *R* does not necessarily mean that the student outcome is not related.

Table 1: Curriculum mapping to IMSE student outcomes.

Course No.	Courses	Student outcomes										
No.	General education	a	b	c	d	e	f	g	h	i	j	k
	Humanities and social science electives								R		R	
	English language courses							R				
	Math and science courses and laboratories	R										
No.	Basic engineering requirements	a	b	c	d	e	f	g	h	i	j	k
600-102	Workshop		R				R					
600-104	Engineering Graphics							R				R
600-200	Computer Programming for Engineers											R
600-202	Statics	R				R						
600-204	Strength of Materials	R				R						
600-205	Electrical Engineering Fundamentals	R				R						R
600-207	Electrical Engineering Fundamentals Laboratory	R	R			R						R
600-208	Engineering Thermodynamics	R				R			R			
600-209	Engineering Economy	R				R			R		R	R
600-304	Engineering Probability and Statistics	R				R						R
600-308	Numerical Methods in Engineers	R				R						R
No.	IMSE requirements	a	b	c	d	e	f	g	h	i	j	k
630-241	Material Science and Metallurgy	R										
630-353	Manufacturing Processes					R						

650-312	Petroleum Industry	R				R						R
660-221	Introduction to Industrial Engineering		R		R	R	R	R		R		
660-312	Industrial Engineering Laboratories		R		R			R			R	R
660-321	Work Design and Measurements	R	R	R					R		R	R
660-325	Safety and Health for Engineers		R		R		R	R	R	R	R	R
660-351	Engineering Statistical Analysis	R	R			R						R
660-352	Production Cost Analysis	R				R			R		R	R
660-361	Operation Research I	R		R		R				R		R
660-372	Project Management and Control				R	R	R	R		R		R
660-434	Facilities Planning and Design	R		R		R		R				R
660-454	Production Planning and Inventory Control	R		R		R						R
660-457	Quality Control	R	R			R				R	R	R
660-461	Operation Research II	R				R						R
660-471	Engineering Management				R		R	R	R		R	
660-481	Systems Simulation		R	R	R	R		R		R		R
660-496	Design in Industrial Engineering	R	R	R	R	R	R	R				R
No.	IMSE electives	a	b	c	d	e	f	g	h	i	j	k
660-381	Data and Decision Analysis		R			R						R
660-395	Industrial Engineering Internship				R	R	R	R			R	R
660-419	Special Topics in Industrial Engineering											R
660-425	Human Factors Engineering		R	R	R		R	R	R	R	R	R
660-429	Ergonomics and Safety in Process Industry			R	R		R	R	R		R	R
660-445	Manufacturing Systems	R		R		R					R	R
660-446	Computer Aided Manufacturing			R		R						R
660-451	Reliability and Maintainability Engineering	R	R	R		R	R		R		R	R
660-456	Productivity Improvement Methods			R	R	R	R					R
660-458	Design of Experiments	R	R	R	R	R		R				R
660-459	Quality in Health Care			R	R	R	R	R	R		R	R
660-464	Optimisation Methods	R				R						R
660-470	Supply Chain and Logistics	R		R	R	R				R	R	R
660-487	Expert Systems in Industrial Engineering	R		R	R	R		R				R
660-489	Special Topics in Management Systems Engineering											R
660-494	Industrial Engineering in Process and Service Systems	R			R	R		R	R		R	R

ASSESSMENT TOOLS

The IMSE programme regularly assesses and evaluates the extent to which SOs are being attained. Figure 1 shows the factors that have gone into the process of developing the various components of the programme starting with the mission all the way to the courses' syllabi. The factors/drivers consist of benchmarking with leading IE programmes, directions and input from Kuwait University, the College of Engineering and Petroleum (CEP), ABET guidelines and input from the identified four constituencies. The figure's model is aligned with common strategic planning models, where the mission and goals are first developed based on external and internal factors/drivers. This is followed by deploying the goals through specific objectives at the courses' level. Evaluation at various levels of design and implementation are conducted and results are used to improve the performance.

Continuous improvement is triggered by setting expected attainment levels to the SOs and subsequently assessing - using different tools at various frequencies - the actual levels of attainment. Results of the assessments are used to continuously improve the programme and feedback the constituencies.

The assessment process is generally handled through a series of steps that starts with the Assessment Secretary who receives the data, analyses it and, then, presents it to the Undergraduate Programme Committee, which evaluates the results of the analysis and recommends actions to the Department Chairman. The Chairman, where necessary, introduces relevant recommendations to the Department Council, which makes the final recommendations.

Table 2: Assessment tools used.

Assessment tool	Conducted by
Exit Survey	CEP
Instructor Class Evaluation	CEP
Student Outcome Assessment	IMSE
Design in Industrial Engineering - Employer Survey	IMSE

Table 2 lists four assessment tools used for the process of continuous improvement along with the responsible party (CEP or IMSE). Two of the tools, the exit survey and the employer survey, indirectly measure the SOs; whereas the other two directly measure the SOs. The four surveys provide complete programme evaluation; two of the surveys (instructor class evaluation and student outcome assessment) provide process level assessment throughout the students' period of study, whereas, the exit and employer surveys provide output and impact level assessment. All surveys, except the student outcome assessment, are based on a 5-point Likert-scale with a few open-ended questions at the end of the survey. As for the student outcome assessment, it consists of the weighted average of the performance of students in assignments, examinations, and project. It is important to note that all students for an evaluated class participate in the student outcome assessment. As for the exit survey, all students participate, whereas, for the employer survey, the specific employers that house the projects do the assessment.

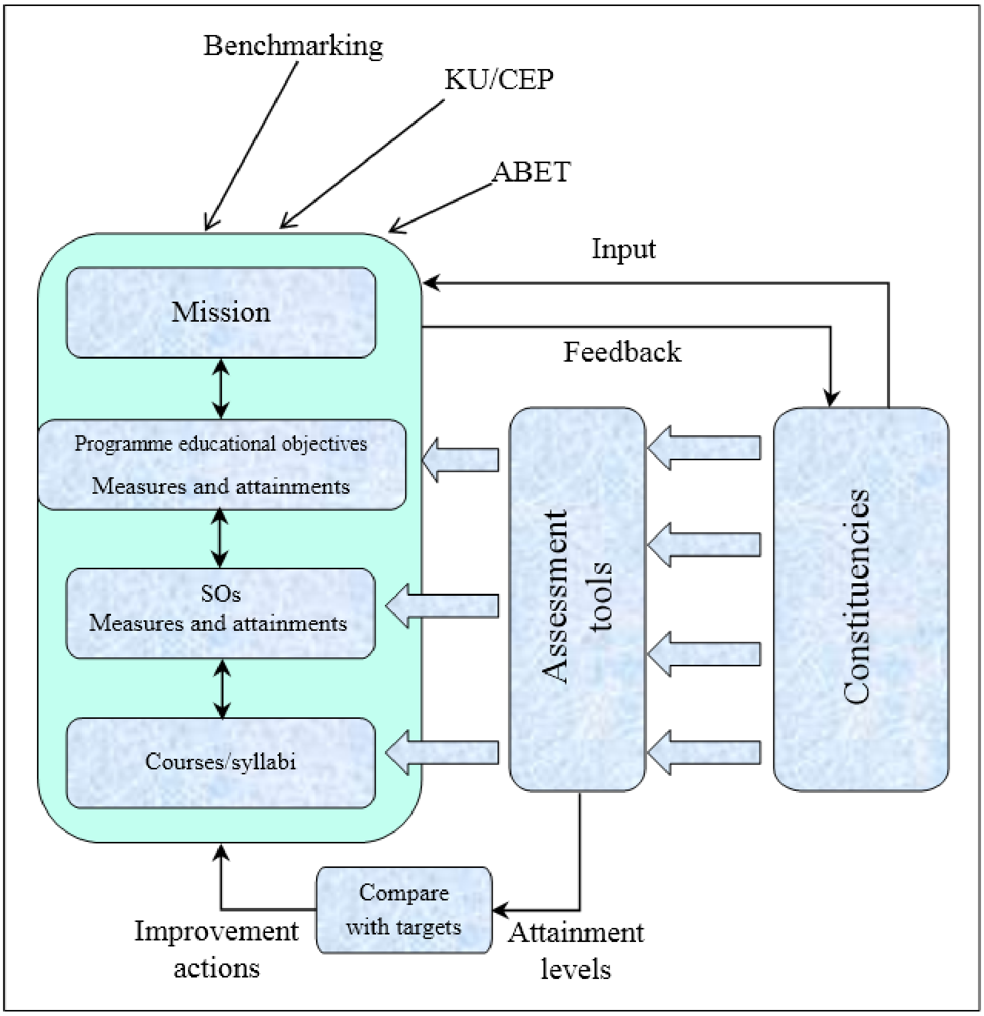

Figure 1: The process of the development, evaluation and improvement of the SOs.

To facilitate assessment and continuous improvement, each of the student outcomes (SOs) *a* to *k* is broken down into the components shown in Table 3. This decomposition was taken into consideration to promote comprehension among faculty members in order to support the evaluation of each student outcome. With the decomposition, the faculty may identify specific evidences for each outcome.

The IMSE programme was using only the instructor class evaluation (ICE) and the exit survey (ES) for the evaluation of student outcomes until Fall 2011. Since then, two additional assessment tools were initiated: the student outcome assessment (SOA) and the employer survey: design in industrial engineering as shown in Table 4.

The instructor class evaluation is administered by CEP; where each faculty member completes the form at the end of each semester for each course. The faculty member evaluates the students' performance in relation to the course's relevant outcomes using a scale of 1 to 5; where 1 = very weak, 2 = weak, 3 = satisfactory, 4 = very good and 5 = excellent performance.

The exit survey is also administered by CEP; where each graduating student completes the form. In addition to questions related to the student outcomes, the survey asks other questions related to future plans, assessment of the learning environment at KU, assessment of the support services at KU and general assessment. It should be noted that the survey questions related to the student outcomes do not match with the exact wording of the defined student outcomes, but they clearly map to them.

Table 3: Breaking of each SO into components.

Student outcomes		Components
a	Ability to apply knowledge of mathematics, science and engineering.	Develop models describing the behaviour of systems or processes. Obtain solutions to predict behaviour of systems or processes. Evaluate and interpret model predictions.
b	Ability to design and conduct experiments related to deterministic or stochastic systems, as well as to analyse and interpret data.	Design experiments or experimental procedure. Conduct experiments. Analyse and interpret experimental data.
c	Ability to design process and integrated systems that achieve system design objectives, which typically include considerations of productivity, quality, profitability, and ergonomics and safety.	Establish objectives of a design project based on needs. Formulate the design problem based on objectives and constraints. Generate ideas and alternative solutions for a given problem. Evaluate alternatives and be able to choose the best. Create a prototype or model that embodies or represents the chosen solution.
d	Ability to work in multidisciplinary teams.	Recognise essential requirements of effective teams. Function effectively in teams to complete a given task.
e	Ability to identify, formulate and solve industrial and management systems engineering problems.	Identify an IMSE related problem or an opportunity for improvement (OFI). Define problem or OFI. Analyse and propose changes to address problem/OFI. Develop and validate the proposed changes.
f	Understanding of professional and ethical responsibility.	Demonstrate knowledge of professional codes of ethics. Evaluate ethical dimensions of a problem/case.
g	Ability to communicate effectively.	Communicate effectively in written form. Communicate effectively in oral form. Communicate effectively in visual form.
h	Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.	Identify economic and societal impacts of engineering solutions. Recognise the engineer responsibilities towards society.
i	Ability to engage in life-long learning and appreciate the need for continual self-development.	Recognise the need for life-long learning. Acquire new knowledge/skills independently.
j	Knowledge of contemporary issues.	Identify relevant socio-political, economic and technological issues. Identify ways engineers might contribute to societal development.
k	Ability to use the techniques, skills, and the modern engineering tools necessary for industrial and management systems engineering practice.	Use state-of-the-art computing and communication tools for the effective and efficient practice of IMSE engineer. Use state-of-the-art devices and equipment for the effective and efficient practice of IMSE engineer.

The student outcome assessment is administered by the IMSE Department, which was initiated in Fall 2011. This form is completed for selected outcomes relevant to the course by the faculty member. The score for each outcome reflects the average quantitative direct measurement of the students' performance on the relevant assignments. The assignments might include homework, examinations, quizzes, projects and presentations.

The design in industrial engineering - employer survey is also administered by the IMSE Department, which was also initiated in Fall 2011.

In this course, students are divided into groups to work in a selected organisation in which each group is assigned to a department or a division, and supervised by professional top-level personnel from that department. The students frequently visit the organisation to identify the problem, collect data, perform analysis and propose solutions.

At the conclusion of the course, students give two presentations; one to the faculty members and a second to the public at which company representatives are present. The survey, in which they express their assessment of the students' achievement of the outcome, is completed by the company supervisors.

The expected level of attainment for each outcome is set at 60%. This attainment level may be reconsidered at a future date for the possibility of raising the level of expectation.

Table 4: Assessment tools used for student outcomes.

Assessment tools	Assessor	Frequency	Start date
*Instructor Class Evaluation**	Faculty	Every semester	Before 2007
Exit Survey	Student	Every year	Before 2007
Student Outcome Assessment	Faculty	Every semester	Fall 2011
Design in Industrial Engineering - Employer Survey	Employer	Every semester	Fall 2011

*This instrument tool has been revised as of spring 2012

ASSESSMENT RESULTS

The results of the instructor class evaluation are summarised in Table 5 starting from Fall 2008. The scores represent the average of evaluations of all faculty members who have assessed the specified student outcome in a given semester. The averaging approach is also used in Tables 6-8 for other tools. The results for the exit survey, the student outcome assessment, and the design in industrial engineering - employer survey are summarised in Tables 6 to 8, respectively.

Table 5: Results of the attainment of student outcomes using the instructor class evaluation.

SOs	Fall 2008	Spring 2009	Fall 2009	Spring 2010	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012	G. Avg.	SD
a	80.0	80.0	90.0	70.0	75.4	73.0	72.0	76.4	78.7	77.3	5.9
b	80.0	80.0	86.7	83.0	74.3	70.0	75.0	70.0	73.3	76.9	5.8
c	100	84.0	77.5	68.0	70.0	75.0	65.0	64.4	77.8	75.7	7.0
d	80.0	85.7	80.0	75.0	65.0	80.0	70.0	85.0	78.2	77.7	6.7
e	80.0	76.0	86.0	74.0	71.3	70.0	74.3	75.0	78.9	76.2	4.9
f	73.3	74.3	85.0	73.0	80.0	70.0	75.0	85.0	73.3	76.6	5.5
g	80.0	80.0	88.0	85.0	80.0	67.0	73.3	80.0	75.6	78.8	6.2
h	80.0	74.3	86.7	77.0	68.0	80.0	66.7	70.0	77.8	75.6	6.5
i	60.0	72.0	100	80.0	60.0	67.0	73.3	68.0	68.0	72.0	6.7
j	60.0	76.7	80.0	60.0	60.0	67.0	75.0	85.0	70.0	70.4	9.4
k	86.7	80.0	84.4	86.0	70.8	77.0	72.5	71.1	80.0	78.7	6.3

Table 6: Results of the attainment of student outcomes using the exit survey.

SOs	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	G. Avg.	SD
a	88.0	80.0	80.0	82.0	78.0	81.6	3.8
b	82.0	78.0	72.0	80.0	76.0	77.6	3.8
c	80.0	82.0	76.0	80.0	80.0	79.6	2.2
d	86.0	90.0	84.0	92.0	84.0	87.2	3.6
e	82.0	80.0	78.0	82.0	78.0	80.0	2.0
f	84.0	82.0	78.0	82.0	84.0	82.0	2.4
g	79.0	80.0	80.0	78.0	81.0	79.6	1.1
h	80.0	80.0	82.0	84.0	78.0	80.8	2.3
i	72.0	74.0	78.0	76.0	78.0	75.6	2.6
j	74.0	64.0	76.0	72.0	76.0	72.4	5.0
k	80.0	76.0	72.0	72.0	78.0	75.6	3.6

Table 7: Results of the attainment of student outcomes using the student outcome assessment.

SOs	Fall 2011	Spring 2012	Fall 2012	G Avg.	SD
a	70.6	78.0	76.7	75.1	4.0
b	75.3	81.0	80.2	78.8	3.1
c	80.5	78.0	84.7	81.1	3.4
d	84.9	85.0	92.2	87.4	4.2
e	81.4	79.0	77.7	79.4	1.9
f	73.6	84.0	84.7	80.8	6.2
g	79.2	82.0	84.1	81.8	2.4
h	75.4	82.0	61.6	73.0	10.4
i	78.7	81.0	89.5	83.1	5.7
j	81.7	85.0	70.4	79.0	7.7
k	77.4	83.0	82.3	80.9	3.1

Table 8: Results of the attainment of student outcomes using IMSE 496: design in IE - employer survey.

SOs	Fall 2011	Spring 2012	Fall 2012	G Avg.	SD
a	92	90	98	93.3	4.2
b	88	82	96	88.7	7.0
c	90	90	94	91.3	2.3
d	98	90	96	94.7	4.2
e	92	88	91	90.3	2.1
f	86	90	96	90.7	5.0
g	92	90	96	92.7	3.1
h	86	82	88	85.3	3.1
i	88	90	98	92.0	5.3
j	92	94	87	91.0	3.6
k	92	90	98	93.3	4.2

In Table 5, the two scores of 100 (shaded) refer to single instances of evaluation. Considering the nature of the scale 1 to 5, these two scores are discarded from computation of the grand average (G. Avg.) and standard deviation (SD) in the last two columns. The results in Table 5 generally show that all SOs on average exceed the satisfactory level of 60%; where all SOs have an average score in the 70s. Also, the standard deviation is in single digit, indicating a generally small level of variation.

The results in Table 6 generally show that they significantly exceed the satisfactory level of 60% and the standard deviation is also very small, indicating low variation.

The results in Table 7 generally show that they significantly exceed the satisfactory level of 60% and the standard deviation is relatively low considering that it is calculated based on only 3 observations.

Moreover, the results in Table 8 generally show that they greatly exceed the satisfactory level of 60% and the variation is small. The high scores provided by employers may be attributed to the fact that this is a capstone course where students supposedly have achieved high level of performance across all SOs. Since this level of scoring is expected, the UPC has decided to use a revised questionnaire starting from Fall 2013, in which the employer is asked more relevant questions, with focus on measuring students' readiness for employment.

The following paragraphs provide brief coverage of all student outcomes showing the results in the instructor class evaluation (ICE), the student outcome assessment (SOA), and the exit survey (ES). The employer survey for the senior design course is not included since it addresses only one course, and its results are generally high in the 80s and 90s.

For all the outcomes, *a-k*, it is clear from Figures 2-12 that the threshold value of 60 is exceeded in all evaluations for all semesters.

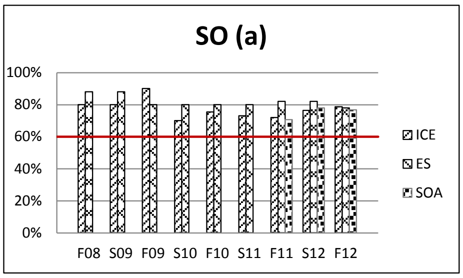

Figure 2: The results for student outcome (a).

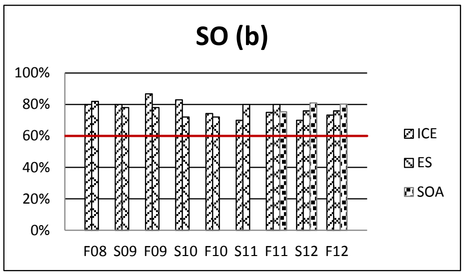

Figure 3: The results for student outcome (b).

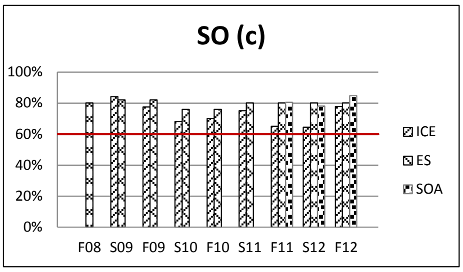

Figure 4: The results for student outcome (c).

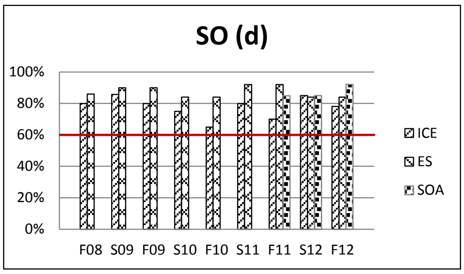

Figure 5: The results for student outcome (d).

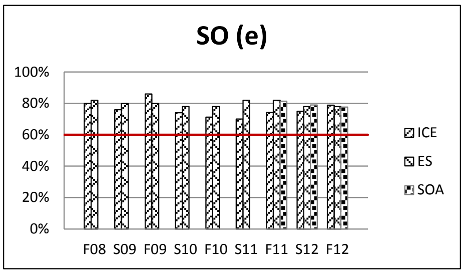

Figure 6: The results for student outcome (e).

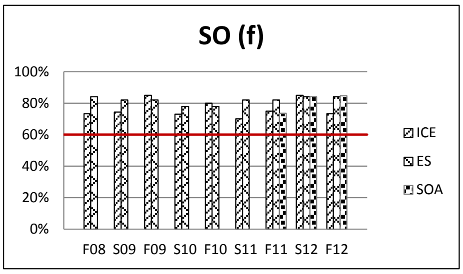

Figure 7: The results for student outcome (f).

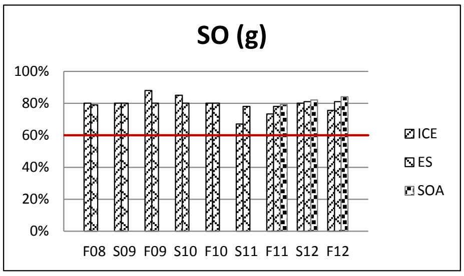

Figure 8: The results for student outcome (g).

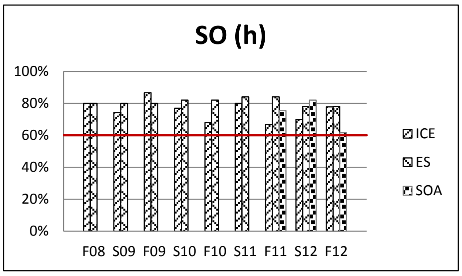

Figure 9: The results for student outcome (h).

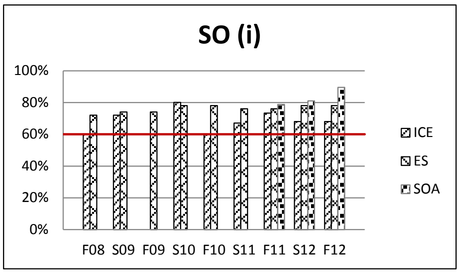

Figure 10: The results for student outcome (i).

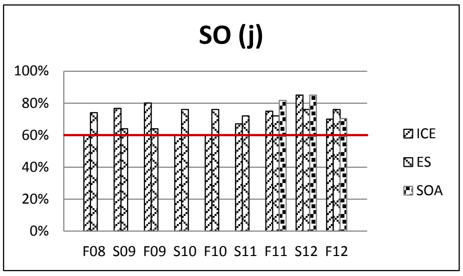

Figure 11: The results for student outcome (j).

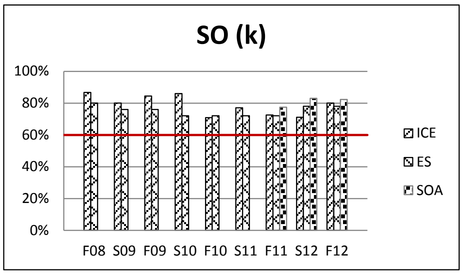

Figure 12: The results for student outcome (k).

As can be seen from Figures 2, 4-7, 9, 10 and 12, for outcomes *a, c, d, e, f, h, i* and *k*, the ES results exceed other results, indicating that students reach their full capabilities in these outcomes at the conclusion of their study. For outcomes *b* and *g*, on the other hand, Figures 3 and 8 show that the ES results in the earlier semesters lag behind the ICE results. However, in later semesters they lead the ICE; possibly indicating that the perception of faculty was rather high in earlier semesters, but was corrected in later semesters. Lastly, the comparison between ES and ICE results does not show any pattern for outcome *j* (see Figure 11); therefore, it is not possible to discern any conclusion.

As can be seen from Figures 2, 7 and 8, for outcomes *a*, *f* and *g*, the SOA and ICE results are consistently close to each other, indicating that the perception of the instructor agrees with the actual performance of the students with regard to these outcomes.

Figures 3 and 4 show that the SOA and ICE results in the last two semesters for outcome *b* and three semesters for outcome *c*, there is an indication that the SOA is higher than ICE; however, the difference is not statistically significant.

As for the SOA and ICE results, they are consistently close to each other for outcomes *e* and *j* (see Figures 6 and 11); indicating that the perception of the instructor agrees with the actual performance of the students with regard to these outcomes.

For outcome *h*, see Figure 9; there is a difference between the results of SOA and ICE. However, later analysis shows that it is not statistically significant.

The results for SOA seem to be higher than those for ICE for outcome *k* (see Figure 12). However, statistically the difference is not significant, indicating that the perception of the instructor agrees with the actual performance of the students with regard to this outcome.

CONCLUSIONS

In this article, the authors have described the assessment of student outcomes for the Industrial and Management Systems Engineering programme at Kuwait University. Student outcomes, a key component of ABET requirements, describe what students are expected to know and be able to do by the time of graduation in terms of knowledge, skills and behaviours.

The authors have developed a framework model where an assessment process and a set of tools were utilised to drive improvement in student outcomes. Two types of assessment tools were employed; direct and indirect. The direct one assesses students' performance in each course for selected student outcomes; whereas, in the indirect one the students assess their performance using a survey consisting of the eleven students outcomes. Furthermore, the four assessment tools provided performance evaluation of process, output and impact. The application of the assessment tools indicated that the target levels have been achieved.

Future assessment may employ four zones rather than a single target value to evaluate each SOs. A red danger zone where performance falls way below expectation, a yellow warning zone where performance falls below expectation, a green zone where performance exceeds expectation and a blue sky zone where performance way exceeds expectations.

REFERENCES

1. Ah, J., Using the Malcolm-Baldrige-national-quality-award criteria to assess a company quality program. *TAPPI J.*, 73, 293-294 (1990).
2. Doeleman, H.J., ten Have, S. and Ahaus, C.T.B., Empirical evidence on applying the European Foundation for Quality Management Excellence Model, a literature review. *Total Quality Manage. and Business Excellence,* 25, 439-460 (2014).
3. Krueger, D.C., Parast, M.M. and Adams, S., Six Sigma implementation: a qualitative case study using grounded theory. *Production Planning and Control,* 25, 873-889 (2014).
4. Joon, P.D. and Kang, I., The study of follow-up audit compliance for quality management system in subcontractors of shipbuilding industry based on ISO 9000 requirements changes. *J. of Korea Safety Manage. and Science,* 13, 161-169 (2011).
5. Mendes, P., Nunes, L.M. and Teixeira, M.R., Quantitative performance targets by using balanced scorecard system: application to waste management and public administration. *Waste Manage. and Research*, 32, 927-936 (2014).
6. Van Vaerenbergh, Y., De Keyser, A. and Lariviere, B., Customer intentions to invoke service guarantees, do excellence in service recovery, type of guarantee and cultural orientation matter? *Managing Service Quality*, 24, 45-62 (2014).
7. Patil, A. and Codner, C., Accreditation of engineering education: review, observations and proposal for global accreditation. *European J. of Engng. Educ.*, 32, 639-651 (2007).
8. Christoforou, A.P. and Yigit, A.S., Improving teaching and learning in engineering education through a continuous process. *European J. of Engng. Educ.,* 33, 105-116 (2008).
9. Augusti, G., Transnational recognition and accreditation of engineering educational programmes in Europe: perspectives in a global framework. *European J. of Engng. Educ.,* 31, 249-260 (2006).
10. Augusti, G., Accreditation of engineering programmes: European perspectives and challenges in a global context. *European J. of Engng. Educ.*, 32, 273-283 (2007).
11. Aqlan, F., Al-Araidah, O. and Al-Hawari, T., Quality assurance and accreditation of engineering education in Jordan. *European J. of Engng. Educ.*, 35, 311-323 (2010).
12. Agboola, O.P., Elinwa, U.K., Accreditation of engineering and architectural education in Nigeria: the way forward. *Proc. 2nd World Conf. on Educational Technol. Research*, 83, 836-840 (2013).
13. Al-Nashash, H., Khalid, A., Qaddoumi, N., Al-Assaf, Y., Assaleh, K., Dhaouadi, R. and El-Tarhuni, M., Improving electrical engineering education at the American University of Sharjah through continuous assessment. *European J. of Engng. Educ.,* 34, 15-28 (2009).
14. Abu-Jdayil, B. and Al-Attar, H., Curriculum assessment as a direct tool in ABET outcomes assessment in a chemical engineering programme. *European J. of Engng. Educ.*, 35, 489-505 (2010).
15. Allen, R.H., Acharya, S., Jancuk, C. and Shoukas, A.A., Sharing best practices in teaching biomedical engineering design. *Annals of Biomedical Engng.*, 41, 1869-1879 (2013).
16. Hilla, M., Booneb, K., Anwarb, R., Gaumerc, R.B. and Camardac, K.V., The future of chemical engineering design: impact of faculty makeup and industrial needs. *Computer Aided Chemical Engng.,* 34, 88-97 (2014).

Professor Ali Allahverdi received his BS from Istanbul Technical University, Turkey, and his MSc and PhD from Rensselaer Polytechnic Institute, USA. He has been a faculty member at the Industrial and Management Systems Engineering of Kuwait University since 1995. He received the Distinguished Researcher Award and Research Performance Award from Kuwait University in 2003 and 2004, respectively, and Dissertation Prize from Rensselaer Polytechnic Institute in 1993. He has published over 100 papers in well-known international journals and presented more than 80 papers at international conferences. He has been the editor of the European Journal of Industrial Engineering since 2007, and served as guest editor for the European Journal of Operations Research and the International Journal of Operations Research. He is currently serving as an associate editor of several journals and on the editorial boards of several other journals. He has been an ABET evaluator since 2011.

Professor Tariq Aldowaisan received his BS, MSc and PhD from Arizona State University, USA. He is currently a professor at the Industrial and Management Systems Engineering Department at Kuwait University, and an Associate Dean for Planning and Career Development at the College of Engineering and Petroleum. His area of interest is quality, organisational excellence and accreditation. He has published in reputable journals where his publications received a significant number of citations. Dr Aldowaisan also has professional designations from the American Society for Quality; they are CQA, CQE and CQM/OE. He performs consulting and training to both private and public institutions.