

*Original Research Article*

# Awareness of UAE University Chemical Engineering Students on ABET Accreditation criterion/a-k outcomes linked to the course syllabi

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## Abstract

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It is important that engineering students are to be well-aware with the ABET (*Accreditation Board for Engineering and Technology*) accreditation process including its a-k outcomes and their coverage in the course syllabi presented to them at the beginning of the courses. Therefore, the objective of this current study is to conduct a comprehensive survey among the chemical engineering students of UAE University to examine their familiarity with a-k outcomes linked to the course syllabi and their significance in ABET accreditation progress. Moreover, students' knowledge about the benefit of obtaining their degrees from an ABET accredited program will also be analyzed. At the end of survey, the participants were asked to suggest the means by which students' awareness on ABET accreditation process can be increased towards their graduation. The results of the survey reveal that UAE University chemical engineering students are somewhat less-aware of the ABET a-k outcomes, ABET accreditation and its benefit towards their career. Moreover, it is found that female students are little more aware with ABET than the male students and a significant increase in awareness is found among the students with high GPA and senior students. In addition, it clearly shows that attending workshops and ABET activities and chemical society activities on ABET accreditation would definitely elevate the ABET awareness among all level students.

**Keywords:** ABET a-k outcomes, course syllabi, curriculum design, engineering accreditation, students' awareness

## INTRODUCTION

Engineers are increasingly being molded into professionals that not only handle the technical aspects of a project but are also expected to engage in multinational teams at different points around the globe; this requires them to use their problem solving skills and scientific knowledge, as well as group work effectiveness and social awareness (Sala et al., 2011; Dee et al. 2015). And in order for a standardized curriculum and teaching of engineering discipline worldwide, a reliable accreditation such as ABET (Accreditation Board for Engineering and Technology) is of great importance. Accreditation can be defined as a process for evaluating

an educational institution or program to examine if it meets the specified standards of educational quality. Its purpose is to ensure that the prospective students graduating from an accredited institution or program have achieved at least the minimum competency required in their chosen fields of study (Prados et al. 2005).

However, until the early 20th century, very few efforts were put into standardizing the engineering programs (Prados et al., 2005; Culver et al., 2005). In fact, it was in 1922 that the formal accreditation of an engineering program was undertaken by American Institute of Chemical Engineers (AIChE), which developed a

recommended chemical engineering curriculum structure. AIChE managed to establish a committee to evaluate chemical engineering programs and to publish a list of those institutions whose programs satisfied the recommended criteria (Prados et al., 2005).

ABET has certain criteria that are required for the deemed accreditation by an institution and comprises a total of eight of them including: (1) Students, (2) Program Educational Objectives, (3) Student Outcomes, (4) Continuous Improvement, (5) Curriculum, (6) Faculty, (7) Facilities, and (8) Institutional Support. It is the responsibility of the program(s) seeking accreditation to demonstrate effectively that their particular programs meet these criteria (Anon, 2014). The accreditation criteria used to evaluate all American engineering programs have been discussed and revised extensively since 1996 (Felder and Brent, 2003). Among the eight different ABET criteria, the first one is the students (criterion 1) which is a crucial element in the accreditation process, moreover student outcomes, which is the third criterion, which is a set of eleven outcomes that are required to be practiced by all engineering graduates. According to (Shuman et al., 2005), gaining mastery of the professional skills is an important factor in the future success of engineers as global problem solvers. The outcomes, a-k, are divided into two categories in which a set of five "hard" skills and the other set of "professional" skills that emphasize the qualities of good communication, teamwork, and understanding ethics. Some awareness skills on the other hand, such as lifelong learning and a knowledge of contemporary issues are also regarded as part of the complete professionalism criteria important for an engineer (Shuman et al., 2005; Koehn et al., 2009).

Nevertheless, limited work in literature has been dedicated to bring about the implementation of these qualities into engineering students of different disciplines (Felder and Brent, 2003). It is well understood that equipping students with the specified educational and professional outcomes must begin at the individual course level whereby the faculty members instill the accreditation elements into the contents of the course. Usually much attention is given to assessing outcomes, and hence providing students with thorough curriculum awareness. It is crucial that students are aware of the specific skill set they are expected to learn according to the ABET 3 (a-k) criteria. A coherent curriculum formulated by the faculty members and cooperative learning environment helps students to achieve more. There are some present works in the literature that have attempted to establish this awareness, for instance, (Guilbeau and Pizziconi, 1998) described the importance of practicing ethical and social responsibilities in professional settings by increasing awareness of the codes of ethics and improving on communication skills such as oral and written presentations. Also, (Manseur, 2003), addressed some updated ABET requirements that

fosters broad educational skills to help achieve department-stated outcomes and objectives. And, (Koehn et al., 2009) presented the level of student understanding of typical contemporary issues held by the engineering students. Moreover, regional studies (Attiyah and Khalifa, 2009; Al-Alawi et al., 2009; Aldowaisan and Allahverdi, 2015; Aldowaisan and Allahverdi, 2016) have also been conducted previously, including the recent survey conducted in the mechanical engineering department at UAE University in 2009 (Mourad and Selim, 2010).

The College of Engineering at the United Arab Emirates University (UAEU) was inaugurated in 1980 and comprises of five academic departments including Architectural Engineering, Chemical Engineering, Civil Engineering, Communication Engineering, Electrical Engineering, Mechanical Engineering, and Petroleum Engineering. All programs offered in the college were first accredited by ABET in 1998 and since then have been involved in ongoing ABET accreditation visits and revision cycles (Mourad and Selim, 2010). Assessment of the student outcomes (3a-3k) have been thoroughly discussed in the literature (Felder and Brent, 2003), however implementing it to equip students with these specific outcomes is lacking and hence needs greater attention. In view of the above, this paper aims to obtain information quantitatively through a thorough questionnaire about the students' awareness towards the ABET accreditation.

## METHODOLOGY

A comprehensive survey (shown in Table 1) has been developed by the authors to assess the awareness of ABET accreditation and criterion familiarity amongst the chemical engineering students in UAEU. The designed survey includes general information on ABET such as general concept, specific ABET criterion, program outcomes and the advantage of having an accredited degree. As part of the department's continuous effort in improving the chemical engineering program offered at UAEU, the authors aim to equip its students with a better knowledge of ABET. The questionnaire was distributed to all levels of chemical engineering students. The study population involved 105 students (30 males and 75 females).

## RESULTS AND DISCUSSION

The survey was designed to mainly evaluate the general knowledge that students had regarding ABET, their outlook on the different course outcomes (a-k) and their feedback for further improvement into the awareness. The questions (1 to 5) were aimed to measure the basic awareness of ABET, such as knowing the role of the ABET accreditation and its merits. The

**Table 1.** Designed questionnaire on the awareness of ABET among UAE University chemical engineering students

<b>The Designed Questionnaire on the awareness about ABET</b>			
<b>Chemical Engineering Program</b>		<b>United Arab Emirates University</b>	
<b><u>Students Awareness about ABET</u></b>			
<p>Thank you for responding to our request. We want to assure you that <i>your name and your individual responses will be kept confidential</i> and will be used only for the purpose of improving the undergraduate curriculum. Your help is greatly appreciated.</p> <p>Instruction: In case you would have any questions about the questionnaire, please contact Dr. Abdulrahman Alraeesi (<a href="mailto:a.alraeesi@uaeu.ac.ae">a.alraeesi@uaeu.ac.ae</a>) or Dr.A.S. Mohammad Mozumder (<a href="mailto:a.s.mozumder@uaeu.ac.ae">a.s.mozumder@uaeu.ac.ae</a>).</p>			
<p>=====</p> <ul style="list-style-type: none"> <li>• <b>Name/ ID:</b>.....</li> <li>• <b>Department:</b>..... <b>Year in Program:</b> 1<sup>st</sup>/ 2<sup>nd</sup>/3<sup>rd</sup>/4<sup>th</sup></li> <li>• <b>Secondary School Grade:</b>.....</li> <li>• <b>Current GPA:</b>.....</li> </ul> <p>=====</p>			
<p>1- When was the first time you heard about ABET? <u>Just today/month ago/last year/2 years ago/since I'm at University</u></p> <p>2- Do you know what ABET stands for? <span style="float: right;">Yes      No</span>            If yes, please state:.....</p> <p>3-The home country of ABET organization is: UK or USA or UAE (circle the correct answer)</p> <p>4- Do you know about the main job of ABET? <span style="float: right;">Yes      No</span>            If yes, please state:.....</p> <p>5-Do you know any example of student's benefit if his/her department get accredited by ABET? <span style="float: right;">Yes      No</span>            If yes, please state: .....</p> <p>6- Have you met with the ABET representative in their last visit? <span style="float: right;">Yes      No</span></p>			
<b>7- Are you AWARE of the following ABET outcomes you should have acquired by the time of your graduation?</b>			
	Very much aware	Some	Not aware
a. Thorough grounding in chemistry, physics, biology, math and engineering subjects such as fluid mechanics, thermodynamics, heat transfer, mass transfer, and reaction kinetics; and the ability to apply knowledge of these subjects in chemical engineering practice.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. An ability to design and conduct different chemical engineering experiments, as well as to analyze and interpret data.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. An ability to analyze, design, and control a system, component and/or process dealing with fluids handling, separation, and chemical/biochemical reactions to meet desired needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. An ability to work and interact effectively in groups/teams which have diverse personalities, cultures, and backgrounds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Ability to identify, formulate, and solve chemical engineering problems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. An understanding of professional and ethical responsibility	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Ability to develop effective oral, written, and interpersonal communication skills.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Ability to evaluate the potential risks, i.e. consequences and probabilities of engineering solutions which may affect society and the environment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. A recognition of the need for and an ability to engage in independent-learning and life-long learning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. A knowledge of contemporary issues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k. An ability to use of computer software such as spreadsheets, mathematics packages, word processors, and design packages in solution of chemical engineering problems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Table 1. Continue

8- Are you aware of the course syllabi content other than the grades distribution?	Yes	No
9- Do you focus on the course outcomes, listed in the syllabus?	Yes	No
10- Please indicate which three outcomes in the list above that you feel are the most important for success in your engineering career (use 3 letters): .....		
11- Based on your training experience, please suggest any other courses or improvements that should be incorporated in the core curriculum to meet the market's current and future needs: ..... .....		
12- After filling out this survey, do you think that you now know about ABET better than before? Yes No		
13- From the following, choose three options that could be helpful in improving students' awareness about ABET accreditation?		
a) Attending lectures on ABET		
b) Brochures		
c) Attending ABET activities		
d) Through Chemical Society activities		
e) Highlighting a-k into the exam questions		
f) Attending workshops on ABET		

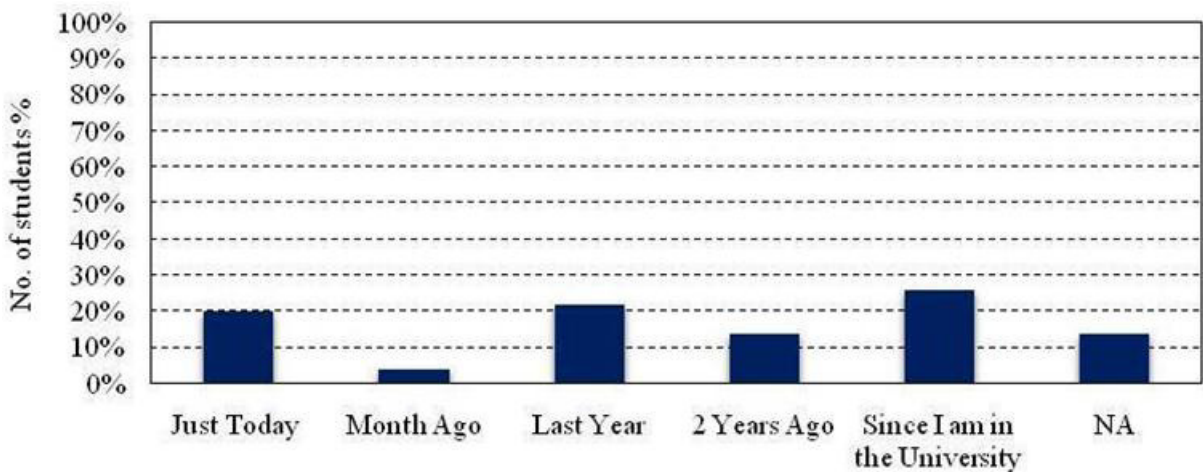


Figure 1. Response to: When was the first time you heard about ABET?

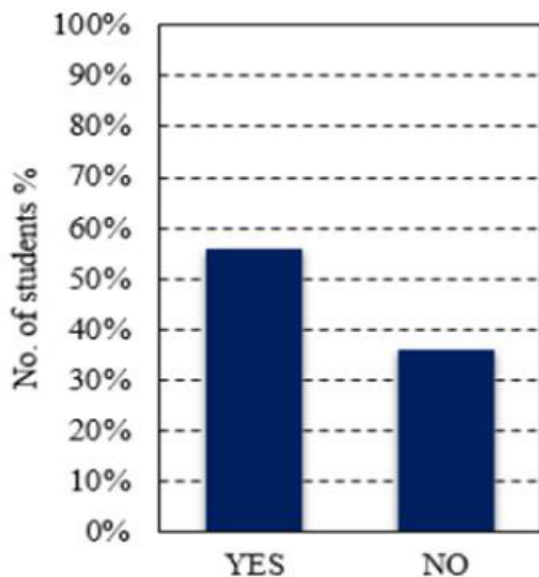


Figure 2. Response to: Do you know what ABET stands for?

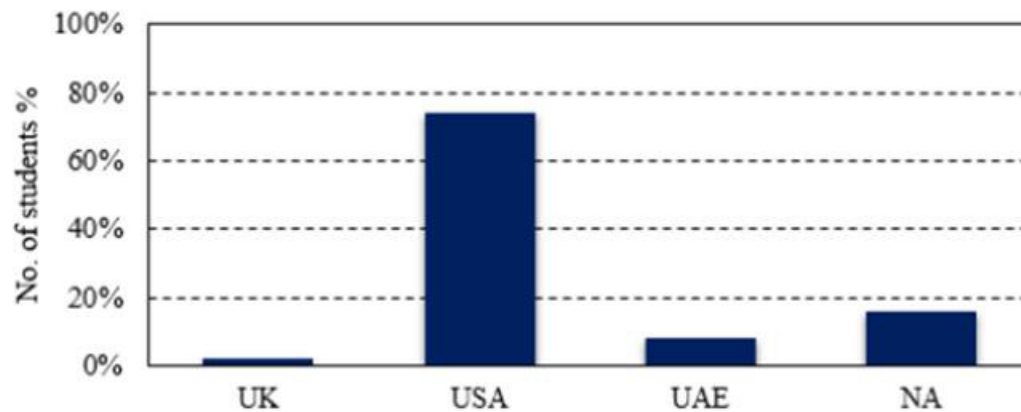


Figure 3. Response to: The home country of ABET organization is?

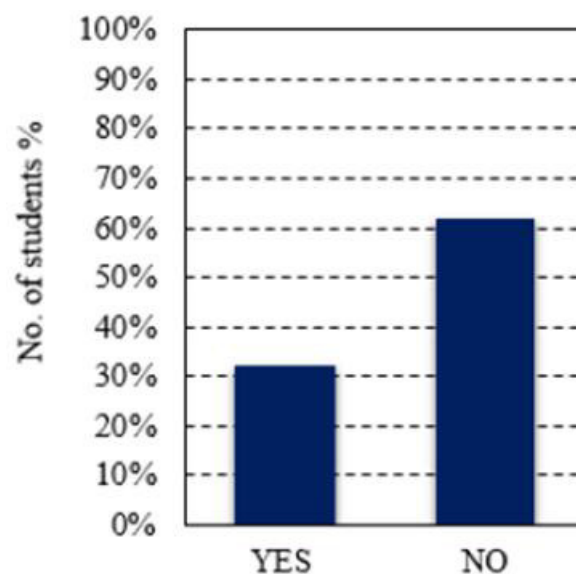


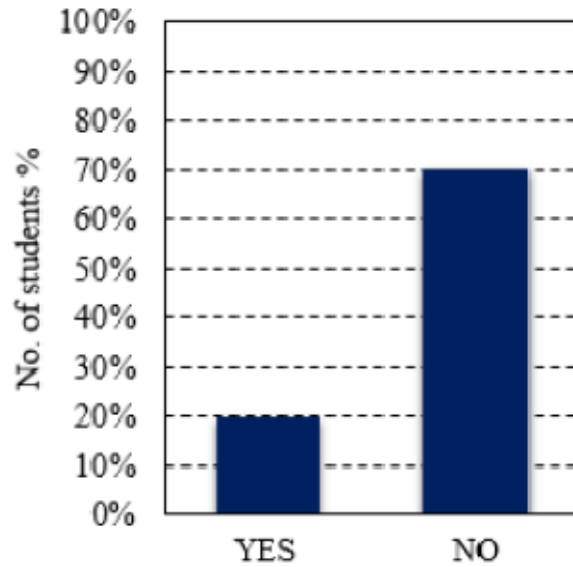
Figure 4. Response to: Do you know about the main job of ABET?

response to the first question (When was the first time you heard about ABET?) is presented in Fig. 1; although the 26% of students had heard of ABET since they joined university, there was also a considerable 20% of students who have just learned about it through this survey. This response itself is a useful indicator to show that although there is some awareness, much more improvement is required. Moreover, 56% of the students indicated that they were aware of what ABET stands for (Figure 2) which clearly indicates that at a department that has been accredited by ABET, almost half of the student body are still not aware of this important recognition. In the similar context, survey by (Mourad and Selim, 2010) at the mechanical engineering department in UAE University in 2009 reported that almost 68% of the students were not aware of ABET, whereas our current study at chemical engineering program in the same university has revealed this unawareness percentage to be 44%.

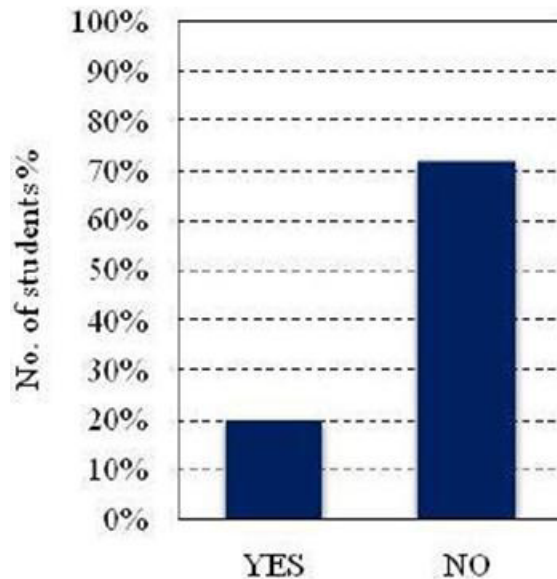
However, a favorable response was received when students were asked about the home country of ABET

(Figure 3), as high as 74% of them answered correctly by selecting USA as compared to a previous study at the same institution where the correct response was selected by only 53% of the students (Mourad and Selim, 2010). However, about 62% (Figure 4) of students indicated that they did know about the main responsibility of ABET, which can be translated as a strong motivation for further efforts by the faculty members of the department and the college itself to provide students more information about the program they are studying in.

It has been discussed in the literature (Sala et al., 2011; Culver et al., 2005; Mourad and Selim, 2010) that incorporating an understanding of ABET criterion along with the study material helps students achieve more not only academically, but also fosters professional growth elsewhere. In line with the above statement, students were asked if they were aware of any benefits that they have if their program/department is accredited by ABET, the response of which is presented in Figure 5, majority of participants (70%) indicated they did not know any of



**Figure 5.** Response to: Do you know any example of student's benefit if his/her department gets accredited by ABET?

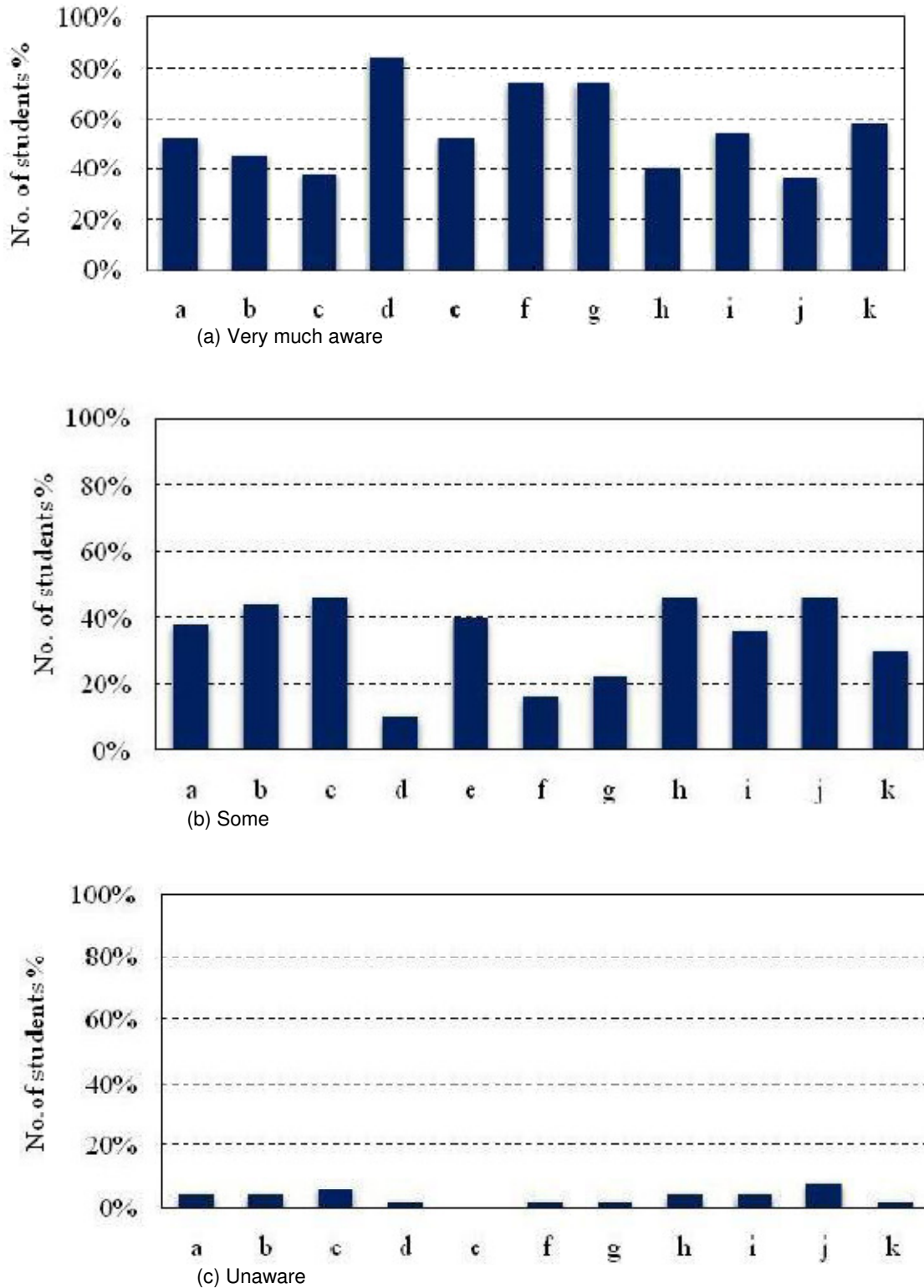


**Figure 6.** Response to: Have you met with the ABET representative in their last visit?

the benefit they might have by studying an ABET accredited program. This is an alarming finding in such a way that although a good number of the students are superficially aware of ABET (shown in the responses of the previous four questions), more than two-third of the students are actually unaware of the key benefit(s) of ABET accreditation in which they are to be much more interested.

The revised ABET criteria (Anon, 2014) encompasses all major aspects of student development into an

engineering and technology program by providing coherent curricula that are designed to meet the professional goals of the students. Students of the chemical engineering department at UAEU were also asked if they ever met with a ABET representative, the responses according to Figure 6, show that 72% had never not met with the ABET representative, although there were at least one mock and one actual ABET team visit last year. And it is implied that the more the students would be involved in the ABET accreditation process the



**Figure 7.** Response to: Are you AWARE of the following ABET outcomes you should have acquired by the time of your graduation?

more they would be aware of its criteria and benefits. This is another pointer that could be improved when the future ABET visits are to be scheduled for the

chemical engineering program.

Since its revision in 2000, the notion of ABET accreditation has been broadened to be a continuous

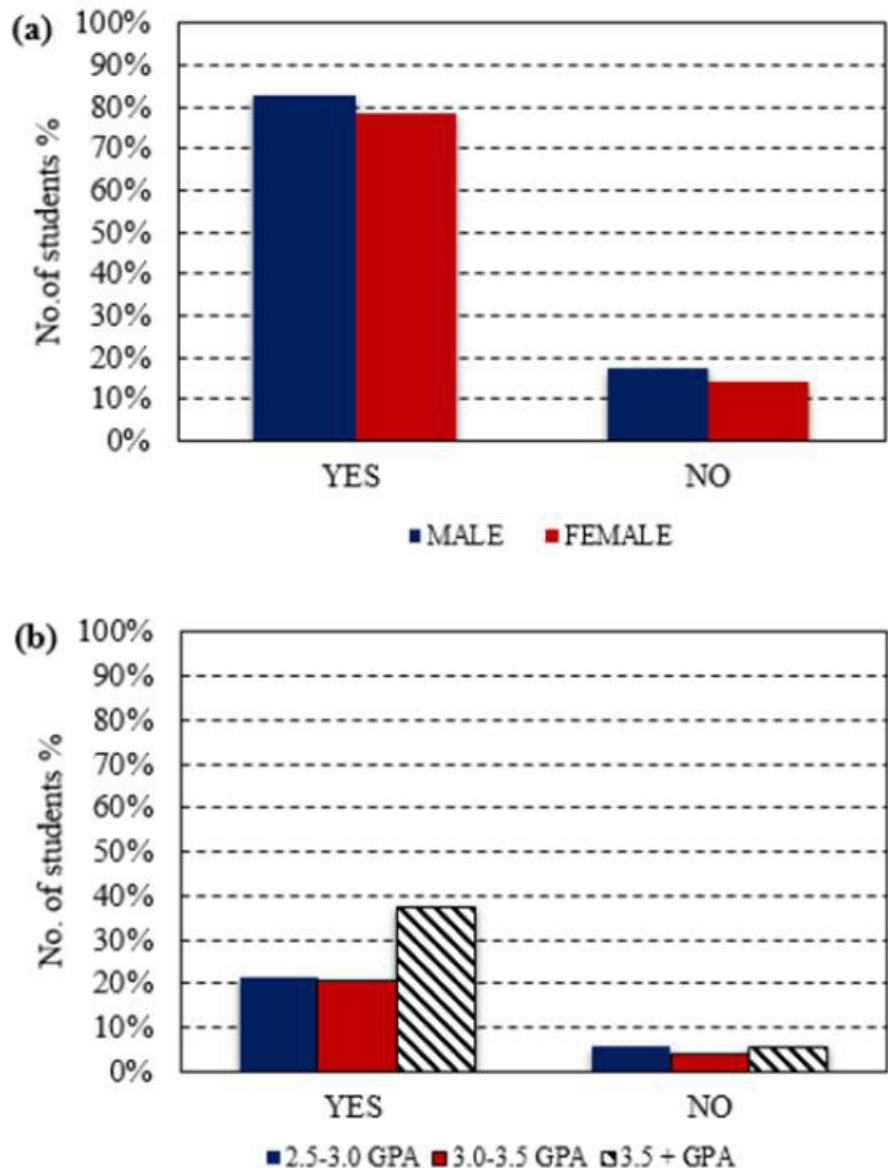
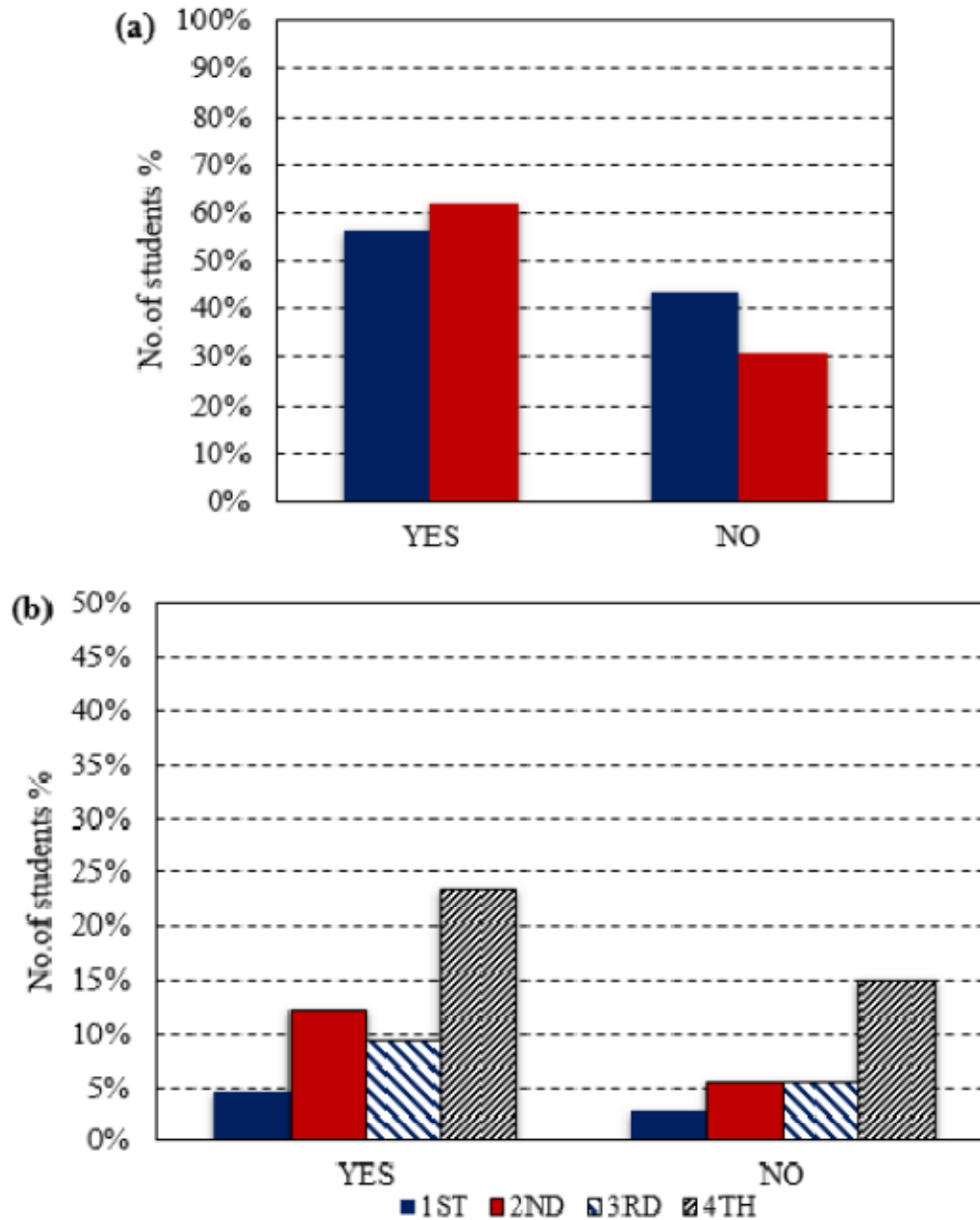


Figure 8. Response to: Are you aware of the course syllabi content other than the grades distribution? Sorted by; (a) Gender (b) GPA

process of development and improvement, rather than a mere examining committee focusing solely on the curriculum (Felder and Brent, 2003). It is common knowledge that ABET consists of eight criteria, out of which first three are mainly discussed for the performance assessment of engineering students that measure the growth of students based on different aspects of their learning experience at the university. Criteria 1 and 2 deal with students and program educational objectives, respectively, that ensure the students are made well aware of their curriculum and are being consulted with regarding their career goals, while the educational objectives ensure the specific program's outcomes align with the institution's mission statement. The third criteria, student outcomes, commonly

referred to as "a-k" that outlines the scope of outcomes the student must achieve at the end of their studies (Anon, 2014).

Students in this survey, were asked about their awareness of the specific outcomes they need to acquire by the end of their studies, each of the 3a-3k criteria was assessed according to three responses: (a) very much aware (b) some (c) not aware. These are presented as bar charts in Figures 7 (a)-(c). Among these results, it was interesting to find that most students in the first response "very well aware" responded well to the interpersonal development as they were pertaining to outcomes d, f and g in which 84%, 74% and 74% students responded, respectively. On the other hand, lowest response amongst Figure 7 (a) was for criteria "j"



**Figure 9.** Response to: Do you focus on the course outcomes, listed in the syllabus? Sorted by: (a) Gender (b) Year of study

with a response of only 36% students. Moreover, about 46% was the highest response for criteria “c” and “h” for which the students chose “some” as their answer; lastly, it was found that very few students were unaware of the program objectives, highest students (8%) responded to outcome “j”. These results indicate that the chemical engineering students are well aware that they have to acquire the ability to work in group (criterion d) in professional and ethical framework (criterion f) and effectively (i.e., both orally and formally) (criterion g) communicate with their group members and others in the organization. Although these skills are very important for someone to succeed in his/her career, it is somewhat

frustrating that our future graduate are unaware of the key outcomes covered in almost all the chemical engineering core courses such as their ability to implement their basic science and engineering knowledge (criterion a) in designing chemical processes and units (criterion c) and solving chemical engineering problems (criterion e), to evaluate potential risks of running a chemical process and to assess its impact on the environment (criterion h). Moreover, the survey respondents are not also aware of contemporary issues related to chemical engineering (criterion j). Therefore, serious measures should be taken into consideration in order to increase students’ awareness on criteria a, c, e

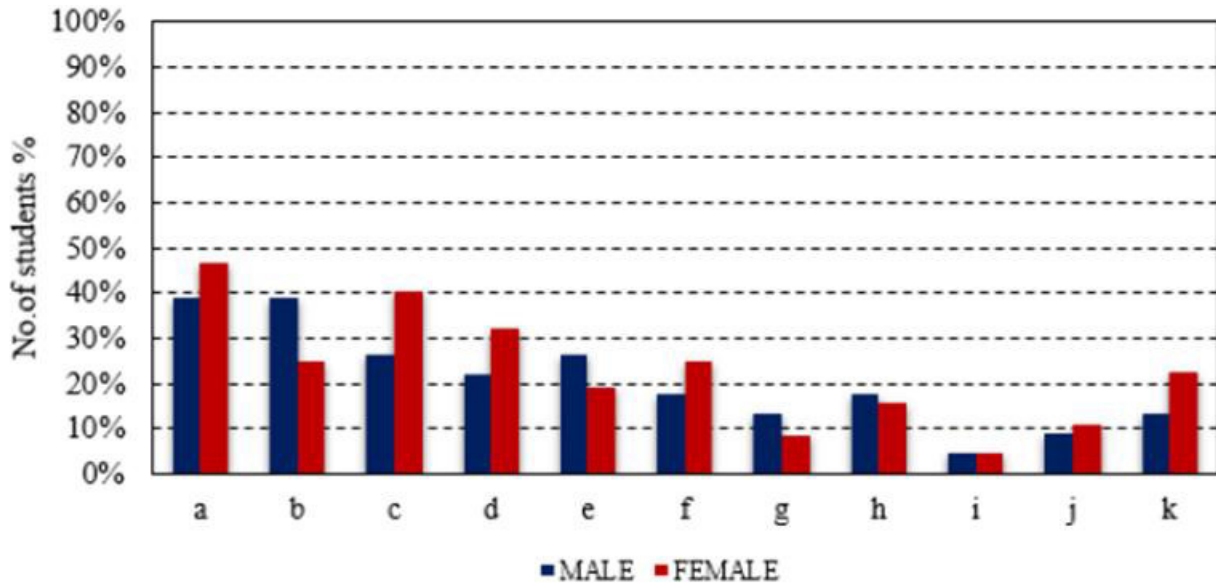


Figure 10. Response to: Please indicate which three outcomes in the list above that you feel are the most important for success in your engineering career

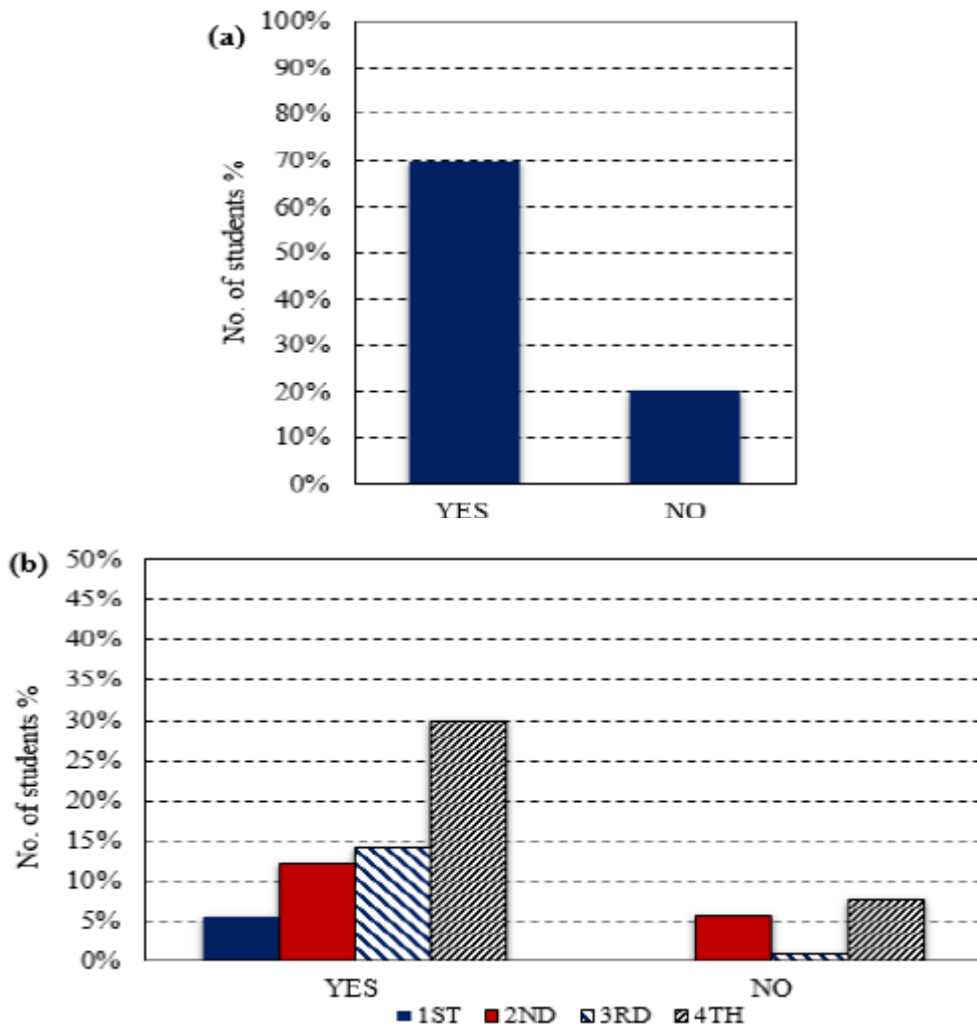
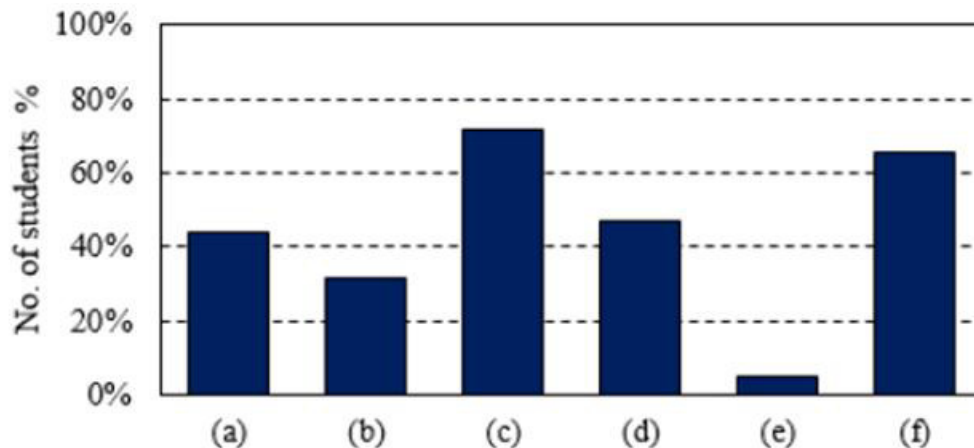


Figure 11. Response to: After filling out this survey, do you think that you now know about ABET better than before? Sorted by; (a) Overall response (b) Year of study



**Figure 12.** Response to: From the following, choose three options that could be helpful in improving students' awareness about ABET accreditation? (a) Attending lectures on ABET (b) Brochures (c) Attending ABET activities (d) Through Chemical Society activities (e) Highlighting a-k into the exam questions (f) Attending workshops on ABET

and j; otherwise, we may not be able to produce enough competent chemical engineers who would eventually lead the industry.

Students were also asked questions pertaining to their knowledge about the course syllabi and course outcomes that are outlined and explained in the beginning of each courses, students' response to this question is presented in Figure 8. It can be inferred from Figure 8 (a) that majority of the students (approx. 80%) were aware of the other parts of syllabi besides the grade distribution, which is a key factor of consideration since the course outcomes and the expected skills are important for the students to realize when they finish the course. Interestingly, in both the responses, male students have a slightly higher response rate than female students, for those in agreement, male students represented as 83% while females as around 79%. Among those who responded as not being aware, males are 17% while females are 14%. In Figure 8 (b) it is noticed, as per the general expectation, that the most students who are aware of the different syllabi content have the grade point average (GPA) of over 3.5 out of 4.0. This indicates that toppers take the course syllabi contents (i.e., learning objectives and outcome) more seriously than the average students.

In the similar context, students were asked about their knowledge of the course outcomes that are carefully outlined in their course syllabi and textbooks; survey responses are illustrated in Figure 9. It is noticed in Figure 9(a) that most of the students focus on the course outcomes (57% male students and 62% female students) and female students are more serious on course outcomes than their male counterpart. Figure 9 (b) depicts the fact that the senior students (i.e., 4th year) are more focused on the course outcomes.

Figure 10 includes the survey responses on the importance of the different ABET (a-k) outcomes to the students. The collective responses suggested that

criterion "a" (*an ability to apply knowledge of mathematics, science, and engineering*) was selected as the most important criterion in their engineering career development, while criterion "i" (*a recognition of the need for, and an ability to engage in life-long learning*) received the lowest response and was, therefore, the least relevant to their career. Moreover, out of the eleven criteria (a-k), seven have received higher response percentage of female students than male. As a comparison, the study conducted by (Mourad and Selim 2010) indicated that most students agreed with criterion "k" being the most relevant to their professional goals, while criterion "j" received the least number of responses. However, ABET requires all the criteria to be thoroughly covered in the departmental courses.

Moreover, the students were asked to provide some suggestions that were needed to ensure the program's outcomes and to improve students' abilities to meet the requirement of the current industry. We found that approximately half of the students responded with some comments (52%). This was an important part of the survey since obtaining specific feedback directly from students helps tailor the program requirements effectively according to students' needs. Majority of responses raised a good point of involving more practical and hands-on training for the course materials they study, so the students can realize the real life applications of the concepts they study. Also, emphasis on including advanced engineering software(s) that are used in workplace was also suggested by the responders.

Proceeding towards the end of the survey, authors found it imperative to ask students whether their awareness about ABET are improved through this survey; the responses are shown in Figures 11 (a) and (b). The results revealed that most of the responders agreed that they learnt more about ABET through this survey, Figure 11 (a) suggests that approximately 70% of

the respondents agreed to have learnt more about ABET, furthermore, Figure 11(b) shows that the highest responses received are from 4<sup>th</sup> year students (30%), least from the 1<sup>st</sup> year students.

The last question of the survey is aimed to receive some feedback on the type of activities that can be held to promote awareness of the ABET accreditation so that the students may fully make the best out of their program. Options (a)-(f) as seen in the survey (see Methodology) were given and their responses are shown in Figure 12. About 68% and 66% students responded that attending ABET workshops and participating in ABET activities, respectively, would possibly increase students' awareness on ABET accreditation, while a very low percentage of students (10%) agreed that highlighting "a-k" outcomes in exam papers would help.

## CONCLUSION

In the present study, students of the Chemical Engineering Department at UAE University participated in a survey that is designed to gain information regarding the students' knowledge on the ABET accreditation, its benefits and expected outcomes. The responses are collected from 105 male and female students studying at various levels of their studies and are analyzed in light of the relevance between the course outcome (a-k) and the course syllabi. The results of the survey indicated that the chemical engineering students at UAEU are not very much aware of the role and benefit of ABET accreditation in their program of study. However, senior year students and particularly, the female students and toppers are more focused with course outcomes and course syllabi content. It is also noticed that although the responders are familiar with some outcomes (d, f and g), they lack awareness to the key criteria such as a, c, e and j. Therefore, encouraging students to attend ABET related lectures and workshops and involving them into ABET activities are recommended to improve their awareness and understanding about ABET and its accreditation process. Indeed, ABET accreditation is not only central to the department but also is essential for the students so that they can take the full advantage of the resources for their long term career development.

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