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EMBEDDING EMPLOYABILITY SKILLS INTO FIRST YEAR UNDERGRADUATE STUDENTS TO ENHANCE GRADUATE CAPABILITIES

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Abstract: *Taylor's University Taylor's Graduate Capabilities (TGC) was created in 2007 to enhance university-level education to meet the ever-changing demands of industry, community and globalization. It is important to universities to produce graduates who can demonstrate their employability. In line with the TGC, a undergraduate chemistry course was selected and this study described how the course was designed to develop employability skills among students. The skills that aimed to be inculcated into students including the ability to retrieve and apply knowledge in practice, problem-solving, communication, team work and presentation. The delivery of this course was conducted through experiential learning. As part of the course assessment, the students were required to complete a chemistry project. The project was assessed according to three parts: chemistry product, poster presentation and final report. In details, the product was assessed based on creative design and functionality. The poster presentation was assessed based on the structure, creative design and communication of the chemistry idea. Finally, the final report was based on the student's area of research within the project such as an overview of the idea of the project, recommendation, improvement and reflection of the process. A questionnaire was conducted at the end of the course to gather students' feedback and perception on employability skills that aimed to develop in this course. Results from the questionnaire showed that students demonstrated that the class and laboratory activities greatly helped them in acquiring employability skills such as problem-solving, team-working, time management, presentation and analytical skills. In conclusion, the design of the chemistry module has achieved the aim of embedding employability skills in student learning. The skills developed here are ones which they will use through their working life.*

Keywords: *Employability Skills, Chemistry, Graduate Capabilities*

Introduction

Employability skills can be promoted in all disciplines including Chemistry. Some of the strategies to increase the employability skills of Chemistry students include extensive hand-on experimental work, design and research projects, oral and written presentations and group work. In 2007, Taylor's University created Taylor's Graduate Capabilities (TGC) to enhance university-level education to meet the ever- changing demands of industry, community and globalization. Taylor's Graduate Capabilities aimed to help the students to achieve the capabilities of lifelong learning, thinking and problem-solving skills, communication skills, interpersonal skills and digital literacy. In line with the Taylor's Graduate Capabilities, this study describes how a Chemistry module was designed with the aim to inculcate employability skills into undergraduate students. The aim of the study was to develop a project-based work for a chemistry course that would reflect the nature and methods of chemistry, as well as tailor the course so that the graduates would be equipped with the necessary employability skills.

Literature Review

In today's education, it is important for universities to produce graduates who can demonstrate their employability. The graduates must be competent in marketable skills or employability skills, such as problem-solving, ICT and time-management skills. These skills prepare graduates for the future, for a constantly changing global labour market and society. Recent articles had highlighted the issues of employability among science graduate (Overton and McGarvey, 2017; Sarkar et al., 2016; Lowden et al., 2011; Hanson and Overton, 2011). A report in 2008 showed that employers were less interested in the academic achievement of their degree and more interested in soft skills or transferable skills such as team working ability and communication from their employees (Archer et al, 2008). Recent shifts in education and labour market policy have resulted in universities being placed under increasing pressure to produce employable graduates (Bridgstock, 2007). University institutions are not simply a place of transfer of knowledge. Instead, it is a place for the students to develop the skills to allow them to fully participate in the university learning experience and to enhance employability (Gerrard et al., 2005). This showed that employability skills in graduate are important considerations when a company is recruiting graduates. Hence students need to do more to prepare themselves to be effective in the workplace.

A number of models of employability have been proposed. A straightforward, practical model of employability was produced and can be used as a framework for working with students (Dacre Pool and Sewell, 2007). One study defined employability using the USEM (Understanding, Skills, Efficacy, and Metacognition) approach (Yorke and Knight, 2006) while some defined employability as having a set of skills, knowledge and personal attributes that make a person more likely to secure, and be successful in their chosen occupation (Hinchcliffe, 2001). Hillage and Pollard defined employability is about having the capability to gain initial employment, maintain employment and obtain new employment if required (Hillage & Pollard, 1998). According to Hillage and Pollard, an individual's 'employability assets' comprise their knowledge (i.e. what they know), skills (what they do with what they know) and attitudes (how they do it). For the individual, employability depends on the knowledge, skills and attitudes they possess, the way they use those assets and present them to employers and the context (e.g. personal circumstances and labour market environment) within which they seek work (Hillage & Pollard, 1998). Another model of employability focussed on decision making skills, opportunity awareness, transition learning (job searching and presentation skills) and self-awareness (Scott and Yates, 2002).

Previous work has found that graduates and employers have mixed reviews about which skills and knowledge areas are more important once graduated for science students (Madewell et al., 2003). According to a study, some of the fundamental skills in many scientific endeavors included problem solving, the design of experiments, oral presentation, data analysis and being able to critically analyse results (Coil et al., 2010). Previous studies had provided some insights on the perceptions of employability skills among chemistry students (Galloway, 2017; Hanson and Overton, 2010). A study done by Hanson and Overton in 2010 highlighted a list of degree skills and classified them as chemistry or generic skill sets (Hanson and Overton, 2010). A study in 2017 showed that generic and employment skills were the most common skills that chemistry students wished to gain in order to enhance their career prospects (Galloway, 2017). Chemistry students are usually unprepared for employment upon graduation as they lack some of these employability skills (Hanson and Overton, 2010; Salman et al, 2012; Sarkar et al., 2016). Despite the fact that these issues have been occurred for many years, there has been little study that focused on the development of these work-related skills within the chemistry curriculum. Several models and underlying frameworks of implementing employability skills into chemistry had been published (Chadha, 2006; Windsor eta l., 2014; Tsaparlis, 2016).

Methodology

This chemistry course (General Chemistry I with laboratory, CHEM 105) was offered every semester in American Degree Program (ADP), School of Liberal Art and Sciences, Taylor's University. In Spring 2017, 15 undergraduate students were enrolled in this course. This course was implemented using blended-learning approach, a mix of face to face (70%) and online (30%) learning. The online learning was conducted using Taylor's Integrated Moodle e-Learning System (TIMeS), the learning management system (LMS) in Taylor's University. The online module site was designed using the R.A.S.A. Model (Hsiung, 2018a). The online learning was used to complement or enhance the classroom face to face learning. Students were required to bring their own device (BYOD) to class (laptop, tablet or smartphone). The face to face teaching sessions were designed to be more workshop-based, allowing the instructor to act more as a facilitator rather than a didactic teacher, and the students to be more in control of their own learning, using problem-solving activities. The active learning puts the responsibility on student and encourages the student to learn.

This course involved the study of basic chemistry phenomenological laws as well as their applications, matter, atomic structure, stoichiometry and chemical bonds. The objectives of this course were for students to understand the chemistry concept and apply them in real word examples. The assessment tasks in this course consisted of final examination (30 %), quizzes (30 %), laboratory (20 %) and a group and individual task (20%). A group-based project (worth 20 % of the module total) was designed based on one of the topic (Thermochemistry) in this course. In this topic, students are required to understand the concept of energy, types of energy, heat transfer and energy changes in chemical reactions.

The students worked in small groups of three or four members, which they selected themselves, and were asked to design and build a novel chemistry product. The theme of chemistry product for this year is solar cooker. The objective of this project is to let students explore on how solar energy can be used to cook food and the concepts of heat transfer. Students are required to design and build an efficient and effective solar cooker that maximizes the use of their materials and their environment. The cooker must collect and store as much of the sun's energy as possible. The built model was used to illustrate and explain the chemical phenomena of heat. Students can use whatever raw material and tools needed for their solar cooker. Extra marks will be given to students if recycle items are used to make the solar cooker. The students were given three weeks to do their research before they develop their model in the chemistry laboratory. No teacher supervision is allowed during the building of the solar cooker. This task is to be done in group and students are to work collaboratively. The groups were required to present their work explaining the chemistry product. The solar cooker will be tested under the sun. The functionality of the solar cooker will be evaluated. This is done by placing a volume of water inside the solar cooker that placed under the sun. The initial temperature is measured and the temperature is measured every hours to record the temperature change. This project consisted of group related task (collaborative research on the prototype and building of the solar cooker in the laboratory) and individual tasks worth 60% (poster presentation and reflection of the group process).

The group task (worth 40%) is based on the development of the solar cooker and it was assessed according to the following criteria: (1) content knowledge, (2) material used, design and innovation, (3) functionality and (4) teamwork. Table 1 showed the rubric for the solar cooker experiment. The individual task (worth 60%) consisted of two parts, poster presentation and personal reflection. Each student is required to communicate the chemistry concepts of solar cooker using poster and write a short reflection about the project. A questionnaire was conducted at the end of the course to gather students' feedback and perception on employability skills that developed in this course.

Table 1: The Scoring Rubric For Solar Cooker

	Poor (1-2)	Fair (3-5)	Good (6-8)	Excellent (9-10)
Content knowledge	Shows little thought process of project. Color is the only thing being considered in design process.	Shows a little more thought process. Shows knowledge concerning conductors.	More thought process in the design aspect of project. Shows knowledge concerning conductors and insulators.	Exceptional thought process evident: Shows understanding of all the concepts: insulators, conductors, color, design showing how to trap heat inside and heat transfer.
Material used, design and innovation	Solar cooker design shows no creativity. Oven was poorly constructed. Little or no effort. No recycle materials were used.	Solar oven shows little creativity or originality. The solar oven was adequately constructed and shows some effort. The design shows little recycle materials.	Solar design is somewhat original and creative. The construction was adequate and shows good effort. Some recycle materials were used.	Solar oven design is original and creative. The solar oven was well constructed and shows lots of effort. The design was innovative and totally built by using recycle materials
Functionality	Oven does not raise temperature above the surrounding temperature	Oven functions by raising the temperature slightly above the surroundings	Oven functions pretty well reaching very high temperatures	Oven functions extraordinarily well reaching the highest temperatures.
Teamwork/ Contribution	Little or no teamwork. One	Minimal teamwork. Work load not	Adequate teamwork. Demonstrated	Excellent teamwork as demonstrated by superior

	person did all the work.	divided evenly, or one or more group members did not do their part.	sufficient communication, job division, and commitment to completing project. Work load divided evenly	communication, problem-solving, and commitment to completing project. Work load divided evenly

Results

As shown in figure 1, a total of four models of solar cooker were designed and built by students. Initial temperature of each model was recorded, and they were put outdoor under the sun to measure the temperature change over eight hours from 9:30 am to 5:30pm. Figure 2 showed the temperature change at different times of four models of solar cooker. According to the results in figure 2, initial temperature of the four models was 28 ˚C and solar cooker model 2 showed the highest recorded temperature of 78 ˚C. This was followed by model 1 (64 ˚C), model 3 (56 ˚C) and model 4 (53 ˚C). When compared to other groups, group 2 demonstrated the highest level of understanding in the concepts of heat transfer and successfully built an efficient and functional solar cooker that trapped most of the heat from the sun. Figure 3 showed an example of poster designed and created by student using PowerPoint presentation.

A questionnaire was given to students to gather students' feedback and the results were analysed. Results showed that majority of students benefited from the class and laboratory activities such as lecture, online learning in TIMeS, group discussion and project work. The students found these activities greatly helped them in the chemistry course. Several questions or statements were included in the questionnaire and the students were required to answer them based on a scale of 1 (strongly agree) to 5 (strongly disagree). The students' response was captured and depicted in figure 6. Most of the students responded positively to the questions. Comments from students were captured and summarized in table 2.

Figure 1: Four Models of Solar Cooker Were Designed and Built by Students

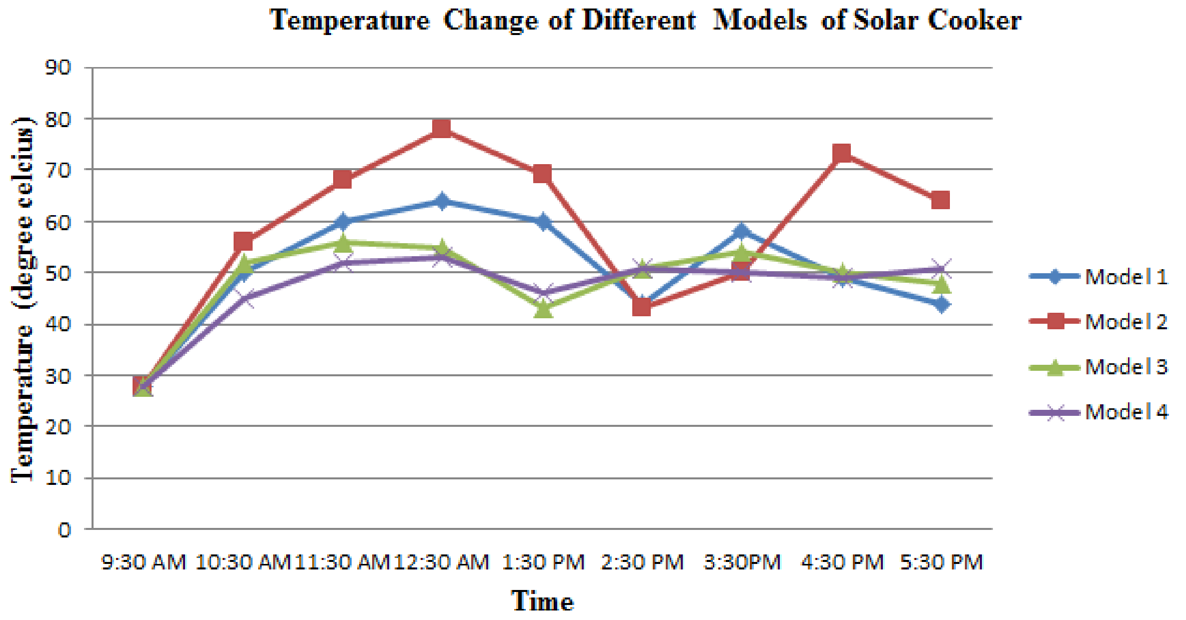

Figure 2: Figure Showed the Temperature Change at Different Times of Four Models of Solar Cooker that Designed and Built by Students

Figure 3: Figure Showed A Solar Cooker Poster that Designed by Student

Figure 4: Figure Showed the Feedback of Students on The Class and Laboratory Activities in Helping Them in The Chemistry Course

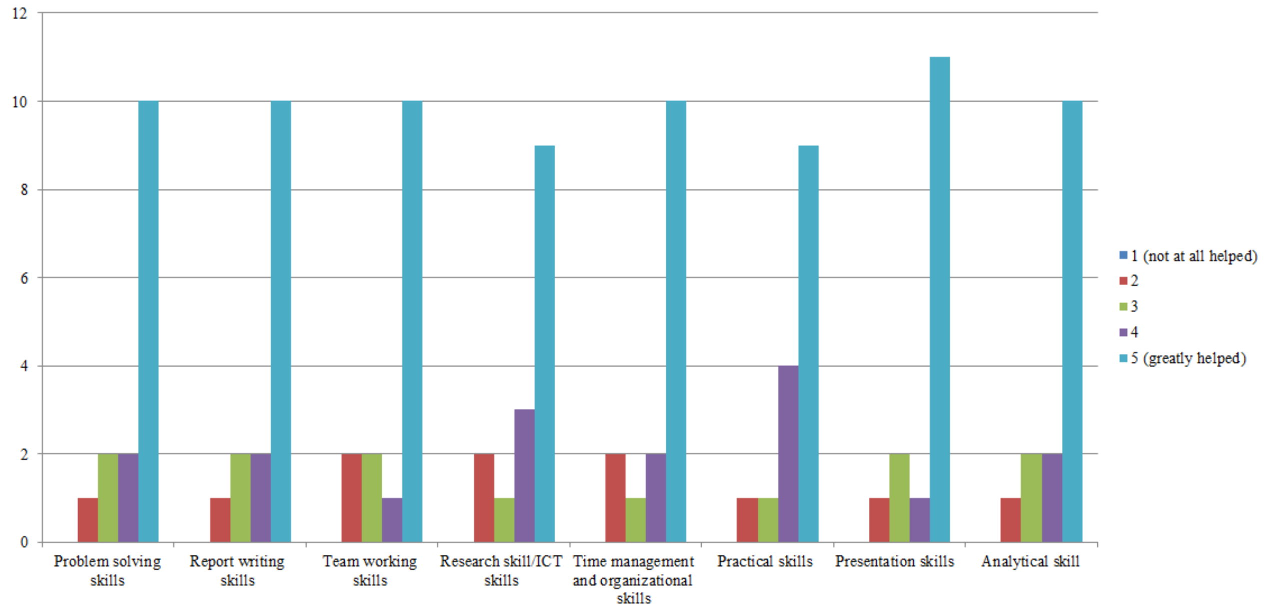

Figure 5: Figure Showed the Feedback of Students on The Skills that Developed in The Chemistry Course

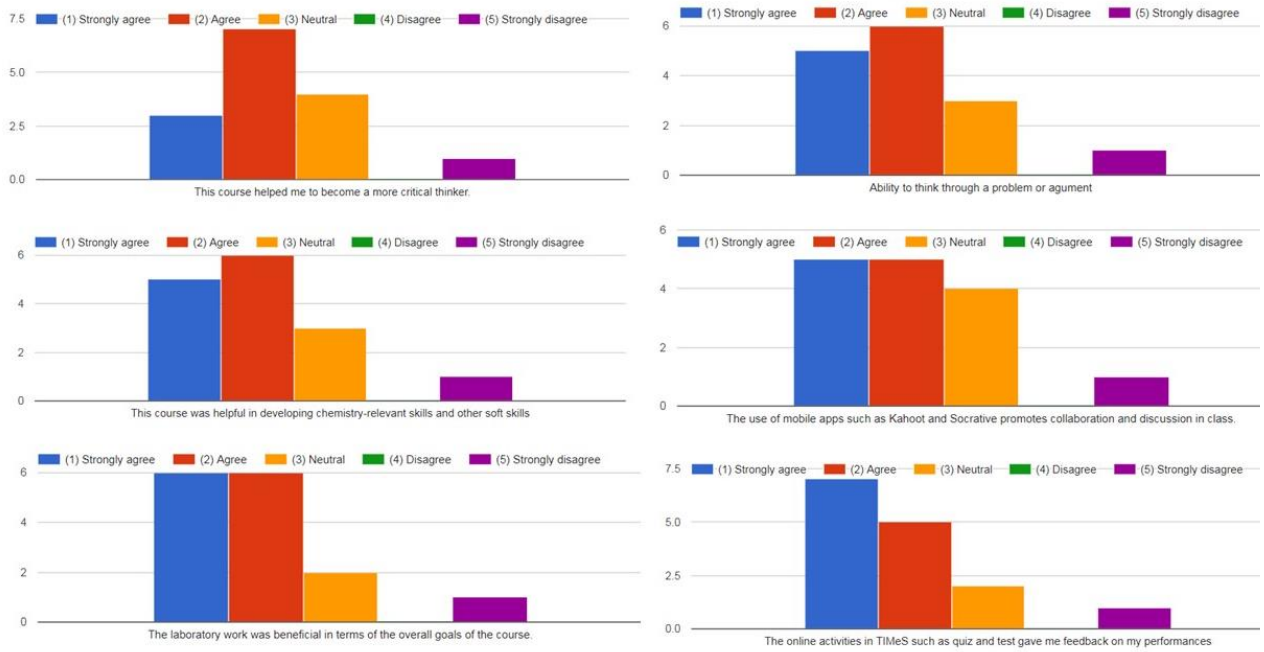

Figure 6: Figure Showed The Results of The Questionnaire

Table 2: Table Showed the Comments from Students on The Questions in The Questionnaire

Questions	Comments from the students
This course helped me to become a more critical thinker.	“Class was interactive and helped a lot in understanding, developing my passion and skills for the subject” “The assignments and quizzes helped me to think more critically” “I've learned how to solve questions which are not straightforward” “The exercises provided from lecturer trigger my brain to think critically” “I can think more critically after conducting the experiment” “I am able to think of how chemicals can combine with each other or neutralize each other as well as what will be produced when the reaction comes to a stop” “This course helps me to think critically”
This course was helpful in developing chemistry-relevant skills and other soft skills.	“Lab works helped me to build chemistry related skills. It teaches me how to do work hands on” “I am more confident to conduct experiment after taking this course” “I am able to comprehend basic chemistry skills that may be need for my further studies in higher chemistry subjects or other science subjects” “I have learned what chemistry is about, what the chemist are doing daily and the understanding of units and the interaction between atoms and molecules” “I learned new thing about chemistry that is the electron configuration which is never taught in high school” “I am able to better understand more about atoms, theories and other things that I would not have without taking this course”

The laboratory work was beneficial in terms of the overall goals of the course.	“Lab work helped us to understand chemistry better as it was more practical” “It taught me how to do hands on work” “I know more about chemistry while conducting the experiments” “Lab experiments helps me to remember the results of the experiments which helps to answer in written test” “I was able to visualize how the chemical reactions would look like and what they would produce”
Ability to think through a problem or argument	“This course taught me how to communicate with my teammate in team group work” “My problem-solving skills improved through this course because of the questions done in class” “During lab experiments, came across with certain results and it is fairly arguable” “There would be a theory or law that would explain things we experience daily. Thus, if my friends were to ask something chemistry related, I would be more intelligible in my answer”
The use of mobile apps such as Kahoot and Socrative promotes collaboration and discussion in class.	“It was extremely helpful. Provided with better understanding” “Kahoot is my favorite, it is fun when we play it in class” “Socrative helps me to be able to answer structured questions When someone picks a wrong answer, lecturer would explain the question and discuss with us” “Socrative allows me to answer structural questions” “It provided me a more fun and intuitive method of learning that I thoroughly enjoyed”
The online activities in TIMeS such as quiz and test gave me feedback on students’ performances.	“It helped me a lot because when there's some difficult quiz I will ask my friends for help” “In TIMeS, it helps me a lot to answer questions during examination” “I can know whether I was giving the wrong or correct answers through the online activities” “This subject was greatly interactive and fun, therefore helped me to gain more interest and passion for Chemistry” “TIMeS helped me to understand the concept of the multiple-choice questions in written test and prepared me for the test” “I was able to monitor and track my progress on how much I was learning, and which subjects I was lacking in”

Discussion

Many university graduates were not able to impress employers during interviews because they did not have the right skills such as communication and presentation skills. In addition, they cannot contribute to the company once they start work because they are not “work-ready”. Unfortunately, Malaysian universities are not producing “work-ready” graduates because the country’s education system is too exam-oriented. Based on the perspective of employers, academic and vocational qualifications alone are not enough to ensure a graduate’s employment. A graduate need to demonstrate personal competences to secure employment. This shows that a balanced and well-rounded graduate more marketable. In view of that, this study aimed to embed employability skills in first year students to enhance their graduate capabilities. The chemistry module is now well established, but it is important that each learning outcomes is clearly explained and linked to employability, otherwise the students begin to question why they are doing it. Based on students feedback, the activities had successfully embedded the desired employability skills into their learning.

The delivery of this course was conducted through experiential learning, where students actively take part in the learning process. The face to face session in class focused more on student activities instead of lecture. Example of instructional techniques used include group project, student polling and discussion of results and facilitated group discussions with open-ended questions. This module had demonstrated how to leverage cutting-edge technologies to create innovative learning environment in a “dry” Chemistry subject and transformed traditional ways of teaching (Hsiung, 2017; Hsiung, 2018a; Hsiung, 2018b; Hsiung, 2018c). For example, the use of interactive game-based learning and engaging classroom response system (CRS) such as “Kahoot” and “Socrative” could transform traditional teaching methods in Chemistry. As shown in the questionnaire, majority of the students loved these technologies as they created a fun and engaging learning experiences. The online activities consisted of interaction chemical lesson, animation, simulation and online quizzes. They can help explain complex and difficult concepts more clearly than a printed textbook or PowerPoint. Simulated exercise also allows the students to visualize step by step chemical calculation. These online activities increased students’ understanding and provided them with valuable feedbacks.

As employers regard the ability to work in teams as one of the most desirable graduate attributes, students with experience of group working are thought to be better prepared for the workplace (Hall and Buzwell, 2012; Chapman et al., 2006). Published studies had showed that generic skills were less well developed than the discipline-specific knowledge and skills within degree programmes (Hanson and Overton, 2010; Sarkar, 2016). In this course, students were trained to work in group. They were given group assignment, group projects and group experiments. Most students liked group working. This kind of work and project-based learning make an important contribution to the development of employability skills. For example, the students developed problem-solving skills when they were given a task to build a functional solar cooker. The laboratory and project work enabled the students to demonstrate their capacity for synthesizing knowledge and applying it in practice. These works also trained their team working and communication skills. They learned the ways to work well with others. They were also learned to respect individual differences, listen to and consider all team members’ ideas. Group work also allowed the student to exercise leaderships as they were participated as team leaders or effective team members in project assignments. Students were given opportunities to communicate chemical ideas in when the students created their project using PowerPoint presentation and presented their project using poster. Other advantages of working in group include: a better understanding of the topic, an increased level of engagement and sharing of workload. Working in collaboration with others also helped the students to know more about themselves. For example, working together in designing and building of the solar cooker help each student identify his or her own strengths and weaknesses.

After the class and lab activities, the students were also asked to reflect on their experience and identify skills that they had developed during the activities. The student perception of several employability skills was evaluated and summarized in figure 5. It is noteworthy that a large number of students confirmed that class and laboratory activities greatly helped them in acquiring employability skills, such as problem-solving, report writing, team-working, time management, presentation and analytical skills. It can be seen that the majority of the students showed a greater awareness of these skills and a higher expectation of its use in their future occupation. As shown in figure 5, students rated transferable skills (problem-solving, team working, time management, presentation and analytical skills) higher than subject-specific skills (research and practical skills). This showed that these transferable skills were more valued by the students.

Conclusion

Overall, this chemistry module seems to have achieved its purpose in engaging students in developing employability skills, especially group work and presentation skills. By the end of the semester, there were improvements in their problem solving, critical thinking and team working skills as the class and laboratory activities had greatly helped in becoming a more marketable graduate. This study also made them aware the types of skills they will need to demonstrate when seeking employment.

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