Enhancing Knowledge Transfer Experience Through Computer-Aided Design, Virtual Learning Environment and Community Engagement

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Abstract

Knowledge Transfer Program for the construction and maintenance of integrated farming utilizing aquaponics system has been conducted between Universiti Malaysia Pahang, the local school community partner (Al-Irsyad Islamic School) and science school Sultan Haji Ahmad Shah, Kuantan. The knowledge transfer approach was a blending between the use of Computer-Aided Design (CAD), Virtual Learning Environment (VLE) and active (hands-on) participation of the university students and community members to enhance the knowledge transfer experience. Teachers, school students and university final year industrial biotechnology students have participated in the program. The trainer used a free 3D design Google Sketch Up to enhance spatial (3D) understanding of the students in the essential components of the device and the working mechanism. The trained university students were also assessed using Moodle internet-based Virtual Learning Environment (VLE) that has been actively used by academics in UMP. Subsequently, the final year university students applied the knowledge they have learned and trained during the weeks by engaging the local school students in the Knowledge Transfer Program activities (workshops). A total of fifty-six (56) university students have engaged and trained 98 secondary school students (47% female, 53% male) with age from 13 years old (26%) to above 16 years-old (13%). It shows that 93% of the students agreed to have received new skills (basic aquaponics system construction) by this outdoor and hands-on Knowledge Transfer activities, conducted by the senior (university) students. The data also indicated that 82% of the students have an increased appreciation to science due to the application and peer-demonstration of the system. From the video recorded, the school students were able to construct aquaponics system in a team environment without receiving further assistance. This indicates that hands-on and teamwork constructions of a product or technology have significant impacts to the cognitive learning (understanding) in Knowledge Transfer activities.

Keywords: Aquaponics, Blended learning, Virtual Learning Environment (VLE), Knowledge Transfer

1. Introduction

In this era of digital information, teaching tools and learning resources have now become more widely available and accessible to both students and academics to use. This opens a possibility to create a blended and more engaging / stimulating learning experience for students to increase their understanding of a particular topics or concept given during the class. Some of the tools to achieve this objective are the use of free and easy to use '3D design' to improve students spatial abilities - particularly for engineering and science students, as well as internet-based Virtual Learning Environment (VLE) that students can use at their own pace. In addition, hands-on experience and an opportunity to verbally communicate the knowledge learned in the class to other people, such as the local community, would enhance student understanding and learning experience.

Many of the problems that academics face during the teaching and learning exercise include lack of motivation by the students to learn which could be derived from the lack of understanding for a particular topic or concept being taught in the class or (to be fair with the students) could also be due to monotonous teaching practices given by the academics. In this paper, the author will briefly describe the implementation of 'Blended and Active' students-centred learning tool as one of the teaching innovations or methods which could be used to minimize the problems described.

2. Blended and active approach

Blended and Active students learning experience (**Figure 1**) refers to the use of multimedia (such as 3D design, animation and video), interactivity using online 'open learning platform and assessment tools (VLE)' such as Moodle, as well as active hands-on participation of the students. The later can be implemented during the classroom / laboratory session or preferably outdoor in the form of 'community engagement' within the framework of *Knowledge Transfer Program* for community which has been used by the author to teach some courses or subjects in our faculty. In this paper, the author will briefly describe the key features of the innovative teaching practices and show some of the results of implementation and impacts they have given to the students as well as to the local community. The main benefits and impacts for the students are briefly listed in **Figure 1**, which include increased spatial understanding, creative and innovative thinking as well as hands-on and communication skills.

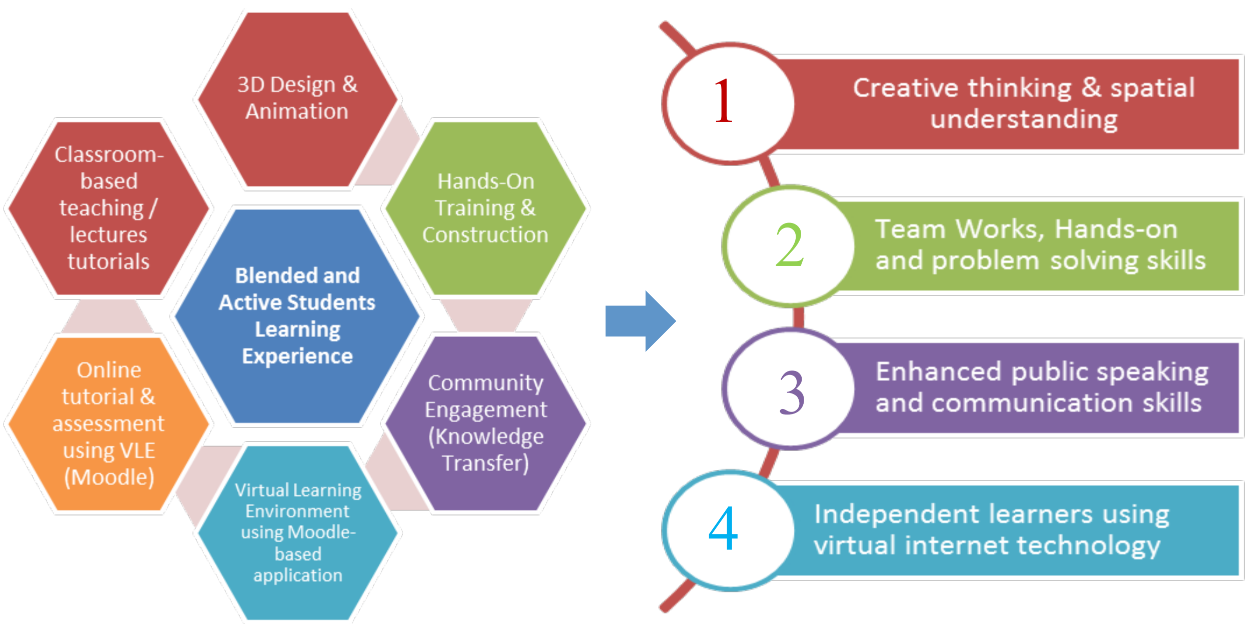

Figure 1. '*Blended and active*' student learning approach.

3. Educational theories and practice

According to the "*Multiple Intelligences*" educational theories put forward by Howard Gardner in 1983, there are at least seven (7) ways or types of peope in the world that learn and understand the knowledge better. This was described by the theorist as the *seven intelligences*. Of the most relevant theories to this paper are the '*visual-spatial*' intelligence, '*body-kinesthetic*' and '*interpersonal*' intelligence such as the ability to work with others in a team to achieve a common objective. In addition, the innovative teaching practice described in this paper is in the same idea with the *Partnership for the 21st Century Skills* (US Department of Education and MacArthur Foundation and individuals such as Henry Jenkins, Mimi Ito and John Seely Brown who proposed the idea (learning theory) that in this increasingly digital and connected age, skills necessary for students to master and experience success in school and life include digital literacy, traditional literacy, media literacy, content knowledge, and learning / innovation skills.

In practice, students taking the engineering and science courses that involve devices (such as biosensor, biomedical or biotechnological devices) could be expected to obtain a full or better understanding of the concept and the device if the teaching facilitators (teachers, lecturers or presenters) use a 3D design and animation tool to illustrate the concept and the system. In particular, this teaching tool helps increasing students spatial understanding of the object. One of the easiest, free and widely-used 3D design software is *Google Sketch Up*. It comes with full online video tutorial for the users to build various 3D objects from scratch. The video tutorials are also widely available from YouTube that have been uploaded actively by community. Alternatively, the free software comes with an online community-based library (or warehouse) of 3D objects which the users can download and use freely (for modification, adjustments, etc.) for non-commercial or educational purposes.

In this paper, we will provide example of activities that enhance the knowledge transfer program based on the educational theories put forward by Howard Gardner (1983).

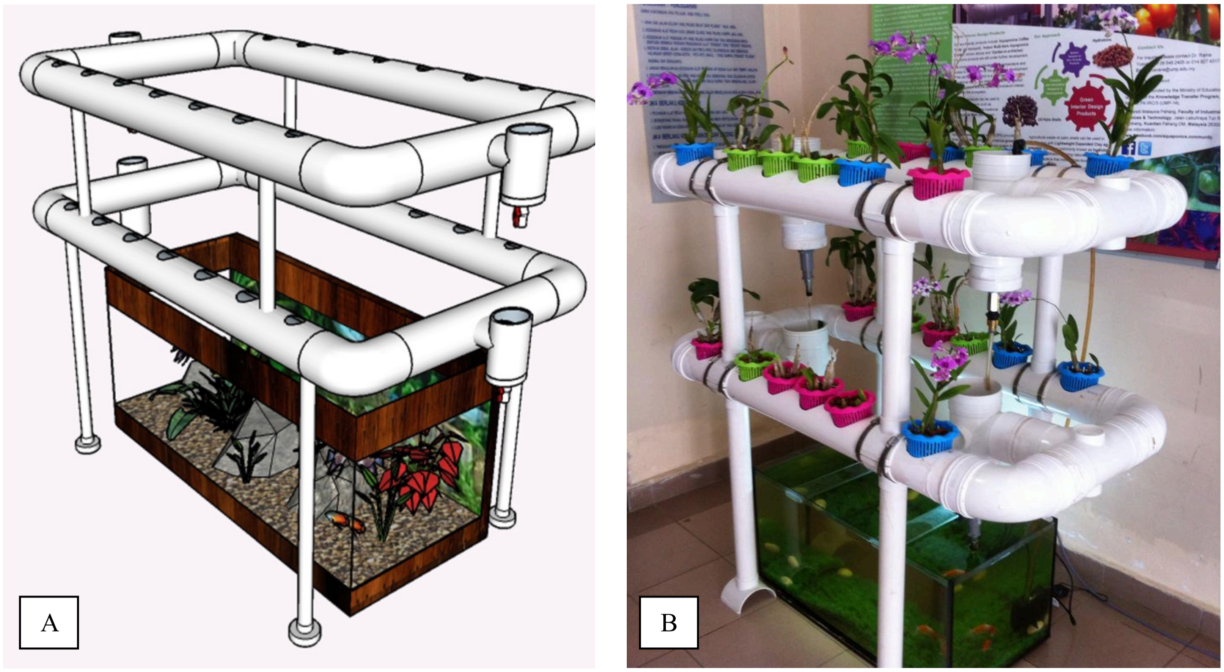

Figure 2. Example of implementation from a '3D design' of an indoor aquaponics orchid-growing kit (A) to the construction of the actual object (B). *Google Sketch Up* can be used to enhance teaching and learning experience as proposed by the *Visual-Spatial* inteligence theory (Gardner, 1983).

3.1. Enhancement through computer-aided design for visual-spatial intelligence

Figure 2 shows an example of 2D snapshot (image) of a 3D design that the author has used in the classroom. The object (**Figure 2**. Part A) was designed using *Google Sketch Up* and constructed in real-life by the students (**Figure 2**. Part B). *Google Sketch Up* can be used to enhance teaching and learning experience as described in the *Visual-Spatial* inteligence theory (Gardner, 1983). People with high visual-spatial intelligence are good at remembering images, faces, and fine details. They are able to visualize objects from different angles. This in turn enhances their understanding of an object, instrument or devices. From the photo of the real object (**Figure 2** Part B), it is clear that students were able to duplicate the 3D object design with high similarity with only minor differences due to unavailability of parts (e.g. the foot of the legs, the orientation of dispose channel (left and right, etc).

Students can also improve their visual-spatial intelligence by exploring the 3D design object. As a consequence, they are able to accurately judge the distance between object geometry and visualize the project that includes design and creativity. A research study has shown that students' appreciation of three-dimensional molecular structures differs according to the kind of representation used. The best results were achieved with the use of concrete, and pseudo-concrete types of representations (e.g. three-dimensional models, their photographs, computer-generated models). However, the use of more abstract types (e.g. schematic representations, stereochemical formula) was less effective (Ferk *et al*, 2003).

In addition, during the construction of the 3D device (such as aquaponics system), students develop their team work and hands-on skills.

3.2. Enhancement through body-kinesthetic learning activities

Gardner (1993) defined characteristics of bodily-kinesthetic intelligence as including: using one's body in highly differentiated and skilled ways, for expressive and goal-directed purposes. In addition, working skillfully with objects, both those that involve the fine motor movements of one's fingers and hands and those that exploit gross motor movements of the body. It is also suggested that controlling bodily motions and the capacity to handle objects are characteristics of body-kinesthetic intelligence.

In relation to this theory, **Figure 3** shows outdoor activities of the students developing the product that include training or briefing by the instructor, building up the system (construction) and finally assessment of their affective and psychomotor domains through direct observation and following a specified rubric

Figure 3. Hands-on training of UMP students for the construction of a portable aquaponics system followed by assessment of the students affective and psychomotor domains for organizing, conceptualizing and team-work as well as their hands-on (motoric) skills as proposed by "*Body-Kinesthetic*' learning theories (Gardner, 1983)

assessment system. This is in addition to classroom teaching of the theoretical materials and functionalities of the device.

3.3. Enhancement through interpersonal intelligence

Interpersonal intelligence as described by Gardner (1993) is the ability to understand and interact effectively with others. It involves effective verbal and non-verbal communication, the ability to note distinctions among others, sensitivity to the moods and temperaments of others, and the ability to entertain multiple perspectives. People with interpersonal intelligence are good dealing with other people and thrive well in social interactions. They are good at reading, empathize and understanding others. They are good at working with others and have many friends. They learn best through interaction and dialogue.

In relation this educational theory, the next step following assessment of the students affective and psychomotor domains, is to assess their communication skills by engaging with the local school community. This method further increases their (cognitive) understanding of the system while practicing / showing the construction of the system to other students. This is in line with the '*Interpersonnal*' intelligence also put forward by Gardner in 1983.

Figure 4 shows students of Universiti Malaysia Pahang, Faculty of Industrial Sciences and Technology under Industrial Biotechnology program interacted with the younger (junior / high school) students explaining the concept of the technology (aquaponics) in an easy-to-understand language, under the framework of *Knowledge Transfer Program* for community funded by the Malaysian Ministry of Education (Grant Number: FK-IRC/3 (UMP-14), Period: 2014 - 2016).

4. Engagement with the local schools community

The result of community engagement by fifty-six (56) UMP Industrial Biotechnology students (2014 / 2015) has resulted in a positive impact to both groups of students. **Figure 5** shows some of the feedbacks from the school community indicating satisfactory (excellent) program has been given by the trained UMP students. From the data of 98 secondary school students (47% female and 53% male) with age ranging from 13 years old (26%) to above 16 years old (13%), it shows that 93% of the students agree to have received new skills by this outdoor and hands-on Knowledge Transfer activities conducted by students at university level (i.e. the UMP students)

The data also indicates (even only qualitatively) that

Figure 4. Engagement of the local school communities by the UMP students (2014 / 2015) under the *Knowledge Transfer Program* for Community. The schools shown are Al-Irsyad Islamic School Kuantan and Sains School Sultan Haji Ahmad Shah, Kuantan. The activity involves a total of 98 students from the local community.

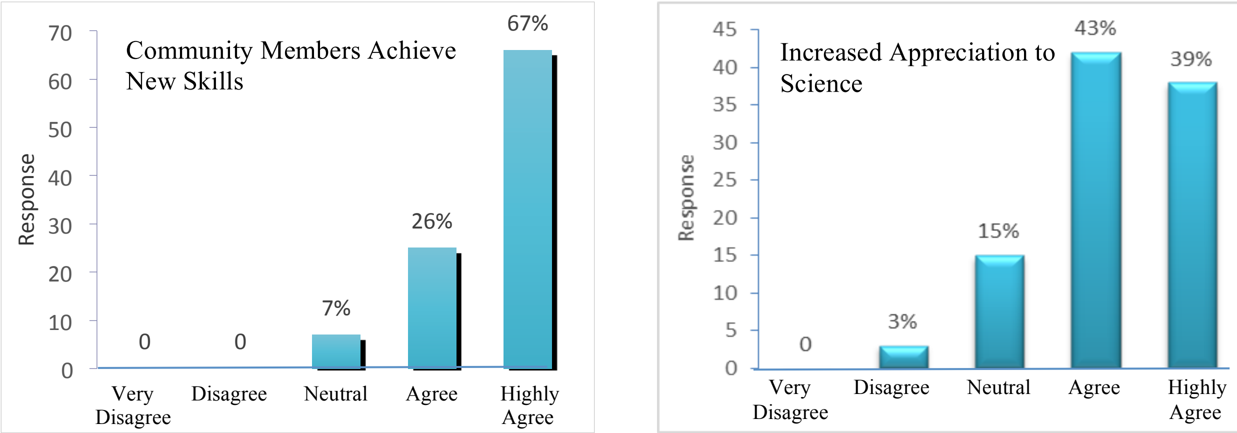

Figure 5. Qualitative response from the community in terms of (A) Knowledge Transfer performance as indicated by the achievement of new skills and (B) Increased appreciation to science

82% of the 98 secondary school students have an increased appreciation to science due to the application and peer demonstration of the system. From the video documentation that we have recorded, the school students were able to construct aquaponics system in a team environment without receiving further assistance from the UMP students. This indicates that hands-on and teamwork construction of a product or a technology have a significant impacts to the cognitive learning (understanding) of the students.

5. Virtual Learning Environment

The implementation of *Virtual Learning Environment* (via Moodle-based application) in UMP for teaching, learning and assessment in addition to normal (classroom-based) teaching session has only been implemented recently . The photo in **Figure 6** shows the use of technology (ICT) by the students for learning and assessment purposes. This is in line with the educational theories put forward by the partnership for the *21st Century Skills* (US Department of Education and MacArthur Foundation). The use of internet-based (virtual) learning environment (Moodle-based application) shows student's digital literacy, media literacy, content knowledge, and learning / innovation skills.

Figure 6. The use of ICT facility by the students for teaching, learning and assessment purposes as an indication of the student's digital literacy.

Typical sample of students performance as a result of blended and active learning approach including *Virtual Learning Environment* as implemented by the author last year is shown in **Figure 7**, with only 1 (or 2) problematic student appeared in each year due to various reasons such as failure to perform or attend the final exam, etc.

The use of *VLE* (*Moodle-based application*) for learning and assessment purposes allows academics in UMP (for example) to set the mode of quiz to be closed-book or open book. The open book quiz or tutorial could be conducted anywhere and anytime by the students within the time and duration specified by the instructor. However, the closed book assessment using internet-based (Moodle) application, must be conducted in a computer room where the examiner can invigilate the progress of the assessment (quiz or test). The results of these two different modes of assessment (closed-book and open-book) are expectedly quite different. **Figure 8** shows that many of the students achieve well (or high grade) under open-book quiz or tutorial. This is an expected results for tutorial type teaching or assessment. On the other hand, the result of closed-book quiz or test shows a more normally-distributed achievement by the students (*Gaussian* distribution).

Depending on the nature of the subjects, most lecturers in the Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang have implemented blended teaching and learning using *Virtual Learning Environment* (*VLE*). **Table 1** shows

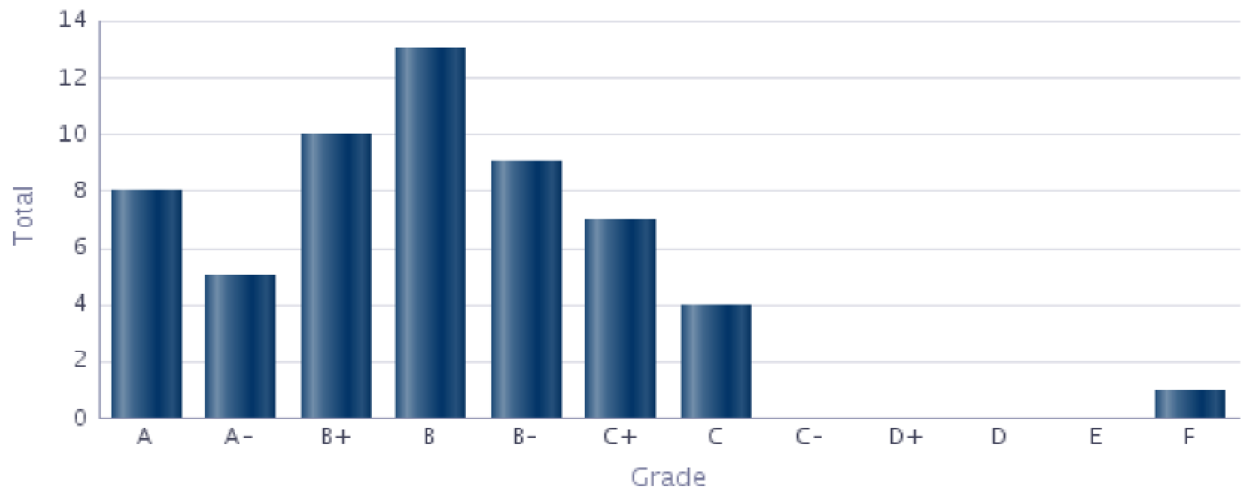

Figure 7. A typical (sample) of students' academic performance as a result of '*Blended Learning Environment*' conducted by the author in *Biomanufacturing* course (2014/2015)

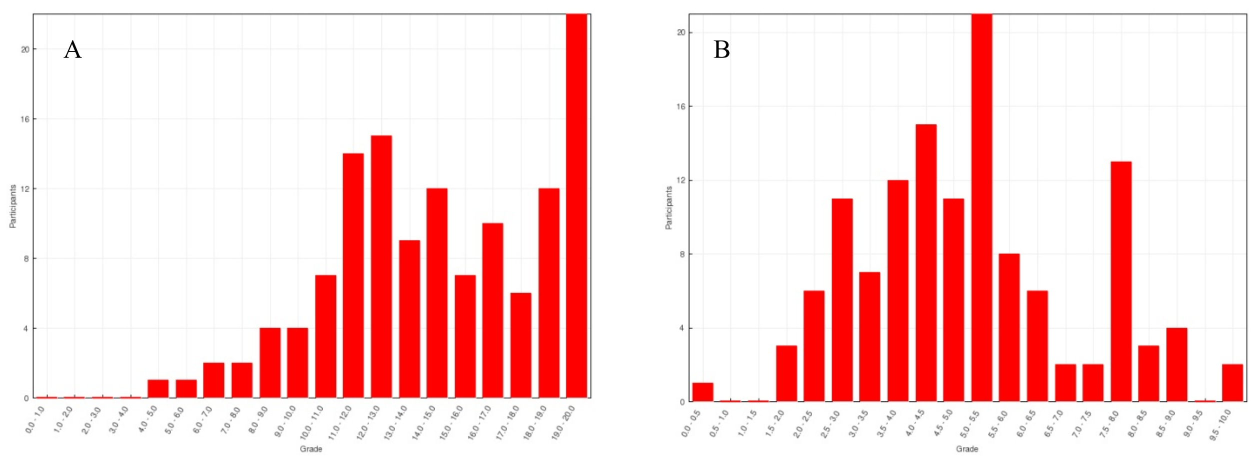

Figure 8. Typical results of assessment using internet-based Virtual Learning Environment. (A). Open-book quiz or tutorial. (B) Closed-book quiz

	Number	Percentage
Course Offered	90	100%
Course Offered achieved Blended Learning Mode	46	51%
CAP PSPTN Blended learning Mode Target	45	50%
Course Offered not achieved Blended Learning Mode	44	49%

Table 1. Summary of courses offered by the Faculty of Industrial Sciences and Technology achieving 'Blended Learning Mode' using Moodle-based application during Semester 2 Session 2014/2015.

Semester	Session	Category	Average Mark (%)	Average Index
2	2014/2015	Lecture	85	4.26
2	2014/2015	Laboratory	90	4.50
1	2014/2015	Lecture	87	4.35
2	2013/2014	Lecture	91	4.53
2	2013/2014	Laboratory	86	4.31

Table 2. UMP Students feedback / evaluation survey towards the overall teaching and learning activities (including the use of *Blended Learning System*) conducted by the main author[1]

the summary of the activity for Semester 2 Session 2014 / 2015. Due to confidentiality matters, detailed list of courses that have or have not met '*Blended Learning*' mode are not shown in **Table 1**. According to the Table, 49 % (or 44 courses) have not achieved blended learning mode in our faculty. These are mainly *Laboratory* courses which are offered in almost all core subjects, or alternatively *Industrial Training* courses and *Final Year Project* courses for four (4) main academic programs in our faculty.

Students Satisfaction (Evaluation) Surveys for teaching and learning activities for all academic members in the University Malaysia Pahang are also conducted regularly by the local academic administrator or authority in UMP. The result of implementing *Blended Learning* mode by the main author of this paper is summarized in **Table 2**.

From **Table 2** it can be seen that the use of *Blended Learning* mode for teaching and learning activities conducted by the author in the previous few semesters received an overall mark of around 87.8% from the students with an average index of 4.39. In general, 80% and above or an average index > 4 is considered as *good* performance. However, this statistics does not show the significance of '*Blended* and *Active*' learning approach to the overall performance shown in **Table 2**, nor it shows student satisfaction to the overall teaching and learning activity using the proposed '*Blended* and *Active*' learning approach.

6. Conclusion

It can be concluded that the use of *Blended and Active Students-centred Learning* approach gave a positive effect towards both the students and the community. The role of academics (lecturers and teachers) should mainly be the facilitator of teaching and learning activities. Students of all ages can now access all the information they need in the palm of their hands via the use of smart phones, tablets and computers connected to the internet. What students really need is the guidance that connects theoretical materials taught in the class to the real world application. The use of *Virtual Learning Environment* and 3D design tool as well as engagement with the (real world) community could enhance students early learning experience at school and at higher education institution.

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