Making the First Semester Your Own: Personal Experience and Lessons from a Chemical Engineering Freshman

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Abstract

There lies a sea of reviews and experiences on the progression from engineering students to diverse careers and countless other pursuits. Yet, less is mentioned about the actual student First Year Experience (FYE), in particular: relating to the context of engineering, and towards becoming advanced learners. In order to stimulate awareness and strengthen confidence among future learners entering undergraduate engineering programs, especially chemical engineering, this paper integrates three key aspects: a genuine reflection from an undergraduate engineering student on the first semester; how to benefit as much as possible from the very beginning at University, and most importantly, making the learning process suited to one's abilities. This is to explore more about how first year students can identify learning methods suited to their own strengths and a growing factor to their weaknesses. In addition, this paper intends to showcase a brief process in crafting and developing an initial engineering identity as a student, and advance to what is hoped to be a successful engineering education and career. I personally found my first semester at University of Technology Malaysia (UTM) to be inspirational and a boost to my love for all facets relating to elementary engineering know-how. Hence, through my writing, I share "true to life" experiences in my personal learning journey through the first semester at UTM. This will be entwined with lessons I learnt on how to gain the most from the start, shaping a mature mindset and much more. Ultimately, it aims to motivate fresh engineering students of the future, and display to them that in every step of the undergraduate journey, lies lessons, whether it be in their failures or successes.

Keywords: Developing an Engineering Identity, First Year Experience (FYE), Learning Process, Undergraduate, Education

Introduction

How can first year engineering students develop a suited identity, to rightfully explore the world of engineering from an early stage? This paper aims to investigate ways to answer this question. Around 30 million practicing engineers globally and 10 million Science, Technology, Engineering & Mathematics (STEM) students graduated in only China, India and the USA combined, for 2016 alone (McCarthy, 2017). This shows the incredible relevance, importance and popularity of the engineering and STEM-based disciplines. With the number of engineering graduates having grown by 1.44% in just one year (from 4.48 million in 2018 to 4.54 million in 2019) in the USA alone (Data USA, 2020), one question arises: Why choose an engineering degree, in a field which appears to be saturated?

The reason is because engineering prospects, in reality, are far from becoming saturated. Being one of the most diverse professions, engineers have been key players in both technological and mankind's advancements since the beginning of the industrial era to what is now being called the fourth industrial revolution of connected, digitized technology (Xu et al., 2018). Meanwhile, numerous types of engineering disciplines are present today (Elmogahzy, 2020), they include: aerospace; chemical and process; civil and

environmental; electrical and electronics; software; medical; and bioengineering among others (Cebr, 2016). Engineering interweaves STEM, economics, physical, natural and social sciences, humanities and much more. So, engineering truly means to build, construct & design things, and constantly improve their functioning and efficiency to solve societies' biggest challenges, while ensuring a sustainable route is followed (Rosen, 2012).

To put it into a clearer perspective, engineering can be defined as creatively applying a vast range of scientific principles in the real-world climate, and to "invent, design, build, maintain, and improve structures, machines, devices, systems, materials and processes" (Rosemberg et al., 2015). This not only allows capable engineering graduates to almost always transcend to another career, but also succeed in a variety of work environments, anywhere in the world. It is also because engineering-based applications integrate almost all types of proficiencies in the bigger picture of scientific formulations, design and practicability. Furthermore, with ever-growing technological efficiencies and development (Çalışkan, 2015), upcoming research prospects, combined with the cruciality towards controlling climate change, investing in space exploration, advancing in healthcare, creating more effectively designed

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machinery and systems that make life exponentially more secure amongst countless other missions, engineers are required to work across all these projects. In addition, it has proliferated the need for innovative solutions to intricate issues, thus the need for engineers in the global industrial, economic, agricultural, environmental and all other sectors (Rosemberg et al., 2015).

So, the initial story of an engineering student, which almost all engineers have been through in the beginning of their education, training and career, needs to be studied and explored. This is to raise awareness on the central, yet delicate process of developing an engineering identity, which has to match and be molded individually. As a result, molding a finely tuned engineering identity, which differs person-to-person, is crucial in the way great engineering and scientific innovations arise. Most importantly, knowing about the learning processes that will help shape exceptional engineers of the future, with a diverse skill-set, all sharpened to suit the different and difficult scenarios, is necessary. Besides, the development of such skills, that successful future engineers require from the learning stage as students, entails much more than building knowledge and fundamental know-how, but stretches to psychological, ethical and other aspects. This training of mental stability and emotional intelligence is correlated to handling pressure and obstacles in the future workplace with self-control and resilience (Serrat, 2017) and is of foremost importance. Eventually, it could assist in the development of a proper engineering identity on an individual basis, wherein each student understands the role they play in engineering and beyond (Rodriguez et al., 2018).

Based on these elements, this paper looks at a personal account of my engineering story for the first semester at UTM, the learning growth I went through, the corresponding challenges and far more. Subsequently, one chief mission of this study is to raise alertness on the importance of student learning experiences in the first semester, and how writing about such personal accounts may offer prospects of progressive research into refining teacher and student philosophies (Reber, 2011), within and beyond the classroom. It also aims to enhance opportunities for research into how learners, from the very beginning, can develop this properly suited engineering identity that works towards their advantages and enriches their caliber.

Methods

The preliminary source of information in terms of reflection and structuring used in this study was from typed Reflection Journals, made over the first semester in the Industrial Seminar and Profession (ISP) course. This series of journals I wrote include reviews, thoughts, feedback, evaluation and details on all learning curves that occurred. It also contains every

stage of my personal development relating to certain learning outcomes, which was applied across all seven courses I took. The journals were recorded regularly over 3-week periods, with a total of 4 journals encapsulating the first twelve weeks and the META Reflection Journal (Zakaria et al., 2020) covering the final 3 weeks of the semester. All journals were digitally completed using Microsoft Word. Secondly, for the Introduction to Engineering (ITE), Mathematics and implementation-based courses, the primary details were synthesized from my Learning Portfolio created at the end of the semester, with additional guidance received from lecturers. This learning portfolio remains a written record of my goals, reflection, feedback and analysis in identifying weaknesses and strengths over the course of the first semester. An attempt was made to meticulously cover all specifics and recollections across every assignment and topics on a weekly basis. This was to assure a detailed narrative study would be possible in future research and works.

Relating to this paper, learning theories and processes are integrated at selected parts, to correctly describe my student learning experience in connection to authentic education models that exist, largely encapsulating the sphere of engineering and STEM. Such theories include: Mezirow's Transformative Learning Theory; The Constructivist Learning Theory; Curriculum and Thinking Mathematics; Alderfer's ERG Theory of Motivation; and The Cognitive Learning Theory among others. Primarily, I decided to display my complete learning growth by merging Daniel Goleman's Emotional Intelligence theory and model (Goleman, 1995) of my personal emotional development (Chopra et al., 2010), throughout the semester. Simultaneously, it was interesting and valuable because it aided in building my sense of an initial engineering identity using systems of self-awareness, self-management, and seasoning my own characteristics such as a personal identity (Godwin, 2016). Figure 1 is a representation of this model.

Furthermore, a systematic approach using revitalized explanations of the personal learning process and reflection was used. It allowed me with a particular method of writing using the storytelling approach, by means of an active and personal voice. This also facilitated me to identify the lesser efficient methods in my unique learning process, and work on aptitude development as a preparation for the semesters that will follow. Hence, the dominant style used in the reflection journals and learning portfolio, which is consequently implemented in this paper, is the Narrative Inquiry analysis method. It embodies a qualitative data analysis approach, wherein a personal story of the learning experience is told, to best represent my unique journey to learners and readers of tomorrow. The reason narrative enquiry, and chiefly autobiographical narrative inquiry, is chosen is to present observations from the student angle

accurately and its ability to correctly express an honest viewpoint through storytelling (Clandinin, 2006) from the writer's plane of thought and aims to make a connection with the reader (Bullough et al., 2001). Furthermore, the primary qualitative data sources and input in this paper has been carried out through the process of observation and using diachronic data. This assisted in reaching beyond a limit of chronological sequences in learning, and rather analyzing each part in a more dynamic and communicative manner (Polkinghorne, 1995).

Figure 1: Goleman's Emotional Intelligence Model (2002)

Findings and Discussion

Why I Chose Chemical Engineering

A life changing question was when I asked myself: "What do I want to dedicate my undergraduate degree towards?". Given my early curiosity in the STEM and humanities areas, there were four things I was genuinely passionate about: Writing; Chemical properties and structures of molecules and atoms in matter; Nature; and the Inner workings of the brain of living organisms. Such fascinations translated to four turfs of undergraduate programs I desired to choose from: Literature; Chemistry; Environmental Science and Neuroscience. After times deep thought, long nights awake and several honest conversations with my parents and high school teachers close to me, I felt that having the basis of a chemical engineer in the beginning of my higher education, would best suit my future missions and potential to contribute to society.

These aspirations include: doing both further studies and research into Neuroscience, which is largely dependent on the processes controlled by countless chemicals and compounds within the body of living organisms; becoming an environmental

engineer, where I could apply and contribute towards designing and improving the efficiency of renewable technologies and materials of the future; and finally, writing and publishing a book, which has been a personal longing of mine.

Thus, the only course I felt was fitting to such long-desired ambitions would be Chemical Engineering. Honestly, I tend to be an explorer in terms of what I like to study and may get bored with one certain subject, but love the next. Hereafter, given I comprehended what I loved, Chemical Engineering became like an opening door to a variety of career and educational choices for the future, which I admire and continue to value.

Accordingly, to all future learners considering an undergraduate engineering degree, sculpt a sense of clarity for why you really want to do engineering. It does not mean to have the whole picture and life plan already in mind, but rather your long-term and personal intentions, hopes and dreams. Moreover, before choosing an engineering program, consider having true conversations about your plans with people you trust, ranging from parents and teachers, to senior friends and siblings.

More vitally, after you have some opinions and thoughts, try finding contacts for practicing engineers to have meetings or discussions with, which will guide you in getting a bigger picture of what your future might involve in the engineering line. However, the ultimate decision should be one's own calling, what your heart tells you, like it told me to choose Chemical Engineering at UTM.

Early Lessons from the Mistakes I Made

When beginning the transition to an undergraduate engineering program, there will come waves of anticipation, nervousness and self-questioning, especially in the first semester. After successfully completing the documentation processes to become an official undergraduate student, arrives the moment of real work. Congratulations for coming this far to become a student at your respective learning institution; so, what next? Herein begins the vivacious learning journey, with the start of lectures and classes for your respective courses and subjects. My voyage began with the interesting experience of introducing myself to lecturers across all courses, meeting new students and peers who will be taking the same degree as me: Bachelor of Chemical Engineering with Honors.

I felt valued from the start of my undergraduate journey, as in a welcoming meeting held by the Chair of our School of Chemical and Energy Engineering at UTM, I asked on sincere advice to do well throughout our time as undergraduates. To my surprise, the question was praised for being greatly important and this was my first authentic graceful moment in the program. All I can say is that I was fortunate enough to experience such a rich instant of interaction with professors, lecturers, staff and students from the very

start. As a result, it helped me cultivate confidence; which formed a huge portion of the engineering identity I continually aim towards: Becoming an effective global communicator and leader in the field of engineering. As mentioned in the book How to Win Friends and Influence People (Carnegie, 2009), it is necessary and highly advisable to start becoming a good listener. Furthermore, you must begin to practice an encouraging and positive temperament, and truly hear what others have to say. If peers are initially conserved or quiet, motivate your surrounding students to have conversations and find out more about each other.

Similarly, this motivation can be branched towards Alderfer's ERG Theory of Motivation, where the three aspects of: Existence (which I relate to asking about a person's wellbeing); Relatedness (forming a common ground for talking and communicating to form closer relations); and Growth (commend others on their potential and achievements) all help in forming strong bonds with others from the very start of your time at university (Yang et al., 2011). You will realize the immense value of this later on. Similarly, another noteworthy aspect of education research that has been beneficial to my performance is slowly becoming an active learner. This idea of active learning is valuable and says that active learners go above the normal step in the classroom by asking questions, discussing, debating, brainstorming than simply listening and viewing (Felder et al., 1988). Hence, I benefited from forming student discussion groups, working with others during exercises and before tests, to retain information more effectively and elevate my proactiveness as an active learner.

Now, some of the most enjoyable courses in the first semester for an engineering program will involve on building the conceptual way of thinking, and on the larger aspect of uses of engineering. Courses that enhance such perspectives for me included Introduction to Engineering, Industrial Seminar and Profession, Introduction to Computer Programming, Engineering Drawings and similarly structured courses. To perform to the best of your abilities, give your best efforts to participating actively in the lecturing sessions and ask questions you really need answers to, without any hesitation. Often, a common fear among fresh undergraduates is the fear of a lecturer condemning a student of one wrong question, and even the fear of facing embarrassment amongst peers. However, this remains far from reality as it is assured that lecturers at higher education institutes are exceedingly knowledgeable and mature. It is my observation that lecturers constantly encourage and prefer active student groups that ask vital questions and interact well with them. Hence, often more times than not, the question you ask stimulates every student to participate more attentively during the lecturing session.

Asking well-formed questions will also help in establishing a good relation with your lecturers when others in class tend to be more reserved. Hence, as you practice the art of critically thinking and then asking well-rounded questions, peers and friends will also gain confidence to ask better questions themselves, which is bound to be advantageous to each and every learner, building trust (Brooks et al., 2018), and a key player in becoming fruitful in academia, STEM, engineering and beyond (Vale, 2013). Swiftly, to become an exceptional learner and develop an engineering identity that matches to you, growing your emotional intelligence must be equally matched to the process of performing well academically, and both should balance each other harmoniously. A student can do this by understanding their feelings and thoughts after a class, reviewing what they understood, and if it was not to their liking, then considering on improvements to change their emotions towards something more productive (Goleman, 1995).

With the ever-evolving technological era and the availability of countless smart devices, it is beyond useful to become "tech-savvy" and learn about any new devices and functions as opportunities arise. It will be supportive in the long-run to have a voice or even a video recorder, fully charged, with you at all times. Recording entire lecture sessions for future use (Groen et al., 2016) will not only allow you to rerun and absorb certain parts for strengthening information retention, but help in making well-constructed notes and brainstorm for projects and assignments, which will surely be given and will require you to apply problem-solving based methods. This was true in my case as a first semester student where the impact of lecture capture was beneficial in me learn better both inside and outside the classroom environment (Danielson et al., 2014). Fortunately, in most of the classes I had, the lecturers were proactive in recording each of our session through Cisco Webex or Google meet platforms, and thereby sharing each recording in e-learning (an UTM based student application), for future referencing by students such as me. This was also greatly beneficial for those who could not make it for a class that day, or for those with unstable internet connections, audio issues, etc. during the class. On occasions, I used the MacBook screen recording function, which had proper sound quality in all captured lecture videos, and helped me recall each topic better before tests and quizzes, compared to only reading notes.

A study on the effectiveness of lecture capture that relates to this discussion (Danielson et al., 2014), showed indeed that students learned more through recording lectures, with 93% of the 222 students who responded in the survey stating that they felt somewhat to very beneficial in learning better using lecture capture. Furthermore, a series of 75 studies on the Impact of Lecture capture, done between 2003 and 2019 and reported (Panopto, 2020), revealed that

recording lectures for student's future use is correlated to higher grades, better knowledge absorption among other advantages in connection to academic performance. Figure 2 shows a pie chart of the impact of lecture capture on achievement (where blue is Improves Achievement and red is No improvement on Achievement). In further inquiry, it shows that the likelihood of negative impact of lecture capturing on student achievement was virtually insignificant.
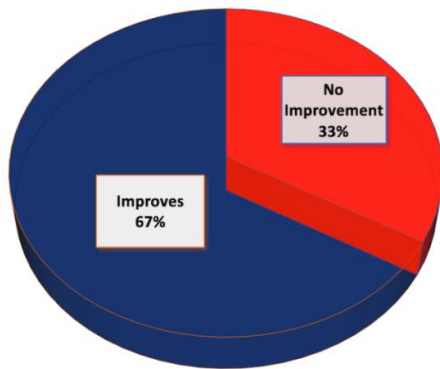

Figure 2: Impact of Lecture Capture on Student Achievement

Nevertheless, the first study on the effectiveness of lecture capture revealed in its responses that a significant number of faculty members and students felt recording and capturing lectures only (and not attending live lectures and classes) would be disadvantageous and disruptive to the overall learning manner for most students (Danielson et al., 2014). Therefore, my advice from the mistake I initially made of not paying attention in some classes and depending too much on recordings at the beginning is this: stay self-vigilant that recording lectures also means you attend every live lecture with sincerity and become involved in the actual sessions given by lecturers, as those have incredibly more value to them. Also, it is worth telling that in the first semester, do not be demotivated or make the mistake of relating peak performance in tests and quizzes to your engineering identity growth like I initially did (Gray et al., 2021). There will be so plentiful time to improve yourself, your results and grades. For that reason, stay optimistic, learn from mistakes and hone your strengths.

Reflecting on Things I Have Learnt

When I progressed through some of the introductory courses for the first semester in my Bachelor of Chemical Engineering program, I felt a deep connection to the beauty of both mechanical and digital tools that have been created over the past few decades for engineers, architects and for use in several other careers. As I began to observe every single thing I learned from day to day, and reflected upon them, I was surprised with the sophistication that withholds

engineering and STEM developments of the 21st century. Mankind has truly come so far, and a look at how much we have advanced in the last 100 years inspires me to do greater things continually (Diamandis, 2017). Now is the time to start changing yourself to appreciate the learning journey from the very beginning. Through progressing in all the courses discussed below, I started noticing things in my surroundings that I was unaware of prior. Soon, this journey of appreciation, alertness and a changed outlook, began guiding me resourcefully through the first semester, as it might do for you in the future.

Introduction to Computer Programming

My journey of appreciation started with the Introduction to Programming (ICP) course, where I gained the skill of basic MATLAB coding, writing longer coding structures to form loops etc., which will be tremendously valuable towards learning more advanced programs in the near future. This was improved upon with the Industrial Seminar and Profession (ISP) course, which also covered one seminar presented by an experienced individual on Programming, MATLAB in particular. To be honest, ICP had been one of the most challenging courses for me, right after Engineering Mathematics, as I felt the urge to understand the concepts of programming better as well as keeping up with my six other courses. What I mean is, to learn programming takes time, more time for some (like me) to truly understand the purpose of what one is doing, which is essential in remembering the details for future use, and in future careers, where one will have to face solving real-world problems using advanced technology and computer science.

Based on these factors, learning a programming language like MATLAB has built my logical way of thinking in other areas of life. I can now imagine and conceptualize the many careers that deal with large numbers, huge amount of data and mathematical methods, which are needed to provide a simplistic yet detailed presentation of datasets. This process is made possible using programs like MATLAB, which open doors for plotting, testing conditions and measuring a degree to which one variable may influence many others. After further thought on it, I was able to relate it to the similar complex processes occurring continuously in nature, where ecosystems are interrelated and the concentration of a certain chemical or population of a certain species has indicated to affect all other living organisms. Plus, it is where many ecologists and biologists give their whole lives to: studying the fundamental and intricate processes that make life on earth possible, most of which remains a mystery.

Moreover, keeping in mind that codes are just like nature's systems, where one line of code effects the next, and one error or fault in the code script may make the program invalid, thus unable to function until it is corrected or replaced. So, considering and thinking

about the importance of interdependence in all aspects of life, including engineering, has been a key player in developing my engineering identity over the first semester. I can relate this to a beautiful learning process I came across after reading a few articles and papers: Lifelong Learning (London, 2012). Here, we were not actually given all that we needed to know to produce final ICP group project of a complex user-friendly program. Our lecturers gave us the fundamental information and basic know-how to progress into learning more about the MATLAB program independently, in order to best produce a program suited to our preferences. In this way, I was able to test different ways to make the program with my team, and it helped me gain interest, much deeper than if only a textbook would have provided. So, I learned for myself the new and hidden features that could be used for our program, to make it user-friendly; a key requirement of the group project related to Introduction to Engineering S&H 2021, a case study and project which I talk more about later. Perhaps, I have started to realize that developing a passion for a subject in this manner has loads of advantages when I transcend to an organization for work, that values responsibility and self-directed problem-solving methods (Zakaria et al., 2020). This brings me to a quote by the co-founder of Apple Inc., Steve Jobs: "It doesn't make sense to hire smart people and tell them what to do. We hire smart people so they can tell us what to do."

In regard to this, if there is one thing all students can learn before entering an engineering degree; or any other degree for that matter, it would be basic software programming and introductory computer science, as this has become central in the era we now live in and venture through.

Introduction to Engineering and Industrial Seminar & Profession

Next, the two courses which had a strong impact in my engineering identity development, as well as personal growth, was Introduction to Engineering (ITE) and Industrial Seminar and Profession (ISP). Most of the assignments and projects covered for the ITE and ISP courses were wholly new to me in both their structure and content. What was more enthralling to me were the course learning outcomes (CLO) (Zakaria et al., 2020), which I looked at as being dedicated missions to instill within us students by the end of the semester. Independent learning was predominant for all exercises done in teams and individually, to produce the best work with creativity. Later, I could correlate this process to Mezirow's Transformative Learning theory (Christie et al., 2015), where in order to produce the best work, I had to do a lot of self-examination, assessment of beliefs and the faults I had in my opinions of the world and for a particular case. This aided me to produce an overall

view on a topic, think freely, consider new ideas and opinions that did not match mine, without any bias towards the variation of ideas. I was slowly growing and beginning to investigate multiple views through articles, interviews and make an adaptable choice of my own. This was necessary to create fair and accurate pieces of work, mostly concerning the use of STEM and engineering-based methods.

Following this, came the case of Cooperative Problem-based learning (CPBL), which was basically real-life case study problems using a contructive approach (Zakaria et al., 2020), and was the main idea behind our group project in ascending Stages 1, 2 and 3 for the Safety and Health 2021 campaign, a case study to showcase this CPBL. I recall that CPBL was impactful in the way it differed to traditional learning techniques (Masek et al., 2012). In CPBL, I learnt to work and research on a certain issue before we were fully taught about it. For example, when covering the topic of Hazard Identification and Risk Analysis for all possible hazards that we had to observe in our vicinity for a one-week period, we were given the problem of health and safety and why hazards need to be controlled and their risks minimized, and we were given a few methods such as HIRARC, Data collection methods, that we discussed in cluster groups in the classroom to present our own ideas. Furthermore, when forming an Engineering solution in teams, for a hazard presenting concerning risk in the local vicinity based on our data collection, we were given on methods to form and innovate engineering solutions rather than specific solution ideas. This supported my experience in filtering true information from irrelevant sources both online and offline, as I researched and learnt so much about Hazards, solutions, etc. I also noticed how to form a proper strategy to complete tasks with my teammates and stand the pressure during moments of work overload making reports, videos as well as nearing deadlines for presentations and Peer Teaching Notes (PTNs).

I felt that there was no one correct approach to this course as it considered multiple solutions to the problem at each Stage. Additionally, the problem was given to us from the very start, and we had to do the research and present findings based on what we learn ourselves or already know. The part I loved most about the whole first semester had to be this ITE group project, which I feel preserves the Cognitive Learning theory as its mainframe (Yilmaz, 2011). Here, I learned the value of research and data collection that investigators as well as engineers dedicate in contributing to, and opening doors to newer research prospects into fields such as Health and Safety within communities, the significance of Sustainability in both engineering and the global society across the three sustainability pillars (economic, social, environmental), engineering ethics and various other topics. Overall, the ITE course was truly beneficial in preparing me for new and more complex challenges

and projects, both individually and in teams, in the future of my engineering studies and career.

As for ISP, it was a dedicated course to growing our imagination and dimensional way of thinking towards engineering and afar. What I gained and recall most about this course was the numerous individuals, all experienced in their fields, mostly originating from the engineering line, to become leading members, learners and leaders globally and within Malaysia. Every week was a new seminar with fresh faces of invited guests, UTM alumni, and having expertise in the topic we would cover that particular week, mostly aligning to guide us though our ITE assignment and project stages along the way. One week would be about Engineering Ethics, the next on Success and Failure Factors at University; Effective Presentation Skills Excellent and PowerPoint slides; and the following week on developing TRIZ Problem-solving skills. Yet, the most satisfying part of this course was recalling what had happened on a three-weekly basis and writing about it in Reflection Journals. I loved and almost could not wait for the next reflection journal to be written, given my passion for putting personal stories and memories onto paper, in this case in Microsoft Word. It also rocketed my attention to detail, ways to improve myself in future projects and integrated the building of other soft-skills (Zakaria et al., 2020).

From covering so many types of topics and content, I felt that I had sharpened many of my previously unknown or ignored skills, needed in the engineering world and more importantly relating to my identity development as a future engineer. Some of the abilities I felt were elevated due to this course included: judgement and decision making; critical thinking; active learning; and complex problem-solving. I was absolutely fascinated and surprised when I researched and found that the skills I mentioned were the most relevant and necessary for engineering majors for proper engineering identity development. Thus, I felt proud for understanding myself more through self-reflection, self-evaluation and further active learning, and realized that the ITE and ISP courses were beautiful partners, that conjointly allowed the maturity of my own engineering identity. Figure 3 presents a radical chart of the influence and necessity of the skills shown, for Engineering majors and the engineering field in general (Data USA, 2020).

The Cognitive Learning theory guided me and proved effective towards innovating and designing a prototype solution for my team, that eventually won two awards including the "Top Team in Breakout Room" and amongst "Top 10 Teams" for the whole competition during our online ITE, ISP and ICP combined exhibition held via Webex. This event was especially memorable for me because it was attended by a panel of judges representing several respected institutions across Malaysia including top leading universities and official bodies such as the Department of Environment (DOE), Board of Engineers Malaysia

(BEM), all of whom evaluated the best and most innovative solutions, videos and presentations. Figure 4 shows the three main parts of the actual Cognitive Learning theory as a continuous process and this concluded my lessons and moments for the ITE and ISP courses (Valamis, 2021).
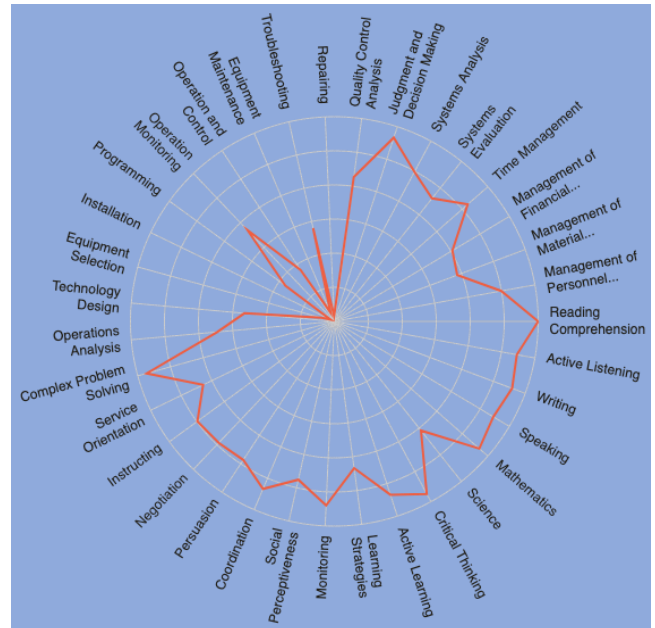

Figure 3: Radical Chart representation on necessity of skills in Engineering majors
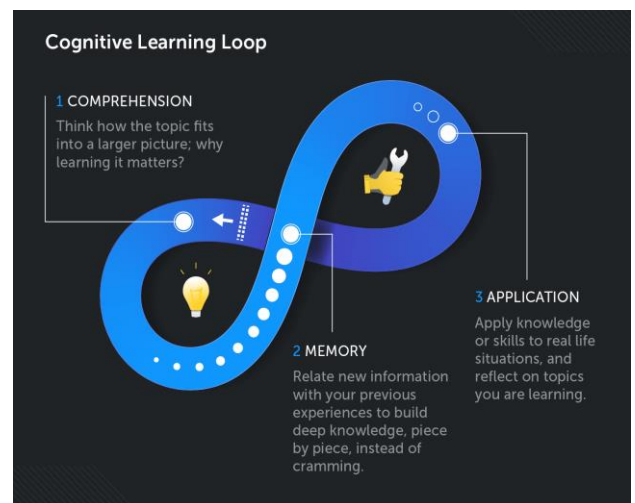

Figure 4: The Cognitive Learning Loop

Engineering Mathematics and Statics

Without a doubt, having a mathematical inclination will exponentially increase your performance and results in an Engineering program. Nevertheless, what about those facing challenges in the area of Mathematics, and their specific branches relating to necessary methods in engineering applications? When I started my first semester and began the Engineering Mathematics course, I would have never realized the value I would gain from it, despite not being strong in mathematics as a whole. The most enjoyable part of

both Statics and Engineering Mathematics were the group assignments where in a 4 to 6-member group, we worked on a particular topic of matrices and applications of statics in the greater picture of engineering. For Statics, I became aware of the true applications of mechanics in rigid bodies such as bridges, everyday tools such as a clothing iron table, etc., and how engineers innovate novel designs with precision, to create the tallest and largest structures worldwide, most of which are extraordinarily beneficial to the global economy and societal development. Hence, such creativity and brilliance in the field of engineering have provided towards easier transportation and the betterment of lives. These are only some of the countless reasons why I chose engineering as my first official degree, because I have been long passionate to innovate and design something unimaginable, which can ultimately lead to mankind's progression.

As I progressed through the semester, thoroughly revising and working on examples for each chapter for the Engineering Mathematics and Statics courses, my mind was stretched to newer levels of thought, both mathematically and logically. I can strongly relate this to an engineering-based concept of Curriculum Mathematics and Mathematical Thinking (Goold et al., 2012). Curriculum Mathematics is where true knowledge, concepts and applications are learnt as a student goes through topics, to develop models, strategies and so forth. On a note, learning and becoming knowledgeable on probability and statistics in particular, will aid all engineering students like it did me, as these topics are applied to almost every aspect and type of engineering (Goold et al., 2012). Meanwhile, Mathematical Thinking is the practicability and actual mathematical way of thinking using the skills learnt and knowledge gained, to progress to use such approaches, build emotional intelligence and refine values, which may be the ultimate use of mathematics to solve real-world problems with originality and innovation.

An important study and survey also revealed that engineers consider Mathematical Thinking to be more dynamic, in the sense of long-term use, and it is "independent of the interaction between engineering discipline and engineering role" when compared to Curriculum Mathematics which is dependent on those two (Goold et al., 2012). What is meant by this is that engineers have a variety of tasks in the real workplace setting, and they may lose part of their engineering discipline and identity as they deal with increasingly more complex and broader problems, in areas outside their expertise. However, I feel that this not only applied to engineers, but many first semester engineering students, including me, where I suffered confusion of thought and understanding when the level of complexity increased before I could properly prepare myself for it. In the mathematical aspect, learning and being strong at mathematics does not always allow for solving highly complex problems directly using knowledge. Hence, to preserve the engineering identity, which is as distinctive as fingerprints, it is crucial to dedicate time towards innovation in teams, practice cognitive based learning methods and always look at the bigger picture using critical thinking. The vital reason for this being that a student needs to experience using mathematics in practical situations, which will be a big part of the true engineering working atmosphere, from the very beginning of their education in the first semester.

A first-year student also needs to experience using mathematics with increasing confidence, even if the progress is slow. Research has shown that learners will often ask themselves and others "Why am I doing mathematics?", I know I did (Harris et al., 2015). Therefore, to critically identify and actively discuss with lecturers on the mathematics course and specific topics that you are taking, is important and valuable in developing a harmonious identity and for your long-term goals. Another effective way I discovered, was to come in touch with some of my course mates for every subject, and actively interact with them from time-to-time. It surprisingly allowed for a refreshing way to absorb new information, as we gave each other brief, but effective tutorials and explanations on certain problems. I was fortunate to work in discussion groups via social media applications (this must be your own effort to network and connect with peers and make friends with confidence), as when a certain problem was not understood by someone, another student who had clarity could beautifully explain to us the details required. I can relate this to Peer Teaching in higher education (Goldschmid et al., 1976), using the dimension of consructivist learning theory of knowledge than just memorizing (Dagar et al., 2016), within and beyond the classroom. This is where students, including me, aided each other in learning and understanding challenging concepts, creating innovative ways of thinking and approach problems with coolness rather than being repelled by issues. To my amazement, I succeeded in completing almost every large assignment and project with proactiveness in teams with peers, much before the given deadlines. So, by the third month of the first semester, I started to feel really comfortable to approach as well as be approached by others for help, and I also actively contributed to their understanding for topics. Then, it increased my self-esteem, empathy (which I gained from understanding others' and sharing my own feelings) and significantly improved my academic performance across all courses.

Engineering Drawings

Drawings created an active atmosphere of learning, not only for myself, but for all others around me, while stimulating the creation of a more dynamic thinking approach to develop a sense of deep understanding of what I learnt from the art of

designing and constructing. I can extend this certain thinking approach again to The Cognitive Learning Theory in classroom (Yilmaz, 2011). I was able to spend some time thinking about the actual purpose of what I was learning and concluded this both software use and engineering drawings could enhance my ability to run and handle more complex programs and boost my imagination for thinking in pictures than words. Additionally, drawing using a sophisticated and mathematical-based software also made me aware of the importance of proportions in the structures that are made by engineers, architects, rocket scientists in humanity's biggest projects throughout history. Just the idea that one single sketch by an engineering student eventually lead to the creation of a NASA satellite was dumbfounding. Next, I was able to move towards learning about how to actually make geometric, orthographic, three dimensional (3-D) and piping designed drawings of components and machinery using AutoCAD 2022. Figure 5 (a) shows one of the 3-D drawings we had to create with correct proportions, shapes and dimensions (excluded here). Next, is an attempt on an Isometric assignment (Figure 5 (b)), including blue lines for correctly constructed dimensions. This Isometric method shows a 3-D drawing; however, integrates observing from different directions and angles of the shape, to construct the drawing using 2-D type illustrations and orthographic

tools, which was challenging but a great learning experience.

Finally, after forming a good base of understanding, getting familiar with AutoCAD 2022 and sharpening my professional drawing skills, I was able to apply it to a real-life and bigger situation after few days of critical thinking and reflection on the best methods.

As briefly mentioned before, I applied my drawing skills aided by the AutoCAD 2022 software to designing the ITE Engineering Solution (named CHASafeties) for my team CHAS, for the final Stage 3 of our Introduction to Engineering Safety and Health 2021 (S&H 2021) report and video exhibition. The final layered and water-resistant safety sticker (Figure 6 (a)) to prevent electric shocks from plugs, sockets, switches (relating to water contact and electrical leakage, a common issue regarding electrical hazards at home and workplaces), and 6 (b) showing the unique part of our solution, a Test bulb with non-contact voltage detection components to alert people of electrical leakage and risk of electrocution in the switch or plug ports, and ensure it can be replaced or repaired immediately, were designed. Interestingly, I got the idea to construct both using the AutoCAD 2022 drawing and drafting software for my team, so this was a perfect transfer of skills from one course to another (Engineering Drawings to ITE), which I remain pleased and proud of.
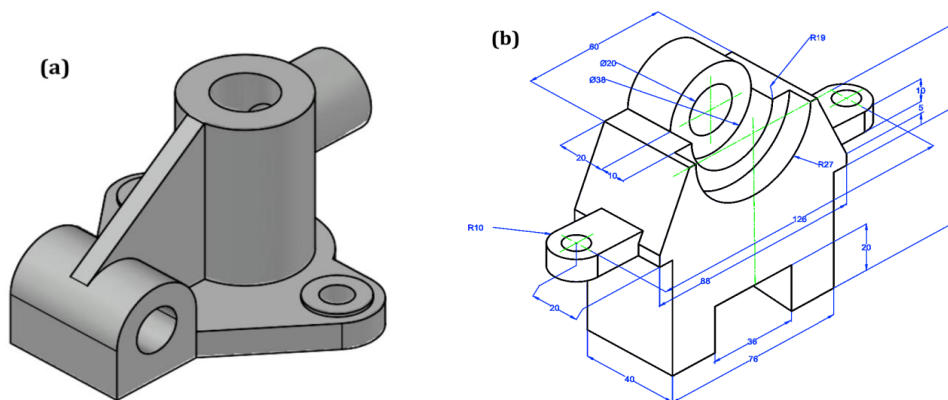

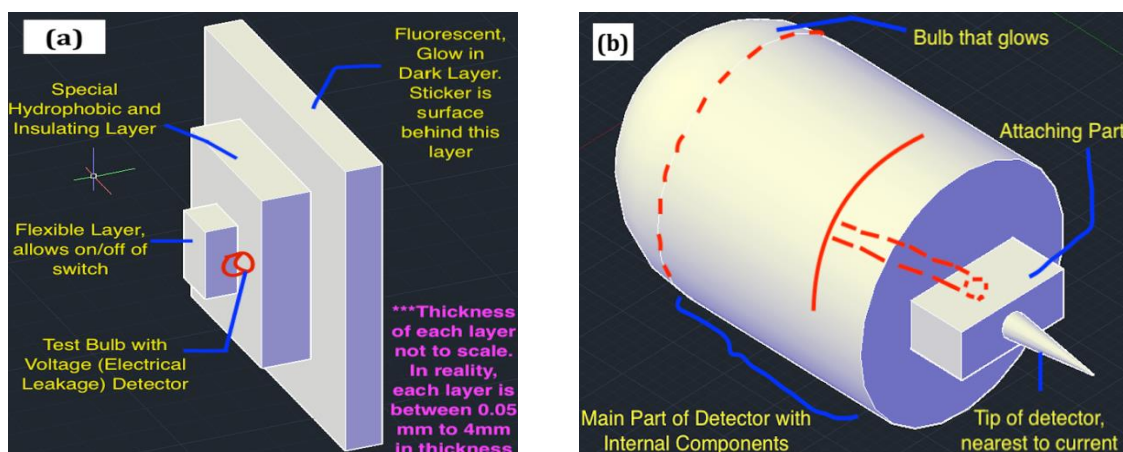**Figure 5: (a) A 3-D drawing assignment (b) Personal attempt on an Isometric drawing assignment**

Figure 6: (a) CHASafeties layered electrical safety sticker drawing (b) Test bulb and non-contact Voltage (Electrical Leakage) detector component.

English Communication Skills

Although I have been conversing in English all my life and is almost bilingual to my native Bengali language, it was a beautiful journey to be involved in this course for the first semester. My lecturer, exceptionally jolly and approachable, was the main reason behind me loving and doing well in this particular course. The highlight was the group project on any topic we liked, creating a video and a piece of reflective writing with three of my friends for the course. I reasoned that dedicating our project to a single topic would be limiting our creativity. Hence, we all did food sharing, talked about life stories, what hobbies we had and future aspirations. As a fairly experienced English language speaker, one thing came to my mind: doing well and enjoying this course was not about the English itself, rather passionate interactions with people to develop trust, and inspiring each other though oral interactions than in only in written form, which I can relate to constructivism (Rao, 2018). Keeping this goal in mind, to simply love the conversations you have with different individuals will help boost your morale and confidence, and might just give you the humane outlook needed to build ethics; a key factor of any engineering identity. The unity that came from us talking to each other about food, what we loved to do in our spare time and our personal goals in life was memorable. Not only did conversing in English make me culturally more mature; which was an interesting match to the Cognitive Constructivist theory of learning by exploring my experience of talking to people (Rao, 2018), but also showed me that outside my mind, lies people with their own stories, passions and ambitions; quite similar to mine, yet unique.

Lifetime Lessons that are worth it

Well, I feel that all I could describe and explain to new engineering students of tomorrow have been done to the best of my abilities and limits. However, I strongly believe that no prodigious journey ever ends, or ever should. That is why, I leave a few, but deep lessons that may take a lifetime to learn, practice and spread, but will be worth it for all those who consider them. Firstly, staying out of your comfort-zone in the sense of trying new things, considering new ideas and interacting with new people. One, two or even all three of these things will give you discomfort as you progress though the first semester at university, career, and if not university, then in life. Sometimes, trying new things seem repulsive, and that it may lead to an undesirable outcome in your life. In truth, much of the time I have spent has only solidified in me that trying new things with new people gives you experiences you never thought was possible. In fact, trying new things from time to time expands the dimension and scale of thought within the human mind. It has to be nothing complex, just a simple idea can lead to great

innovations. That is why considering new ideas, or those that go against your own, should be made a regular and lifetime habit as an engineering student. Next, an unimaginably beneficial lesson that can be practiced is learning how to self-analyze and self-evaluate all actions within one's life and learning progression. Examining how you learn best, and simultaneously analyzing how to effectively absorb knowledge from different sources, is invaluable to your lifetime growth and success. This aspect of self-evaluating using critical thinking can be extended to refining both teacher and student philosophies (Reber, 2011) as well as self-reflection in all fields of academics, occupational as well as social life (Iliff et al., 2019). Self-reflection was a key aspect in my growth and recalling things in a more dynamic way as to their purpose, processes and theoretical comprehension. This was applied to every topic and class I covered throughout the first semester, for all seven courses I took. A basic idea bubble of self-reflection (but not limited to) is shown in Figure 7 ('OC & CP' in the purple bubble can be left out) (Iliff et al., 2019), and can act as a guide for your own learning growth and discovery.
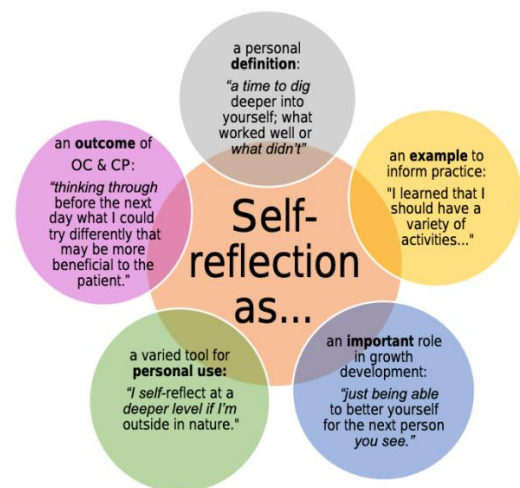

Figure 7: Self-reflection - A basic idea bubble

Finally, communicating throughout this semester, with so many creative and passionate individuals, made me more of a human engineer who understands his or her faults, than a robotic perfectionist, who cannot self-reflect and enjoy nostalgic memories of the learning journey as well as being motivated by mistakes. I feel special to have matured to a state of mindfulness and emotional intelligence, to sustain my growth over the long-term. On an end note, starting a nice conversation on anything with people creates trust and might bring peace to our future world. So, choose words with careful thought, and say them at the right time. I was fortunate to be able to do and understand this partially, given the limitations of online classes compared to live lectures due to the pandemic. However, I feel future learners will have more opportunities of working together compared to present times. Perhaps they will be fortunate to discuss

larger, more complex ideas in a simpler way when learning face-to-face. There is no time to procrastinate, the beauty of learning something new is out there for your taking. All you have to do is give effort in wanting to, and extend your hand saying yes to, learning something new, every single day!

Conclusion

After a deep conversation with myself, and presenting my experience and lessons learnt in the process of developing a personal engineering identity, there are three quintessential ideas that emerge from the findings of this study. First, the learning process of a student at university, particularly in the first semester at undergraduate level, is vastly unique and much more a story of waves of successes and failures than a chronological development process. Secondly, all the lessons I have shared will hopefully aid future engineering students in doing well over the entirety of their degree and program, and perhaps create beautiful memories of being an undergraduate student, that will remain with them for a lifetime.

Lastly, considering the multiple learning theories interweaved within my journey, developing a harmonious identity while excelling academically relies on multiple factors. Growing on such factors depends on true effort from the student's side. Thus, it becomes beneficial for students to keep written accounts of all experiences and challenges faced, to form future studies and research into learning experiences and identity development, using the narrative enquiry analysis or other methods, both within engineering, engineering education and beyond. In conclusion, I advise future freshmen to keep written journals and notes, become story tellers of their journey as students, as opportunities and breakthroughs will arrive when they least expect it.

Acknowledgement

References

Brooks A. W., John L. K., 2018. The Surprising Power of Questions. Issue May-June 2018. Harvard Business Review. 60-67.

Bullough Jr, R. V., & Pinnegar, S. (2001). Guidelines for quality in autobiographical forms of self-study research. Educational researcher, 30(3), 13-21.

Çalışkan H. K., 2015. Technological Change and Economic Growth. Procedia - Social and Behavioral Sciences. vol. 195. 649-654.

Carnegie D., 2009. Book: How to win friends and influence people. New York: Simon & Schuster.

Cebr, 2016. Engineering and economic growth: a global view. A report by Cebr for the Royal Academy of Engineering.

Chopra P. K., Kanji G. K., 2010. Emotional intelligence: A catalyst for inspirational leadership and management excellence. vol. 21(10). Total Quality Management & Business Excellence. 971-1004.

Christie M., Carey M., Robertson A., Grainger P., 2015. Putting transformative learning theory into practice. vol. 55(1). Australian Journal of Adult Learning. 9-30.

Clandinin, D. J. (2006). Narrative inquiry: A methodology for studying lived experience. Research studies in music education, 27(1), 44-54.

Dagar V., Yadav A., 2016. Constructivism: A Paradigm for Teaching and Learning. vol. 7(4). Arts and Social Sciences Journal. 1-4.

Danielson J., Preast V., Bender H., Hassall L., 2014. Is the effectiveness of lecture capture related to teaching approach or content type?, vol. 72. Computers & Education. 121-131.

Data USA, 2020. Classification of Instructional Programs in Engineering. Data from Occupation Net (O*NET) Online.

Diamandis P. H., 2017. A Look at How Much Humanity Has Advanced Over the Last 100 Years. Article on Futurism.com.

Elmogahzy Y. E., 2020. 1 - Textile engineering as a scientific discipline. The Textile Institute Book Series. Engineering Textiles (Second Edition). 1-13.

Felder R. M., Silverman L. K., 1988. Learning and Teaching Styles in Engineering Education. vol. 78(7). Engineering Education. 674-681.

Godwin A., 2016. The Development of a Measure of Engineering Identity. Paper Presented at 2016 ASEE Annual Conference & Exposition. American Society for Engineering Education (ASEE). 10.18260/p.26122.

Goldschmid B., Goldschmid M.L., 1976. Peer teaching in higher education: A review. vol. 5. Higher Education. 9–33.

Goleman D., 1995. Emotional intelligence: Why it can matter more than IQ. New York: Bantam Books.

Goold E., Devitt F., 2012. The role of mathematics in engineering practice and in the formation of engineers. Proceedings of the 40th SEFI Annual Conference 2012. Engineering Education 2020.

Gray C. A., Gray R. E., Canipe M. M., Armfield S. W. J., Tuchscherer R., 2021. Developing Engineering Identity in an Introductory Engineering Course: A Multi-Case Analysis. vol 4(3). Journal of Research in Science Mathematics and Technology Education. 153-177.

Groen J.F., Quigley B., Herry Y., 2016. Examining the Use of Lecture Capture Technology: Implications for Teaching and Learning. vol. 7(1). The Canadian Journal for the Scholarship of Teaching and Learning. Article 8.

Harris D., Black L., Martinez P. H., Pepin B., Williams J., 2015. Mathematics and its value for engineering students: what are the implications for teaching? vol. 46(3). International Journal of Mathematical Education in Science and Technology. DOI: 10.1080/0020739X.2014.979893.

Iliff S. L., Tool G., Bowyer P., Parham L., Fletcher T. S., Freysteinson W. M., 2019. Occupational Therapy Student Conceptions of Self-Reflection in Level II Fieldwork VL. vol. 3(1). Journal of Occupational Therapy Education. 1-23.

London M., 2012. Lifelong Learning: Introduction. Book: The Oxford Handbook of Lifelong Learning (1 ed.). 1-16.

Masek A. B., Yamin S., 2012. A Comparative Study of the Effect of Problem Based Learning and Traditional Learning Approaches on Students' Knowledge Acquisition. vol. 28(5) International Journal of Engineering Education. 1161-1167.

McCarthy N., 2017. The Countries With The Most STEM Graduates, Infographic. Article in Forbes and data from Statista. World Economic Forum.

Polkinghorne, D. E. (1995). Narrative configuration in qualitative analysis. International journal of qualitative studies in education, 8(1), 5-23.

Panopto, 2020. 75 Studies Reveal The Impact Of Lecture Capture. Article on Panopto.com Blog.

Rao X., 2018. Learning Theories that Impact English Teaching and Learning. In Book: University English for Academic Purposes in China. 21-39.

Reber J., 2011. The Under-Examined Life: A Proposal for Critically Evaluating Teachers' and Students' Philosophies of Teaching. vol. 59. College Teaching. 102-110.

Rodriguez, S.L., Lu C., Bartlett M., 2018. Engineering identity development: A review of the higher education literature. vol. 6(3) International Journal of Education in Mathematics, Science and Technology (IJEMST). 254-265. DOI: 10.18404/ijemst.428182.

Rosemberg C., Simmonds P., Potau X., Farla K., Sharp T., Wain M., Cassagneau-Francis O., Kovacs H., 2015. Assessing the economic returns of engineering research and postgraduate training in the UK, Final Report. Technopolis Group.

Rosen, M. A., 2012. Engineering Sustainability: A Technical Approach to Sustainability. vol. 4(12). Sustainability. 2271-2292.

Serrat O., 2017. Understanding and Developing Emotional Intelligence. Book: Knowledge Solutions. 329-339. DOI 10.1007/978-981-10-0983-9_37.

Valamis, 2021. Cognitive Learning, Develop and maintain Learning Culture. Learning Built with a Purpose to Engage Learners. Valamis.

Vale R. D., 2013. The value of asking questions. vol. 24(6). Molecular Biology of the Cell. 680–682.

Xu M., David J. M., Kim S. H., 2018. The Fourth Industrial Revolution: Opportunities and Challenges. vol. 9(2). International Journal of Financial Research. 90-95.

Yang C.L., Hwang M., Chen Y.C., 2011. An empirical study of the existence, relatedness, and growth (ERG) theory in consumer's selection of mobile value-added services. vol. 5(19). African Journal of Business Management. 7885-7898.

Yilmaz K., 2011. The Cognitive Perspective on Learning: Its Theoretical Underpinnings and Implications for Classroom Practices. vol. 84(5). The Clearing House. 204-212.

Zakaria Z. Y., Che Man S. H., Yusof K. M., Sadikin A. N., Aziz M. A. A., Hassim M. H., Mustaffa A. A., Hasbullah H., 2020. Design of First Year Integrated Courses based on Constructive Alignment. vol. 4(2). ASEAN Journal of Engineering Education. 15-25.