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A Critical Outlook On The Role Of Research Practices In Laboratory Towards Student Skills Development In Malaysian And Japanese Public Universities

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Abstract: ***Developing talented graduates to fulfil market challenges is a formidable task for higher education today. By using qualitative method, Malaysian and Japanese professors in selected public universities were interviewed in order to investigate how research practices in laboratory contribute towards student skills development. The result shows that laboratory practices such as group work, mentoring and closed monitoring in organization enhance student employability skills. It is suggested that chain mentoring system from professors to junior researchers to be practiced as a succession planning in developing potential leaders. Closed monitoring between principal investigator, senior and junior researchers is also significant to support not only for professional skills, but also for personality growth and emotional support.***

Keywords: Research practice; Research organization; Laboratory; Student skills; Public universities

I. INTRODUCTION

Universities has been long recognized as the 'engine' for the country's economic development due to its important role in shaping the human capital formation and substantial beneficiaries for research and development (R&D) in the country (Mellander & Florida, 2006; Ponomariov & Boardman, 2010). According to the article in "The Economics", university is characterized as the knowledge factory (Florida & Cohen, 1999). This is due to the knowledge production delivered in many ways, either through formal or non-formal education system. The strong combination between formal and non-formal education would be able to deliver lifelong learning skills among graduates (Biao, 2015). This is truly important to encounter the increasing worldwide complexity and problem day by day. Therefore, graduates are ought to be equipped with lifelong learning skills to adapt to the evolution of technology and knowledge. In this study, the focus on the students' development is expressed through talent transference, particularly on the skillsets that prepare them after graduating.

In universities, research laboratory is the indispensable part of a university that practices both science and humanities (Affeldt, Tolppanen, Aksela, & Eilks, 2017). In universities,

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there are two types of laboratory, namely teaching laboratory and research laboratory. The teaching laboratory is a place where an experimental or practical course for undergraduate study to apply theoretical science in class and mainly focusing on basic research (Beck, Butler, & Da Silva, 2014). Normally, undergraduate students start to learn in this laboratory from first to the third year of their studies. Meanwhile, research laboratory is a place where more advanced research comprising of both basic and applied research are carried out by a certain research group. There are many studies highlighted the importance of research laboratory in providing education and training to graduates (Kerber, 1988; Carnduff & Reid, 2003; Raj & Devi, 2014). For example, Kerber (1988) viewed that laboratory work could develop curiosity of students to explore on wider knowledge and confidence level to reflect themselves as scientists. In addition, to become a scientist, students must be equipped with practical skills, transferable skills and intellectual simulation as presented in Table 1.

Skills	Practices
Research skills	Safety, experimental procedure, manipulating instrument
Transferable skills / Employability skills	Teamwork, organization, time management, communication, presentation, information retrieval, data processing, numeracy, designing strategies, problem-solving
Intellectual Simulation	Connected to the 'real world' through publication, patents and paper conference

Table 1: Three Broad Skills through Laboratory Activities (Carnduff & Reid, 2003; Malik & Setiawan, 2015)

Scientific research requires students to master various skills. Therefore, laboratory provides beneficial experience to gain appropriate research technique; from designing research objectives, making hypotheses, conducting experiments, analyzing results, discussion and deducing into conclusion. In laboratory, there are two important factors that shape the conducive research process, namely the availability of research facility and intellectual resources in research organization.

However, the design of intellectual/scholar resources in developing these set of skills is debatable (Subramaniam, Silong, Uli, & Ismail, 2015). This requires effective laboratory practices that would depend on robust research organization. In laboratory, a research unit in the laboratory is naturally organized by a laboratory head and some members under his/her supervision. The laboratory head appointed is usually a professor or an associate professor and the following members are assistant professors or senior lecturers, postdoctoral researchers, technician, and junior faculty members such as PhDs, masters and final year undergraduate students. Therefore, the research group is characterized by a continuous form of teamwork with different roles to allow the laboratory head aiming for the long-term range goals with minimal risk. The research team works together to hone their management and teamwork skills through proposal writing, recruitment and publish data in journals.

Prior studies demonstrate that student skills could be acquired through high quality human-to-human teaching in laboratory with regard existence of classroom courses (Numprasertchai & Igel, 2005; Stroth, 2015; Subramaniam et al., 2015). This study acknowledges the importance of owing knowledge outside the organization, but it is argued that knowledge activities occur inside the research laboratory significantly lead to the process of students' development. The organization in research laboratory would function to determine the tone and style of their research activities. As such, this is an important mechanism to ensure their activities is propelled along the right track in order to develop students with adequate skills and rich of experience.

Research process in the organization embarks the elements of communication, collaboration, facilitation of networks, support or mentoring and culture to the research operated (Hulcombe, Sturgess, Souvlis, & Fitzgerald, 2014). Henceforth, purpose of this study is to explore the role of research practices in laboratory to develop students' skills. This study provides selected universities in Malaysia and Japan as the case studies because of their closeness in sharing expertise and knowledge. In recent, Malaysia's Foreign Policy was re-oriented to "Look East Policy" after initiated in 1980 (Izzuddin, 2019). The changing policy revives cooperative relationship between Malaysia and Japan, including research and education aspect. Furthermore, as a developing country, it is also reported that research institutions in Malaysia are still lacking to produce quality and trained researcher despite tremendous effort made (Azman, Sirat, & Pang, 2016). Meanwhile, Japan managed to grow fast as a technological inventor even though it had been devastated with an atomic bomb in 1945 (Allen, 2012). The factor of working group practice and motivation for self-improvement in Japanese universities contributes towards fast, innovative and scientific production (Serah & Noor, 2012). In addition, teamwork and communication skills between manufacturing, production, and marketing teams are coordinated well to support the Japanese economic growth (Bess, 1988; Yamaguchi, 2013).

The study first explores the literature on how laboratory activities could benefit students' development and the role of research organization in this. Following a discussion of how data were collected and data analysis, the study examines the strategies laboratory organization used to build skills among and for undergraduate and graduate students. In specific, the study addresses the issue associated with limited funding, misinterpretation of mentor's role and others to take account of existing organizational system.

II. BACKGROUND

Recent work explores and assesses necessity of research activities in laboratory to support the development of students. Bernat, Teller, Gates, and Delgado (2000) argue that benefits of working in research organization is clear, where students could enhance their domain expertise, understand research process, acquire team to solve complex problems and train for higher-order thinking skills. These range from a principal investigator, graduate and undergraduate students to write proposal for research grants application, manage grants, conduct experiments, publish full data, and write article journals (Toole & Czarnitzki, 2009). It is identified that sequence sets of training and mentoring program play an

important role to build solid community of scholars and maintain the continuous supply of skilled human capital in their respective discipline (Azman et al., 2016). There is also literature focuses on relationship of organization in benefitting research institution. A study conducted by Tyler et al. (2016) elaborated the reformation of Hunterian Neurosurgical Laboratory since 1984 after being dormant for about 20 years from the 1960s to the early of 1980s through mentorship, independence, team-building, creativity and people-centered collaboration, while enhancing knowledge, skills, attitude for implementation of cooperative group from supervisor-students or mentor-protégé.

In exploring the relationship of research organization in laboratory activities, this study identified the elements which, it was argued, determine the quality of students' experience. Linn, Palmer, Baranger, Gerard, and Stone (2015) claimed that mentoring is one of the essential elements in universities' laboratory organization. Mentoring participation deals with many perceptions such as "I'm used to following the procedure to do this, to do that" and "I am very frustrated with everything failing as I thought of it coming as magic". Therefore, senior mentors guide students who are juniors to link their research experience and lead them towards the correct path. Normally, mentoring is shared among professors, postdocs, graduate students, and undergraduate students. Studies from Strawn and Livelybrooks (2012) and Feldman, Divoll, and Rogan-Klyve (2013) show that mentoring relationships occur more often between graduates, postdocs, and undergraduate students or peer-mentor relationships and yet less with professors. The trend occurs because of longer time is spent on the technical aspects with postgraduates when compared with professors who advise on theoretical knowledge and professional skills growth. The professional skills are not only applied in the context of research such as problem-solving skills, knowledge, writing skills, designing experiments, and identifying research gaps, but also for their personality growth and emotional support. Therefore, it is significant to have good relationship between professor or principal investigator and students. In addition to the studies, peer mentoring also offers professional supports, mutual respect as well as and enhancing communication skills, teaching skills, and self-esteem through a conducive open-spaced office (Tyler et al., 2016). Given these points, the laboratory environment maximizes daily interaction within the social group in the sense of teamwork to ease workload and for better generated ideas. It is also noted that large number of seniors and active research peers could form an interaction of effective teamwork to ease workload and build academic research community in laboratory.

It is also argued that people who belong to the same group often imitate their laboratory members or mentors and professors, and this is what we refer to as social interaction effects (Falk, Fischbacher, & Gächter, 2013). In the research laboratory, social interaction effect always occurs due to high tendency of laboratory members in cooperating and communicating effectively in the same area of research topic. They collaborate to produce papers together and assign tasks to collect raw data. The basis for this interaction has established a consortium of local social networks and even continues after graduation. According to Linn et al. (2015), it is reported that research experience helps to expand their academic and social science networks beyond the international relationship. They get to learn acting like professionals in designing research as well as feeling ownership and commitment on research projects and groups (Linn et al., 2015; Stroth, 2015).

III. MATERIALS AND METHODS

This study looks at the perspective of research practice, which emphasizes on strategies, challenges and the way it affects the students' professional development. This study used case study approach to get a clear description on the phenomenon by placing it in the context of real life. This approach was carried out through semi-structured interviews with outstanding professors in three reputable and top research universities in Malaysia, namely University of Malaya (UM), University of National Malaysia (UKM) and University of Putra Malaysia (UPM) and in Japan, representatives were selected from Kyoto University, Kyushu University, and Tsukuba University. The multiple case study selected is appropriate in order to get a better understanding on the literature review and the method is consistent with the numbers of previous study. Existing study such as Uiboleht, Karm, and Postareff (2016) interviewed three experienced teachers to assess on the strategies used through multiple approaches in teaching. The same methodology was also applied by Numprasertchai and Igel (2005) who chose multiple case study to carry out interviews with researchers and partners in three research units.

In this study, the criteria of professors selected must be a laboratory head in their research group, possess diverse experience in managing their laboratory and won many prestigious awards. However, the identity of participants will be kept confidential and represented their respective universities in this study. Therefore, in this study, the professors will be represented by participant A, B, C, E, F and H respectively. In order to evaluate their performance, these participants were selected based on few criteria. Firstly, is based on their outstanding laboratory performance and in-line with universities reputation at the national and global. Secondly, their experience in managing research laboratory and outputs through awards and publications in the last 5 years.

In addition, the selected research universities in Malaysia (i.e UM, UPM, UKM, Kyoto University, Kyushu University and Tsukuba University) has consistently shown remarkable achievement in producing numbers of quality human capital and skills (QS Top Universities, n.d.). Additionally, all selected Malaysian universities are situated in Klang Valley area and represent same demographic area and background. However, Japanese universities were selected based on the availability of participants based on existing research network. In general, the participants selected were mainly representing their outstanding reputation as researchers, not merely chosen by the universities.

IV. RESULTS

OUTLOOK INTO MALAYSIA

According to participant A, high technology equipment requires specialized and expert technicians or researchers to operate and troubleshoot the equipment in laboratory, but there are only small number of research laboratories in Malaysia hire certified experts to take responsibility on that particular equipment. However, due to the limited budget, participant A invests on selected students to go for training at industry and overseas to learn the latest technology and to gain knowledge and experience. The selected students will then train their juniors through mentor-apprenticeship system. Therefore, the continuous training and mentoring is inevitable to be carried out because of rapid development in science and technology with new equipment and technology invented every day.

…even to get professional certificates to use machine is very expensive. Sometimes you have to go to overseas which costs a lot of money... When a new machine is coming out, then we send one or two best student(s) to learn about the machine.

(Participant A, Interviewed on July 13th, 2017)

The mentoring process between PI (principal investigator) students and senior-junior is not only limited in the equipment's training but also for their research management skills and able to achieve certain milestone during research progress.

For participant B, teamwork culture in laboratory is unique for practicing team supervision. For PhD candidates, it is common to have three supervisors, with a chairman and two committee members. The rationale to practice this committee supervision is for continuous monitoring purposes. In the same way, multiple layers of laboratory members are encouraged to work together, in which final undergraduate students are guided by PhDs and master's students. In terms of research grant management, students are expected to be independent to do research order and able to write a proposal draft for research grant application.

…PhD students will have three supervisors. It is called "committee supervision" …. One is chairman and another two are committee members… For PhD is three and for master's is at least two… This is the university's regulation... The reason behind this is that if anything happens to any of the supervisors, the other supervisors will continuously monitor the progress of the students.

(Participant B, Interviewed on April 4th, 2017)

In reference to participant C, laboratory research group has a good mixed of researchers from a professor, associate professor, postdocs and students. This hierarchical mixed structure form is aimed to focus on talent management and commonly be known as succession planning. The students are also trained with research management skills to write papers and research report. Nevertheless, in the process of managing and mobilizing the talent, the students might misinterpret the role of mentors to assist them. The mentors are assumed as the servant to do their work instead of giving direction and guidance. Still, a lot of training needs to be taken to train both mentor and mentee.

A good mixed of people with various but related research background and ages in the universities have developed teamwork spirit to complement and collaborate with each other. The participant A stated that "postdoctoral researcher trains junior students do research, while the students help to do experiments and build new area of exploration." Other explanations from participant B were "we have researchers who are young and clueless in research, seniors who have experience for more than 15 years" and "we have researchers with metals specialization, non-metal specialization, polymers, composites and testing researchers. So that is a good mix." Therefore, federation layers of researchers with fusion of disciplines could help to build up successful mentoring style and intellectual infrastructure of talent management.

Furthermore, the social activities organized among laboratory members in all universities are important to communicate effectively, be able to negotiate and create network with different layer of researchers. In addition to participant B, the professional relationship between PI-students is more to friends rather than supervisors-students. As a result, this positive relationship will also expand networks of the same field between PI and students in the future. All in all, this approach is intended not only to involve students in the intellectual activities but also social conversation.

OUTLOOK INTO JAPAN

Mentorship (*Totei Seido*) and training includes items of teamwork culture, monitoring, equipment training, and research management skills. In Japan, research laboratories are organized under the basic organizational unit called *kouza* system, which is modelled on a professor chair system in the early 19th or 20th Germany Universities. The research members are observed based on the seniority-basis hierarchical structure, in which the professor's authority is strong. This chair system used to be very rigid before the third wave of higher educational reformation in 1990, but becoming more flexible nowadays as compared by participants E and F.

……sometimes, it does not function like the "pyramid way" but only one-to-one mentoring. I think it is difficult to continue the system.

(Participant E, Interviewed on February 24th 2017)

Sometimes in small *kouza*, they cooperate to carry out certain research… A student is trained from other groups if they use the same machine and instrument. This student can be trained by senior students from other group, so-called mentor-mentee system…

(Participant F, Interviewed on September 19th 2017)

The chair system illustrates closed-mentoring relationship between senpai and kohai in the same or even other groups. Participant H described that the basis of the relationship is formed by making the research community like a family. Within the hierarchical structure, one monitors each other's performances. There is a sequence of mentoring process with professors who carry out responsibility to guide associate professors and assistant professors to reach a higher level and at the same time, both give equal attention to their students. Afterwards, this mentor-mentee interaction is extended with postdoctoral researchers and doctoral students to guide the master's and undergraduate students.

Besides good equipment, good research topic, and adequate research funds, good operation skill trained by many seniors is also necessary to manipulate multiple and complex data by using equipment. The senpai will guide kohai as the next generation not only to do research but also to maintain harmony in *kouza* and share data for any interrelated experiments. The teamwork culture is also translated into *souji*, a cleaning session every Friday. Each laboratory member will be responsible to participate in this cleaning activity. Overall, all participants E, F, and H equally express similar behaviour of teamwork culture practiced in Japan.

In terms of closed mentoring, there are several scheduled presentations held to promote students' active participation. The activities are held with seniors in a small group for any theoretical discussions to develop the research. For bigger discussions in laboratory seminars, it is known in multi-terms such as *shorokukai*, *bunken zemi*, and *zasshikai*. The discussion is held in a certain way for every research laboratory in universities as follows:

When I was working as an assistant professor, I had meetings once or twice per weeks with my small research group.

(Participant E, Interviewed on February 24th, 2017)

In Japan, we have a meeting once a week depending on the number of students. In my laboratory, a student has to present literature review in 1-2 papers… Usually, the professor does not ask a lot of questions rather than other research members.

(Participant F, Interviewed on September 19th, 2017)

All members gather once a week for seminar/zemi every Friday to give presentation for general review or progress report. At the moment, they ask many questions. In order to create the questions, they also must have certain skills and understand the content.

(Participant H, Interviewed on September 12th, 2017)

In Japanese universities, laboratory activities are also the medium to train research management skills. Through structured mentoring process, students are trained to be good at leadership management, research funding, research partners, and projects. According to participant H, students in the laboratory are trained to perform all techniques related to the research. For example, laboratory and manipulative skills are emphasized to manage proper analytical machines with safety rules. They are highly accustomed to the standard operating procedure (SOP) for every machine, material, and task in the research laboratory. In addition, students would also be familiar with the SOP related to recycling, scheduled waste, burnable waste, and clean room culture.

V. DISCUSSION

The results of this study showed that activity in university laboratory enhance students' skills through three main practices i.e. a research group, mentoring system and closed monitoring.

POSITIONING A STUDENT TO A RESEARCH GROUP

Research practice in a laboratory is built based on the teamwork of multiple generations of researchers. The relationship between professors and students for both countries are inclined towards a professional relationship among them. In addition, it is noted that the authority of research organization in the Japanese laboratory is centralized to the professor, whereby decision of professor at each research organization is highly respected (Ogawa, 2002; Morichika & Shibayama, 2015). Thus, it is normal to see the critical roles played by a professor to discipline students, control over research processes, and even finding job positions for his students after graduation. In Malaysia, students are given bigger opportunities to participate in professional learning and position themselves as a part of wider research community.

On the other hand, the identity of belonging to their research group is one of the impressive characters found in the Japanese research laboratory. For example, the research laboratories in Japan are named based on the laboratory's head such as Saka *Kenkyushitsu*, Shioji *Kenkyushitsu*, Kawamoto *Kenkyushitsu*, and others (Megat Mohamed Noor et al., 2011; Serah & Noor, 2012). In Malaysia, research laboratory is rather known with its course name such as Photonics Research Laboratory, Biomass Energy Laboratory, Materials Science, and Characterization Laboratory. In addition, based on social interaction effect, the sense of belonging to a group would encourage students to imitate their mentors and PI (Falk et al., 2013).

Furthermore, the teamwork culture between student-professor and senior-junior is also a factor that contributes towards a sense of belonging in group. This could be seen from scheduled activities like cleaning the laboratory every Friday to inculcate collaborative attitude, punctuality, and confidentiality levels in any work in the future. This also points the elements of attitude, values, and ethics to complement the holistic approach of human capital (Hashi & Xareed, 2009; Binkley et al., 2012). It is reported that students who are willing to give better commitment towards the group have commonly been trained with good mentoring style (Stroth, 2015).

This fact was shown by some programs held between the alumni from Japanese universities. For instance, in the Kyoto Asean-Forum 2016 and the annual ISTECC (International Sustainability Technology, Environment and Civilization Conference), majority of the participants were alumni from the same kouza or affiliated kouza and learnt from the same professor (http://www.oc.kyoto-u.ac.jp/overseas-centers/kyoto-asean-forum-2016/en/). The event was organized to share their current research output and strategy. The long-lasting relationship is therefore beneficial in creating research networks among them within their own respective field of study. This idea leads to academic genealogy, where the chain of knowledge could be traced; creating diverse networks.

MENTOR-APPRENTICESHIP SYSTEM

In Malaysia and Japan, it is common to see a research laboratory managed without a technician in the laboratory due

to limited cost-factor. This is however against the strategy to adapt to the complex mode of the 21st century knowledge as delineated by Heitkemper et al. (2008). Both depend on the research members under the principles of mentor-apprenticeship to operate and manage equipment as well as manipulate multiple and complex data. In fact, this mentor-apprenticeship system is a common system practiced in the Malaysian and Japanese research laboratories. Despite the similarities, the system is a one way and a non-chain mentoring structure in Malaysia rather than a hierarchical structure in Japan. The pyramid system that is also known as kouza in Japan is practiced through a closed-mentoring relationship, whereas the older guides younger.

This notion rejects negative claims on professors who are simply taking a role to provide infrastructural environment of laboratory but neglecting the responsibility towards the development and performance of their students (Stroth, 2015). Since education is regarded as an intrinsic value in Japan, mentors are always concern on the mentee's development to reach their maximum potential, since it gives connotation to the mentor's failure if the students failed.

Another factor that differentiates Malaysia and Japan in terms of mentorship is the proper guidance from top assistant professors and associate professors to go to a higher level. The mentoring system in Malaysia is focusing on the level of PI-students and postgraduate (senior)-undergraduate student (junior), whilst the mentoring system in Japan encompasses sequence chain of mentoring from professors, associate professors, lecturers, to students based on the senpai-kohai relationship. This concept of learning by teaching enables social interaction and guidance from experts for a collaborative culture as highlighted in the social constructivism theory (Serah & Noor, 2012). The proper system in mentor-apprenticeship as practiced in Japan could also avoid misinterpretation on the role of a mentor to assist them as described by the Malaysian participant. The continuous chain mentoring is consistent to characterize the sequential teamwork of research group as discussed by (Etzkowitz (2003); Hulcombe et al. (2014); Morichika and Shibayama (2015)) in the previous literature section.

It is also noted in the prior study that communication skills, teamwork skills, leadership skills, information management, and professional morals are frequently mentioned in job advertisements (Ooi & Ting, 2017). Following this, proper mentoring system in projecting activities in research organization will be able to improve these skills and meet the current needs of the Malaysian industrial firms.

VI. MONITORING STUDENT'S DEVELOPMENT

As discussed by (Binkley et al. (2012); Azman et al. (2016); Tyler et al. (2016)), research monitoring is crucial in managing the students' talent development. Research monitoring can be discussed in two aspects. The first one is proximity of a professor and next is through research meeting. In both countries, certain professors work in the same research laboratory to monitor the students' progress closely. At the same time, there are also professors who work at other buildings and blocks with the assistance of postdoctoral researchers for continuous monitoring and research laboratory management. The coordination between professor and postdoctoral is important to maintain the mentor-apprenticeship system to occur smoothly. The role of *senpai-kohai* (senior-junior) is important in this situation to especially guide the experimentation process.

In terms of research meeting, there are regular but not scheduled meetings held with PI or supervisors in Malaysia. Sometimes, the formal meeting is held at least once a month or once every two weeks. There are also irregular meetings in certain Malaysian universities and online discussions held rather than face-to-face meetings. In contrast, there are scheduled meetings practiced in Japan to promote continuous and active participation among the students. This scheduled mentoring would cultivate the students' critical thinking, keep them updated, and track the research progress of every member in the laboratory. The research culture is established to be promoted as a training medium to students with adequate knowledge, skills, and attitudes in the future.

The scheduled monitoring process is also translated into managing the analytical machine properly with safety rules. Every machine, materials, and tasks in the research laboratory is highly accustomed to the standard operating procedure (SOP). Students would also be familiar with the SOP related to recycling, scheduled waste, burnable waste, and clean room culture. The responsibility to utilize equipment properly develops the sense of belonging and adaptation to the equipment, materials, and laboratory facilities.

VII. CONCLUDING REMARKS

The power of interaction in an organization is presented through the intellectual infrastructure in the research laboratory. The situation of managing allocation for training is not easy when it comes to limited funding. The mission for scientific production and graduates' training could be in-conflict (Shibayama, Baba, & Walsh, 2015). However, the results suggest that the cost of graduates' training could be reduced through the mentoring system. After joined the practical skill-building program, graduates could transfer the knowledge to their laboratory members and juniors. Since the mentor-apprenticeship is a common research laboratory system practiced throughout the world, it acts as a key strategy to make a tremendous support on the next layer of researchers that is known as succession planning (Azman et al., 2016; Tyler et al., 2016).

Despite that, the data also demonstrate the misinterpretation occurred on the mentoring concept. Hence, it is argued that it could be formalized through the structured mentoring system lies under the intellectual infrastructure (Feldman et al., 2013). The research laboratory must be equipped with good policy system to support the students' development (Shibayama et al., 2015). Based on the data, the mentoring is shared among professor, postdoctoral, graduate and undergraduate students. The peer mentoring relationship between postdoctoral, graduate and undergraduate students focuses more on technical aspect compared to the professor who advises on the theoretical knowledge and professional

skills growth (Strawn & Livelybrooks, 2012; Feldman et al., 2013). The professional skills nurtured not only limited in the context of research but also personality growth and emotional support. In addition to the study, the peer mentoring offers professional supports, mutual respect and expand communication skills, research management skills, teaching skills and self-esteem through the conducive open-spaced office (Tyler et al., 2016; Rosdi et al., 2018). Furthermore, the result drew attention that beyond in-house practices, research laboratory practices also expose graduates towards the professional working spectrum. It is important to provide a learning context whereas graduates can grow as professional researchers or even non-researcher (Brew, Boud, & Malfroy, 2017). These skills also present higher-order cognitive skills and socio-emotional skills that are strongly correlated to the labor market demand and prepared graduates for the job environment (Cunningham & Villaseñor, 2016).

To conclude, organized practices of research laboratories in universities could become hallmarks for the development of local science and technology policies (Ponomariov & Boardman, 2010). Although, this research might not be generalized, yet the discussion provided can be instrumental insofar the way research laboratory could help to develop skilled graduates. In addition, the small sample size in this study also offers further study to explore further activities of research laboratories with a broader sample by taking a phenomenological approach. This study could also explore deeper by complementing practices from both in-house and outside of the laboratory. Therefore, the strategic continuity of in-house practices and outside could link the way these practices occur.

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