IT Experiential Learning: The Living Lab

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Abstract - **In today's competitive job market, businesses will hire people with the relevant work experience, which creates quite a challenge for graduating students. Thus, graduating students also need experience to go with their degrees in order to be competitive in current job market. To better prepare our students, the Computer Information Technology program developed an experiential learning program called the "Living Lab". The Living Lab provides real world experience in all aspects of information technology to students by assigning various projects in a real work environment. This allows students to apply their classroom learning and develop the skills and experience needed to prepare them for today's competitive job market, which is the mission of the Living Lab. Just like the name, the Living Lab experiences remain ever evolving and complicated; thus, finding ways to effectively assess learning persists as a challenge. In this paper, we will show how the Living Lab evolved and the organization, management, and assessment tools used in order to provide students the best experience to assist in their obtaining jobs. Further discussions will show our findings and the innovative ways the lab evolved to take into account the blending of processes, business practices, and academic rigor.**

Keywords - experiential learning; IT; living lab; service

I. INTRODUCTION

According to Ferrara's research [6], the unemployment rate at 9.9% makes the current marketplace even more competitive, which adds more pressure for college graduates. Furthermore, the CareerBuilder survey concludes that less than half of employers prefer to hire recent college graduates in 2010 [6]. Therefore, without work experience, students will have a lower chance of getting a job. In order to help students overcome this difficulty, the Computer Information Technology (CIT) program in the Purdue School of Engineering and Technology at Indiana University Purdue University Indianapolis (IUPUI) developed an experiential learning program called the "Living Lab" (http://cit.iupui.edu/citnet). The Living Lab's mission is to provide experiential learning for students in the Information Technology and Security discipline. It immerses students in a real technology business environment and expands their knowledge and experience beyond the typical classroom environment. The goal of the Living Lab is to promote learning through challenging real-life hands-on experiences that are supervised by faculty, students and staff. Not only do the students improve their hard skills, but they are also taught soft skills.

Just like the name, the Living Lab experience remains ever evolving and complicated; thus, finding ways to effectively assess learning persists as a challenge. Furthermore, because the Living Lab is still so new, being able to organize and manage it won't be an easy task. With the efficient organization and management tools, the Living Lab's foundation will be greatly enhanced. It is necessary to assess student's learning, and to find the way to improve the organization and management of the Living Lab in order to ensure the validity of the course and provide students with the best experience to assist in the process of life-long learning and the ability to gain employment.

II. BACKGROUND

A. Literature Review

Experiential learning – or learning by doing – is an important factor in education improvement. The purpose of experiential learning is to fill the gap between theory and practice. Consequently, many researchers such as Walker [7], Krane [3], and McCarthy [4] have shown interest in experiential learning, which was proven to be a valuable asset in education. All of these authors believe that it is important to bring theory which was studied in class into a real-life situation where the students can apply what they have learned to solve problems. They agree that experiential learning plays a significant role in education improvement. In their research, they explained the link between theory and application as well as the necessity of experiential learning. However, each of them expressed their ideas in a unique way.

Walker [7] described the process of experiential learning, and how students adapted to this process. Unlike Walker [7], Krane [3] implemented a self-directed learning course and showed its result. McCarthy [4] took a different path and focused on comparing an example of experiential learning and traditional learning. According to Walker [7], the process of experiential learning moved students from passive recipients of information to learners who observed and experienced phenomena in the workplace; as a result, the students were better equipped to implement the principles they learned from class in the marketplace. While Walker [7] showed a general process of experiential learning, Krane [3] applied it to a specific area such as physiology. He realized that there was a disconnection between what information was retained in the laboratory exercise and its application in a practical setting. According to Krane [3], students tended to memorize information in a static pattern rather than process information and formulate strategies for truly understanding the dynamism. Krane [3] created a course which was designed to extend the individual lessons performed in the laboratory course with self-directed learning through the contextual application of information. He also showed that the students' responses were overwhelmingly positive despite a small number of students expressing disappointment due to schedule conflict or an

unexpected event. On the other hand, McCarthy [4] didn't apply experiential learning to any specific area, but compared between case study method which was popularly used in a class and job shadowing method which was integrated into a business course. McCarthy [4] said that direct learning forced students to make their own decisions when facing a real-life problem. When students engaged in tasks, it fostered the development of their skills. McCarthy [4] incorporated job shadowing in a junior-level business communication course. Students who took this course would need to write a research paper, orally share experience with each other and complete a survey. After that, she evaluated all activities, and used paired-samples t test for job shadowing and cases. With the t test in 95% confidence level, she concluded that experiential learning was preferred over traditional learning.

In the same way, Massachusetts Institute of Technology (MIT) developed a similar program called "Action Learning" (http://actionlearning.mit.edu). MIT Action Lab said "Our approach integrates theory, real world practice, and personal reflection to develop principled, innovative leaders who solve complex problems and produce systemic changes" [5]. For this reason, Action Learning offers many opportunities for students such as China and India Lab, E-Lab, Global Health Delivery Lab, Global Entrepreneurship Lab, i-Teams, L-Lab, P-Lab, and S-Lab. Each of these labs encloses a different segment of learning perspective. China and India Lab focus on international cooperation while E-Lab focuses on local internship. Global Health Delivery Lab helps students learn about healthcare perspective. The i-Teams (short for "Innovation Teams") lab teaches students the process of science and technology's commercial potential. And Global Entrepreneurship Lab, L-Lab, P-Lab, and S-Lab focus on business perspective.

In short, all of these researchers have proven the important role of experiential learning. Walker [7] showed a general process of experiential learning which consisted of four stages, whereas Krane [3] actually implemented experiential learning to a specific area such as physiology. On the other hand, McCarthy [4] compared between case study method and experiential learning method. Furthermore, MIT University realized the advantage of experiential learning and developed the "Action Learning" program [5]. In other words, experiential learning was an excellent supplement to the classroom environment, which allows student's learning to extend past classroom walls and into the real world environment. Experiential learning presents students the opportunities and problem solving skills which are usually encountered in the workplace so that it required them to think and apply theories to solve problems. It also helps them experience teamwork and expand their learning. Walker said: "This process is indeed a necessary tool in which students expand their abilities to analyze, reflect, and make adjustments" [7]. However, Walker [7] showed a general process of experiential learning but didn't show the application of the process. Krane [3] applied experiential learning to a specific area such as physiology, but didn't actually assess student's learning in depth. McCarthy [4] analyzed and compared experiential learning with traditional learning, but she didn't analyze for the actual improvement of student's learning. Moreover, MIT "Action Learning" program [5] is too general and doesn't focus specifically on Information Technology. Most of their labs are on external sites and are optional for students whereas "Living Lab" is an in-class and required course which students have to take before graduation. The "Living Lab" is a true experiential program and focuses on a student's true immersion into the business environment.

B. Living Lab Genesis and Organization

It is all started back in 2001 when the CIT faculty needed a server that ran Microsoft's IIS 4.0 for their courses. However, due to security risk, University Information Technology Services (UITS) would not install it in any of their labs. Therefore, the CIT program acquired their own servers starting with two machines. The servers continued to grow, not only to be used for courses, but also to support faculty for their testing space. The first recruited CIT student was able to maintain, monitor and administrate the servers. Meanwhile, the program coordinator was also trying to design hands-on laboratory for networking courses. From there, the idea grew and the Living Lab was born.

The course requires no previous work experience and students that have completed the introductory networking courses are eligible for the Living Lab. The students work under the supervision of faculty and/or staff, supporting CIT's web site, database, security, and networking labs. The internal projects vary from being simple to being complex such as server management. When their level of experience and expertise grows, students are ready to work on external projects in other companies who cooperate with the Living Lab such as Simon Properties Group, Inc.

The first Living Lab roster started with 6 students and grew to 24 students in the fall of 2010. Currently, there is an average of 14 students attending the Living Lab each semester. The CIT program utilizes two student classrooms (ET005 and ET007) to support the lab work for networking and security classes. Today, the Living Lab has expanded to include support for other departments at IUPUI. There are 15 workstations in the room ET005, 30 workstations in the room ET007, and 32 servers in the server room (ET005A). These labs are isolated from the campus network, and give the students administrator access to the workstations, which provides a realistic working environment without a risk of security breach on the campus network. As a result, it offers instructors in the security courses a chance to introduce vulnerability and risk assessment tools for the students. Moreover, the Living Lab provides firewalls, switches, routers, etc. as class materials to students. Therefore, the students get some hands-on experience using equipment and software as part of their class work. Students who complete the Living Lab gain even more experience by maintaining the labs and completing assigned projects. Furthermore, all of the classes taught by the CIT program have the ability to host applications and websites on the Living Lab servers. These servers are also built, administered and maintained by students in the Living Lab. Fig. 1 shows an overview of the Living Lab organization.

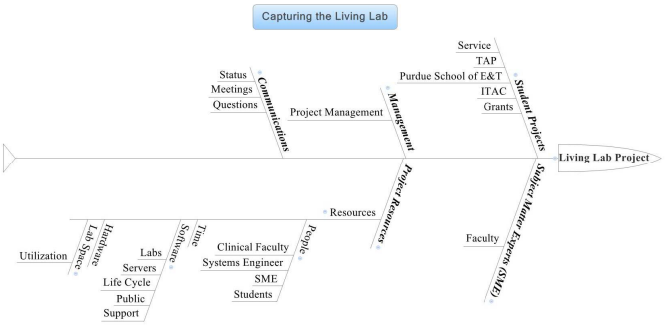

Figure 1. Living Lab overview.

III. MANAGEMENT

To qualify for the Living Lab, students must have successfully completed the first two semesters of courses in the curriculum. It is a required course before the students graduate.

All members are required to attend weekly meetings, including supervising faculty. In the weekly meeting, each student must report on their project work. These meetings are conducted similarly to status meetings in a corporate environment, which provides each student with real world experience. In addition, students are present in the Living Lab on Fridays and Saturdays from 9am to 5pm during the semester (supervised by systems engineer). Supervising faculty and staff have weekly planning meetings as well. Project management tools are used to track the progress and document milestones for each project. The project management tools provide a roadmap for the students to make sure deadlines are met. Projects being assigned to students include technology projects for the department, external service learning projects, university-wide projects. Recognizing the role of reflection in extracting learning from experience, each student in the Living Lab is required. Students keep track of their projects during the semester by writing status reports and journals. Status reports document all the project milestones. Journals document project activity as well as any processes helping to accomplish a particular task in the project with personal reflection. As a result, journals offer students a chance to reflect on what they have been learning and how it relates to the theory they memorized from courses taken before. Likewise, students also need to create documentation (how-to) by recording their processes, procedures and fixes. This is extremely important. Not only does it help students to have a best practice, but also makes the process easier. If a similar situation arises, other students can look at the documentation for help. As the students reflect and document on their project work, they gain confidence in their ability to accomplish any IT project or task that they are given. It is amazing to see students without experience come into the Living Lab as uncertain neophytes and leave with confidence in themselves and their abilities. Fig. 2 illustrates the Living Lab methodology.

Figure 2. Living Lab methodology.

The project opportunities for students are wide-ranging. Projects can come from the CIT program itself, other university-wide departments, or even externally from other companies, and nonprofit companies. Here is a list of some projects, which were assigned to students in the Living Lab. More information about Living Lab projects can be found via our website at http://cit.iupui.edu/citnet.

- Living Lab web site development
- SharePoint server / Oracle server setup
- Secure media sanitization
- Bacula Backup Project
- Dell OpenManage Server Admin
- Symantec Ghost implementation
- Encryption protocols implementation
- Nagios setup and configuration
- Forensic projects: Encase, FTK
- External projects: Simon Property Group, Inc., Avon Church

At the end of semester, students are required to submit all deliverables for grading: project report, presentation, poster, weekly status, and journal. The project report is an overall summary of all the project work, including what students have accomplished over the semester and, more importantly, what the Living Lab experience has meant to them. They are expected to clearly state what kind of projects they did, the purpose of each project, how this experience related to their course work, and how it may help them with future employment. To summarize, Fig. 3 shows the flowchart of Living Lab processes.

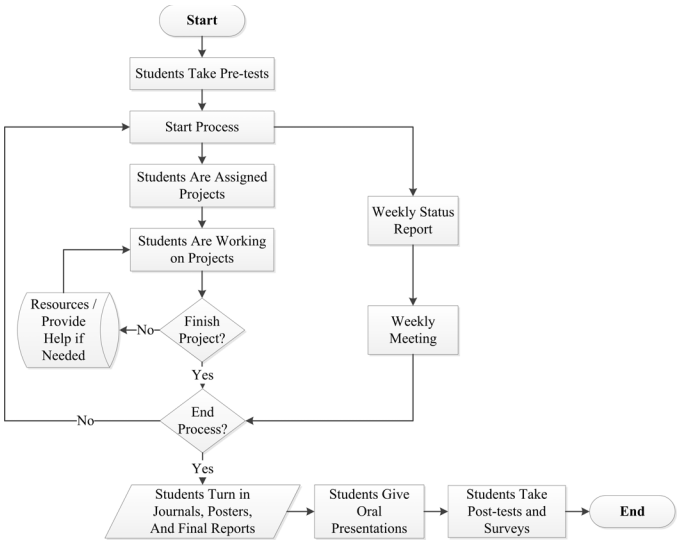

Figure 3. Flowchart of Living Lab processes.

IV. ASSESSMENT OF STUDENT'S LEARNING

Many researchers such as Brinke & Jochems [1], Koriat & Bjork [2] think that student's learning needs to be evaluated. Not only does it help to know whether the student's learning improves during the course but also helps to identify any problem and find a solution for it. Therefore, learning assessment was also an important factor in this picture. It helped to evaluate the student's learning outcomes. Without student's learning assessment, we would not know if students are learning or meeting the course expectations. And the main question is: "Will student's learning increase or remain unchanged after they complete the Living Lab?"

A. Participants

Since this study was intended for the Living Lab, the population of this study was all students participating in Living Lab. Students in the Living Lab between Spring 2010 to Spring 2011 served as the sampling frame (see Table I). That was small enough so that all students in the sampling frame would be included. The advantage of this is the ability to test all the individuals in the segment of the population in order to obtain reliable, valid and accurate results.

TABLE I. SAMPLING FRAME

Semester	Number of students
Spring 2010	13
Fall 2010	16
Spring 2011	7
TOTAL	36

B. Materials

In this study, the quasi-experimental approach was utilized to obtain a general overview of the student's learning performance. Single-Group Pretest/Posttest design was used. A skill assessment test was developed and designed based on general knowledge about Computer Information Technology. It was divided into 9 different areas of knowledge, all of which were necessary for students to know in order to be able to get a job. Also, a course evaluation survey was used to ask for students' opinions and suggestions about the course and the skill assessment test.

C. Procedures

The students took the skill assessment test at the beginning and the end of the Living Lab through an electronic testing tool in the university learning management system. These tests were graded based on a grading checklist with a total of 100 points. The two measures of the pretest and posttest could then be compared, and any differences in the measure were assumed to be the result of the course. Furthermore, at the end of the Living Lab, the students took a course evaluation survey. The surveys were also collected for future reference.

V. RESULTS

By completing the Living Lab, students learn to develop self-directed learning ability in a real-world environment as well as to integrate knowledge studied in the classroom with practical application. They learn to manage projects effectively, work in a team, and communicate their synthesis and interpretation of the experience in both written and oral presentations.

To test for whether student's learning increases or remains unchanged after they complete the Living Lab, pretest and posttest scores were examined. Pretest and posttest scores were collected from 36 students in 3 semesters. Table II shows the mean test scores of pretest and posttest by semester.

Before doing any analysis, the null and alternative hypotheses were defined. The null hypothesis was that student's learning remained unchanged after they completed the Living Lab; and the alternative hypothesis was that student's learning increased after they completed the Living Lab. A paired-samples t test was conducted to determine if there were any significant differences among the pretest and posttest scores. In addition, the result in Table III indicates a significant difference at the 0.05 level of significance among the means of the pretest and posttest scores.

A paired-samples t test was calculated to compare the mean pretest score to the mean posttest score. The mean on the pretest was 22.7597 (sd = 12.35004), and the mean on the posttest was 36.8872 (sd = 21.72411). A significant increase from pretest to posttest was found ($t(35) = -3.675$, $p < 0.001$).

TABLE II. MEAN TEST SCORES

Semester	N	Pretest Mean	Pretest Std. Dev.	Posttest Mean	Posttest Std. Dev.
Spring 2010	13	19.66	0.11	37.65	0.212
Fall 2010	16	27.22	0.137	40.59	0.186
Spring 2011	7	18.34	0.091	27.00	0.289

TABLE III. PAIRED-SAMPLES T TEST

Paired Difference (Pretest – Posttest)	t	df	Sig.

Paired Difference (Pretest – Posttest)				t	df	Sig.
		95% Confidence Interval of the Difference				
Mean	*Standard Deviation*	*Lower*	*Upper*			
-14.128	23.062	-21.93	-6.324	-3.675	35	.001

As a result of the paired-samples t test, we rejected the null hypothesis. Student's learning did increase significantly after they completed the Living Lab. Fig. 4 illustrates the pretest and posttest scores per students.

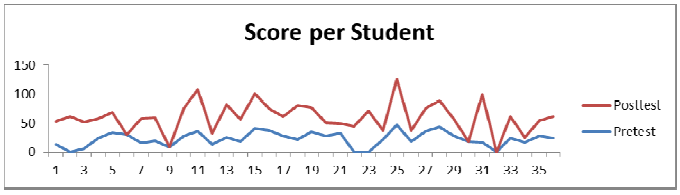

Figure 4. Pretest and posttest score difference among the students.

On the other hand, Fig. 5 illustrates the pretest and posttest score per semester.

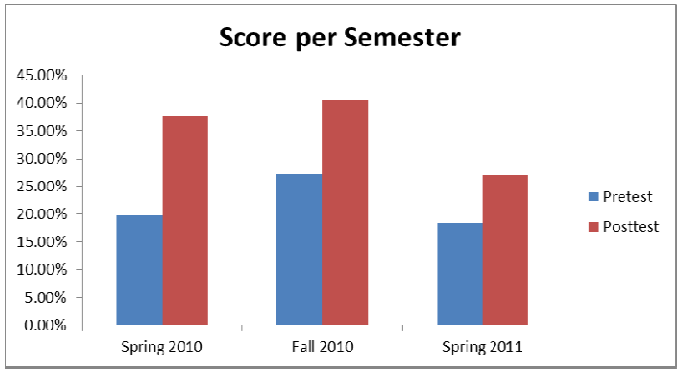

Figure 5. The pretest and posttest scores per semester.

VI. DISCUSSION

The Living Lab aligns with the mission of the CIT program by helping students to develop modern technological skills, effective oral and written communication skills, and the ability to perform well in teams. The program has produced experienced students who can function in the IT space with confidence. Buoyed by its success, and to continue to help prepare our networking students to meet the needs of today's employers, we have recently added a mandatory IT experience for all students in the entire CIT curricula. The Living Lab is one way to meet this requirement. Furthermore, we try to expose students as many different projects possible so that they can experience a variety of skills. Besides receiving many projects from other department or external organizations, we also focus on experiential services such as volunteering projects for churches, charities, etc. Along with the process, there are some challenges that we has faced.

A. Challenges

The Living Lab has faced several challenges over the years, primarily how to accommodate the numbers of interested students, and projects to work on, processes of taking project from initial to final stages, and assessing student work. To be effective, each student or student team must have at least one project that he or she can research, implement, and maintain each semester. Furthermore, Living Lab business hour in the lab for the students to do their work was also a problem. Since the labs and servers supported by the Living Lab are used almost nonstop during the week for CIT courses, business hours for the Living Lab had to be on Friday and Saturday from 9am to 5pm. However, this schedule is not always conducive for those students who work weekdays. In order to solve that problem, students work any other weekday or offsite in the evenings to complete their projects.

B. Assessment Evaluation

Living Lab successfully integrated the work environment into the academic environment. Rapid project completion inside of the Living Lab raises the need of student's learning assessment. It is necessary to perform an assessment on student's learning in order to determine whether students actually learn after completing the Living Lab. Using comparative means analyses, we found that there was a significant difference among the pretest and posttest scores. This can suggest that student's learning did increase after they completed the Living Lab. Surprisingly, as showed in Fig. 5, we could see a slight increase from Spring 2010 semester to Fall 2010 semester, and a significant decrease from Fall 2010 semester to Spring 2011 semester. This change is due to the number of students completing the Living Lab (see Table I). This result suggests that the more data collected, the more accurate the hypothesis test would be.

Because the pretest/posttest design includes only one group, there is a limitation in this study. Testing effect confound might affect the results since experience with previous test may change performance. It occurs when taking a pretest influences students' behavior on a posttest; for example, students would be more relaxed on the posttest because it is now a more familiar testing situation, or taking the pretest allows them to have practice with the particular types of items on the test. The design does not control for potentially confounding extraneous variables such as testing effect; so it is still difficult to identify the effect of the "Living Lab treatment" condition. Furthermore, this study lacks a comparison group. With no comparison group, we do not know whether any observed change in student's learning is due to the "Living Lab treatment" or to something else that may have happened during the time of the study. For example, maybe the students got a job while taking the course. Therefore, the students might have scored higher on the posttest regardless of whether they completed the Living Lab or not.

Further research requires a control group, thus minimizing confounds and ensuring the validity of this study. In addition, the skill assessment test can be re-edited in order to keep the

testing questions updated. A feedback system will be developed to collect the future success of students who took the Living Lab. With this information, we can evaluate how effective the Living Lab is in helping students acquire work. Despite the limitation, the data analysis revealed that student's learning increased significantly after they completed the Living Lab.

VII. Future Work

During the Living Lab development, we found several innovative ways to evolve the lab while taking into account the blending of processes, business practices, and academic rigor.

A. Project Management

In future work, we will implement a SharePoint server incorporating with Microsoft Project to manage the students' projects, documentation, research, and many more. This will be our main base of collecting and storing information. All the incoming project opportunities will also be managed through this server. Furthermore, all the communication between students and staffs or between students and their projects will happen through server services. Therefore, we will have a controllable and centralized system which helps to keep track of students' deliverables, work hours, documentation, etc. This will significantly enhance the Living Lab organization.

B. Assessment Process

In order to improve the assessment process, all the questions in the assessment test need to be revised and restructured. Because the assessment test will measure student's learning through Living Lab process, it needs to cover as many standard skills as possible. Despite that, the assessment can't be too long. Fig. 6 and 7 show an overview of the assessment test which we had used. Furthermore, because each student has a different skill set, it is hard to test him or her based on only one general test. Figure 8 show the new assessment test and includes two parts: general questions and project-based questions. The general questions include all the basic concepts of computer techniques, e.g., shortcut keys, simple command line, standard knowledge about computer information such as policy, network, computer process, etc. The project-based questions will include more specific knowledge of many different areas of IT. Depending on students' background, they will take a different part of the assessment test. As a result, the learning process of students with different majors can fully be assessed.

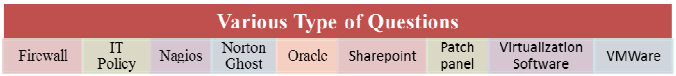

Figure 6. Original set of questions in the assessment test.

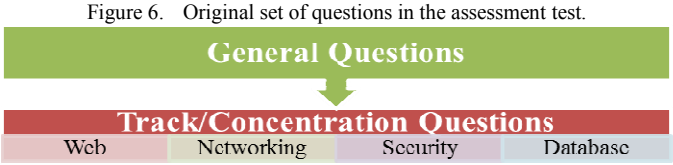

Figure 7. The 2nd generation of the assessment test.

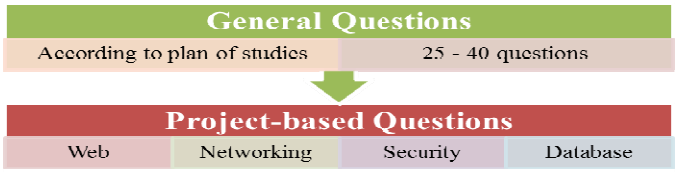

Figure 8. The future of assessment test.

The Living Lab process consists of two aspects, academic and business. The academic portion is based on course outcomes and is graded by a students' performance and final deliverables. The business side, is based on IT current and new project opportunities as well as grant and support. In order to maintain a balance between academic and business, a clear process needs to be defined. Figure 9 demonstrates the interaction among these components.

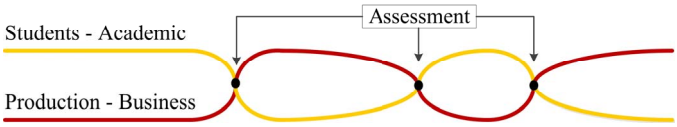

Figure 9. Living Lab streamline.

In conclusion, although the Living Lab is still a new concept, it successfully fulfills its mission. According to the student's learning assessment, the Living Lab significantly helps students improve their skills through the experiential learning process. Furthermore, feedback from the students who took the Living Lab is positive. With constant ongoing innovation, the Living Lab will continue to evolve. It is a very powerful tool of which every educational institution needs to take advantage. Not only does it equip students with knowledge and experience, but it also gives them a solid direction in the way of their professional quest. It is truly one of a kind. It is hoped that this analysis shows the value of the Living Lab, and encourages more institutions to adopt this course.

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