How to adopt Japanese knowledge and technologies to solve societal issues in developing countries through research and innovation

Studying points

Students are expected to experience the journey of a JICA scholarship student who studied in Japan. He and his research team have been utilizing their gained knowledge and expertise in their home country, having adopted a system learnt in Japan that generates effective ways of research to offer solutions to its societal problems.
Through this case discussion, students will reflect on their study and research experience in Japan. Also, they will discuss the possible challenges and/or obstacles that they may face back in their home countries when trying to utilize gained knowledge and expertise. In addition, they will discuss what may hinder them in the process of trying to contribute to their countries' development.

Basic information

- Region: East Africa
- Issue: Adopting Laboratory-Based Education (LBE) in a university in a developing country
- Key words: Higher education, Laboratory-Based Education (LBE), 3D printer, digital fabrication, environmental issues, waste-management, research and innovation
- Country: Republic of Kenya
- Year: 2018-present

Characters

Characters	Description
Dr. James Mutuku Mutua (Main character)	Former JICA scholarship student, Lecturer at the Jomo Kenyatta University of Agriculture and Technology (JKUAT)
Dr. John Odhiambo	Former MEXT scholarship student, Lecturer at the Jomo Kenyatta University of Agriculture and Technology (JKUAT)
Dr. Mariam Kassim Ali	Former scholarship student of Egypt-Japan University of Science and Technology (E-JUST), Lecturer at the Jomo Kenyatta University of Agriculture and Technology (JKUAT)
Dr. Peter Kamita Kihato	Workshop Manager, Engineering Workshops Department at the Jomo Kenyatta University of Agriculture and Technology (JKUAT)

Abbreviations

JICA	Japan International Cooperation Agency
JKUAT	Jomo Kenyatta University of Agriculture and Technology
LBE	Laboratory-Based Education
MEXT	Ministry of Education, Culture, Sports, Science, and Technology
3D	Three-dimensional

Summary

Dr. James Mutuku Mutua, a former JICA scholarship student, completed his PhD at Tottori University in Japan in March 2018. During his study period, he learned about the Laboratory-Based Education (LBE) system. LBE is a form of education which emphasizes to holistically conduct research and education in a laboratory. Laboratory, in this context, is equivalent to a research team. The laboratory is comprised of 4th year undergraduate students and graduate students including both Master and Doctor.
Having learnt in this educational environment, he envisioned to adopt the system and form a laboratory in his university after going back to his home country. However, the journey to the adoption of the system was not as smooth as he had planned.
The chronology of events in this case study is as follows.

Chronology of events

March 2015	Start of Dr. James Mutuku Mutua's study at Tottori University in Japan as a JICA scholarship student
March 2018	Completion of Dr. Mutua's PhD program in Japan
April 2018-Autumn 2018	Negotiation with the Workshop Manager at JKUAT about securing a space for Dr. James Mutua's laboratory
Autumn 2018-End of 2018	Dr. Mutua's recruitment of laboratory members
Early 2019	Start of the laboratory led by Dr. Mutua
Early 2019-present	Ongoing research led by Dr. Mutua and his laboratory members

Key questions

Students are required to discuss the following:

1. What are the unique advantages and good influence LBE can provide to academic engineering research?

2. In order to enhance the LBE advantage in research work, what kind of conditions, circumstances and environment should be prepared?

3. What kind of challenges will you face in your country when you implement LBE system in research work?

4. To solve the challenges listed at Q3, what kind of actions should your country take to design, arrange and implement? And how should you be involved in those actions?

5. What could be the difficulties in utilizing your knowledge and expertise obtained in Japan after going back to your home country?

1. Prologue

In March 2015, Dr. James Mutuku Mutua, currently a Lecturer at the Jomo Kenyatta University of Agriculture and Technology (JKUAT) in the Republic of Kenya, started his study at Tottori University in Japan, under Japan International Cooperation Agency (JICA)'s scholarship program.

Ever since he was a high school student, it was his dream to study in Japan one day where they had well-equipped research facilities and advanced technologies in the field of Engineering. He believed that Japan was a country which is passionate about research. So, he thought he could engage in a suitable environment for cutting-edge research. After several attempts in applying for scholarship program in Japan, he finally obtained a scholarship as a JICA long-term participant.

He arrived in Japan with high hopes for the upcoming three years to engage in his PhD program. He was very excited about what was waiting for him.

He started his study at Tottori University located in the western part of Japan.
He was amazed by how well equipped the facilities in the laboratories in his department were, how organized they were, how they were neatly laid out in the laboratory space and how equipment was well maintained. There was also a lot of modern and high-tech equipment in the laboratory that he had never seen before.

Shortly after starting his study in the university under the guidance and supervision of his Professor, he realized that in the field of science and technology,

Laboratory-Based Education (LBE) is commonly adopted in Japanese Universities. LBE is a form of education which emphasizes to holistically conduct research and education in a laboratory. Under the LBE system, the 4th year undergraduate students, graduate students including Master, Doctoral and Postdoctoral researchers who have completed their PhD take part in the research projects of the laboratory. They jointly conduct research under an academic supervisor's guidance.

In Japan, laboratory affiliation is often implemented for Master and Doctoral students in the field of Science and Technology. This enables students to devote great amount of their time engaging in experiments, discussions, and seminars with their academic supervisors and fellow members. Typically, most Professors would have a laboratory. This laboratory means a research team, not room for experiments. A laboratory often consists of 10-20 students led by an academic supervisor who is a Professor, Associate Professor, and/or Assistant Professor. Normally, students submit an application to join the research team based on their research interests and topic. If the applications are accepted, they get a chance to conduct research under the Professor's guidance and use the university's research facilities.

Many laboratories provide designated workspace for each student to focus on her/his research in the same room as her/his academic supervisor. In addition, laboratories have well-equipped machines, high-tech equipment, reagents, and consumables for students to fully engage in their research activities. Machines and equipment are always well maintained and organized as there are discipline and guidelines set within the laboratory.

Why do many universities in Japan have such rich research facilities? It is because a university's research budgets are secured by multiple financial sources. They include the university's public expenditure, funding from the private sector, other private grants, and the competitive research funds provided by the Japan Society for the Promotion of Science (JSPS) and Japan Science and Technology Agency (JST).

Professors often apply for research funds that enable them to facilitate the procurement of new equipment or the upgrade of existing research facilities in laboratories. Students are entitled to fully utilize the advanced technologies and conduct their research in an extensive research environment.

However, back in Dr. Mutua's university in Kenya, the research budget was not as abundant as Japan. Seeking a budget from his university for new equipment or even materials and reagents was difficult. There were facilities in his university and students could use equipment for their study and research activities, however, the range of equipment was completely different from that in Japan. And how the laboratory was run was different from the Japanese style.

Dr. Mutua remembers that there were weekly meetings with his whole laboratory

to update their research progress in Japan. One-on-one meetings with his supervisor were also conducted to share his concerns and update laboratory research. Also, seminars were organized regularly, which enabled him to enhance his presentation and communication skills. Close daily communication and interactions with his professors and fellow members were stimulating as members had common research goals.

The laboratory consisted of students from different backgrounds. They ranged from 4th year undergraduates to graduate students and postdoctoral researchers. Many of his fellow members who had been affiliated with the laboratory for quite some time had much hands-on experience. They were also highly knowledgeable about the use of machines and equipment in the laboratory. Hence, they could cooperate and assist each other without the presence of their professor.

Thus, the support system within the laboratory was in place, information sharing was well organized and strict timelines were kept and maintained for the students to complete their studies within a certain set period. So, Dr. Mutua thought that he could rely not only on his supervisor but many of his laboratory members when he needed assistance.

He realized that this research environment was deeply embedded in the Japanese culture. The culture values strict time management, close information sharing amongst members and respecting and cooperating with one another to meet the research goals. In addition, he felt that the common Japanese mind of 'Small act can make a difference' existed within the laboratory. This is important as research activities were often time consuming and continuous improvements were inevitable to reach the research goal. In fact, weekly presentations and seminars to seek input from his professors and fellow members accumulated to a good research result, and to the enhancement of research abilities.

The Japanese style of LBE emphasizes research activities conducted in a laboratory. The LBE is centered on team research rather than coursework centered education. Through this learning environment, students can obtain problem solving skills, expertise, and soft skills such as management and communication skills from this practical education through research.

By fully engaging in this Japanese style of LBE in Japan, Dr. Mutua started to engage with the idea of adopting this system back in his home country. This is because he thought this style was very effective as it harnessed better research, and he strongly believed that it could contribute to the research development in his country.

2. Adoption of LBE (physical space)

Dr. Mutua completed his study in Japan in March 2018. He went back to his home country with the vision of adopting the Japanese style of LBE and forming a laboratory based on a research team in his university immediately. However, the

first thing that came to his mind was ‘How could I make that happen?’

To start something new within an organization is not always easy. The immediate problem that Dr. Mutua faced was a lack of space within his university. Compared to Japanese universities, the total number of enrolled students was larger in his university. A lack of classrooms and moreover staff’s office spaces has been a long-term challenge. Many university staff were not able to have individual office space and had to share with other staff.

When he consulted with other colleagues about the idea of implementing laboratory-based research in his university, he received many questions such as ‘How are you going to secure the space when you do not have an office?’; ‘How are you going to get the machines?’; ‘Do you think you are going to get a space to put even two machines?’; ‘Where are you going to get the money to buy machines?’, etc. Some believed that it couldn’t happen in his university as many of the staff were struggling to get office space, research funds, and research equipment.

First, Dr. Mutua consulted with Dr. Peter Kamita Kihato, the Workshop Manager of the Engineering Workshops Department. Dr. Mutua asked Dr. Kihato whether it would be possible to secure a space within a building located at the Administrative building of the Engineering Workshops. This building had several rooms equipped with some machines, equipment, and tools. Both undergraduate and postgraduate Engineering students could use them for classes. Students and staff also used the facility for their research activities. The rooms in this building were always occupied because many classes were being conducted there and many students were using them. Thus, it was not an easy negotiating period for Dr. Mutua. After several months of consultation with Dr. Kihato, Dr. Mutua was finally granted permission to use one of the rooms in this building for his laboratory.

Now that he had secured a space, the next step was to form a laboratory, a research team.

3. Adoption of LBE (members)

Dr. Mutua had an idea about a laboratory. He wanted to establish a research team in the area of Materials Engineering and additive manufacturing which would focus on few thematic areas. And he had several members in mind.

He thought it was indispensable to recruit those who could share the same vision, goal and mind-set in establishing a laboratory. Besides, he wanted those who are time conscious and have strict time management skills. These characteristics were not common in his country. In fact, many people were often laid back and were not time conscious. Nonetheless, luckily enough, he could find several faculty members who had studied in Japan and were well accustomed to the Japanese culture.

One of the potential members was Dr. John Odhiambo. He was a former MEXT scholar. From September 2018, he studied at the same university as Dr. Mutua under the same supervisor. Having experience studying in the same laboratory as Dr. Mutua, Dr. Odhiambo was fully accustomed to the Japanese style of laboratory and believed that this research style could lead to better research outcomes. Another potential member was Dr. Mariam Kassim Ali, an early career researcher. She conducted research in a Japanese university for 9 months, and therefore had experience in the Japanese style of LBE. Other candidate members include those who had obtained a PhD in China and in South Africa. There were also a few other staff members who were considered as the best candidates for the research team.

Most of the best candidates were from the same faculty who had completed their PhD abroad and they had experienced conducting research in a similar environment as Japan.

When Dr. Mutua approached these members, they had all agreed to join his laboratory, as the research team. A research team with 8 members was finally established. The research team had four thematic research areas. Under each thematic area, two staff were appointed as Team leaders. Dr. Mutua also became a thematic leader. Thus, a laboratory was finally formed with those who had a similar mind set in trying their best to achieve their research goals.

4. Adoption of LBE (equipment)

In Kenya, plastic pollution has been one of the major environmental issues. Despite the country's ban on the manufacture, sale and use of plastic bags in 2017, the country has been facing plastic pollution.

Many researchers in the country have come up with innovative ideas to transform plastic waste into useful items. Dr. Mutua's research team was amongst them. The goal of the team was to offer feasible solutions to societal problems through their research and innovation.

One of the technologies that Dr. Mutua's research team used was three-dimensional (3D) printing. 3D printing is a widespread technology that constructs a 3D object from a digital 3D model. The advantages of 3D printing are rapid prototyping, fast design and production and cost-effectiveness. 3D printers can quickly create product models and prototypes. Besides, 3D printing helps in the additive manufacturing of plastics. Hence, 3D printers as well as 3D scanners were critical machines in the advancement of their innovative research.

Although the price range of 3D printers varied from $200 to $1 million, depending on the uniqueness of the technology and quality assurance features, securing this equipment was challenging due to the limited budget. The complicated procurement process made it more difficult. Unlike Japanese universities, procurement in Kenya was not easy.

Japanese universities have many 3D printers. They are commonly manufactured in Japan and many developers/companies produce these machines. When such machines were locally manufactured, they were easily available. The procurement was easy if you had a budget. However, the equipment that Dr. Mutua's team wished to have was not locally manufactured or available in his country. Hence, they had to import it from abroad. In addition to the equipment being expensive, importing such equipment was also a challenge because of the high import duty rate. Also, clearance process of imported goods with customs station was time consuming. It sometimes took up to a year.

What were the possible solutions to overcome budget barriers and sourcing of equipment and materials? This had been the challenge that the research team had faced since the start. The team had eagerly sought research funds from various organizations and applied to research calls every year. Eventually, they had been selected and awarded with some research funds from some organizations. With these funds, they managed to procure 3D printers and 3D scanners which were very instrumental in their research.

Research requires time and patience as results for experiments do not always come out as expected. So does procurement of equipment. Dr. Mutua concurred with the common Japanese mind-set that 'Small acts can make a difference'. He believed that even if it's something small, you should do what you can do so that it makes a difference. This is the mentality that he learned during his study in Japan.

Dr. Mutua and his team continuously introduced new equipment and machines in the laboratory space and begun to feel that the small things were seen to be growing bigger each year. Being able to develop by continuously improving what you have is one of the lessons that Dr. Mutua learned in Japan. And all the work and techniques that he had put into the laboratory was what he had learned in Japan.

5. Adoption of LBE (system)/ Epilogue

Since the launch of the laboratory, a research team in 2019, a number of students (e.g., Bachelor, Masters and PhD students) had approached the team for their supervision. These students learned about the team through some of the team staffs that taught in classes. The team has continuously tried to cultivate the research culture with their students. Eventually, it managed to have Bachelor and Masters students graduate, and even guided a PhD candidate to completion within three years. This was a great add because it was quite common within their university for a PhD candidate to take as long as 5 years or even more to complete their PhD research.

Dr. Mutua and his team have persistently embraced the Japanese-style laboratory culture. They strive to secure time with students, ensure close communication with them, hold regular update meetings, and provide

consultation opportunities for students.

Dr. Mutua's goal is to establish a laboratory system where peer learning is cultivated from the lowest level of Bachelor up to PhD led by the research team. This is still an ongoing process. There are some differences between the Japanese methods and their systems. The first is the composition of team members. Dr. Mutua's research team, the 'Materials and Additive Manufacturing Research Team', is led by him and seven other staff members. The team focuses on two main thematic areas: Development of novel additive manufacturing material, and Applications of novel additive manufacturing materials. Under the two thematic areas, there are two teams, each led by a Team leader. This style is different from the Japanese laboratories where usually one or two Professors and/or Associate or Assistant Professor lead the laboratory in several research areas.

The second difference is the size. In Japanese universities, the average number of students in a laboratory is at most 20 people. Dr. Mutua's research team is larger than that. Currently, 2 PhD candidates, 17 Masters and more than 15 Bachelor students belong to it. This may be because of the large number of students in the university.

The third is the educational system for Engineering students. In Japan, Bachelor students in science and technology field study for 4 years. They choose a laboratory in their 3rd year. When they start their 4th year, they are affiliated to a laboratory and conduct research activities from the beginning of their 4th year. They submit the research result as a thesis at the end of their 4th year, so they have the whole year to engage in research activities there. In Kenya, engineering students study for 5 years. In the first semester of their 4th year, they take a 'research methodology and proposal writing' module. In the first semester of their 5th year, students have another proposal writing module. Eventually, in the second semester, they engage in final project and conduct research for their dissertation. Hence, these students have shorter period to engage in research activities than Japanese students.

The fourth is the laboratory space. Japanese laboratories provide designated workspace for affiliated students so that they can focus on their research in the same room of their academic supervisor. However, Dr. Mutua's laboratory space does not have the capacity to facilitate all research team members. For instance, Bachelor students cannot have designated working spaces. When a meeting involves all the team members, alternative venues have to be arranged.

The fifth is mentorship. The laboratory room has some equipment. Bachelors, Masters, and PhD candidates can use them and learn in the same environment. Nonetheless, the mentorship of senior researchers to young researchers is not so much seen. The integration of all levels of students to enhance and strengthen the research capability is also an ongoing process.

Nevertheless, some features appear to have been adopted successfully. Weekly progress meetings have been conducted with students in different thematic areas. Dedicated day and time have been scheduled for Master and PhD students. Meetings for Bachelor students have been conducted on an ad hoc basis due to the duration of their research period. The research team as a whole conduct monthly meeting to check overall progress. Seminars and presentations have not been conducted periodically but invited speakers from the area of Materials Engineering have been arranged at times to give dedicated talks to his laboratory members.

Different countries have different educational systems and cultural values. What could be the challenges in adopting a foreign educational system in a different country? Adopting foreign educational systems entirely may be unrealistic due to different cultural and learning environments. Hence, adaptation should be necessary for the sustainable implementation of these systems. Dr. Mutua has transformed the Japanese style of LBE in the formation of research teams that are more relevant in the context of Kenya. Thanks to this adaptation, Dr. Mutua and his team continue to produce graduates within certain set periods and to publish their research in refereed/peer reviewed academic journals.

The impact of Japanese style of LBE has been clear and well showcased by Dr. Mutua and his team. In fact, the university management has begun to recognize the team's effort. If this laboratory, the research team is better represented within the university, Dr. Mutua's team can alleviate the years of long-term research that post graduate students are undergoing. Nevertheless, it is still uncertain whether this research culture will permeate to the whole university. Some adjustments and adaptation are always required.

[END]

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Attachment

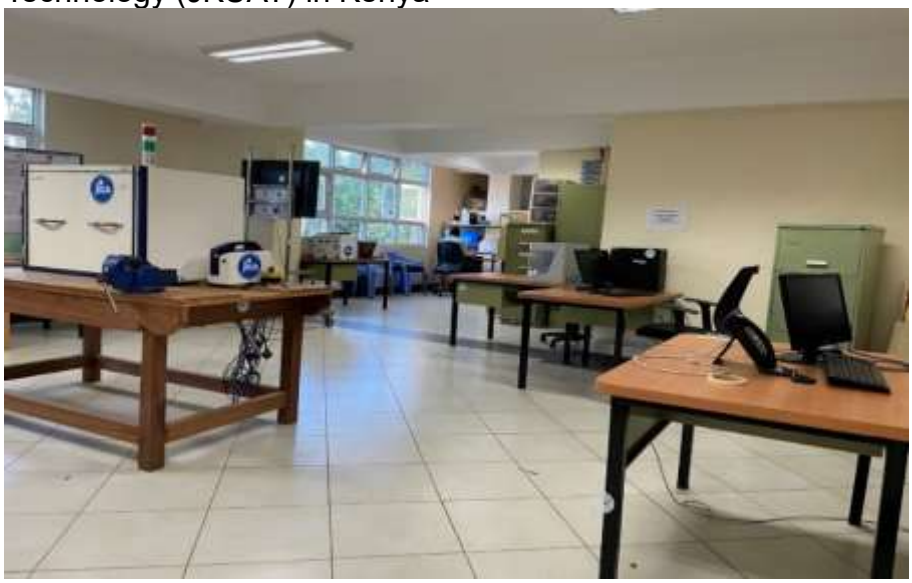
1. Dr. James Mutuku Mutua in a laboratory space at Tottori University in Japan.
2. Laboratory in Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya.

1. Dr. James Mutuku Mutua in a laboratory space at Tottori University in Japan.

Source: Mutua, James Mutuku, (2017) [Photograph of Dr. Mutua in his Professor's laboratory space at Tottori University in Japan]

Source: Mutua, James Mutuku, (2017) [Photograph of Dr. Mutua in his Professor's laboratory space at Tottori University in Japan]

2. Laboratory space in Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya



Source: Oda, Sachiko, (2023) [Photograph of Dr. Mutua's laboratory]