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Human Learning: Case from Underprivileged Students in Science Education

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Abstract

The aim of this article is to highlight the importance of human learning through an extensive case study (over the period of 4 years) for underprivileged students. This case study has provided the insights into how learning and development can be improved through some innovativeness in various practices with conceptual background and justification. Human learning has been an important foundation for developing human capital. Human capital plays a crucial role in long-term competitiveness of an organization as well as economic and social development of a country. The use of Open-loop Learning is applied to help explain how students learn and the effectiveness of learning.

In addition to Open-loop Learning, human learning has to consider various issues which affect how a student learns such as empathy and psychological safety. Contemporary learning and teaching methods such as Team Teaching (especially in science education) and Opportunity to Learn have been examined *with an aim to improve employability of students. In the past, the focus on improving learning and development for students relates to curriculum development, use of digital technology (e.g., e-Learning, Blended Learning, etc.), textbook, and teacher training. Despite massive investment in education, often, the fundamental question on how a student learns has not been tackled.*

Pedagogical research has been under more scrutiny in recent years due to the impacts from digital technology on daily routines of learners. Nevertheless, internet addiction, cyber bullying, and safe internet are some of the growing issues that affect quality of learning and eventually how a student learns. By focusing on the development at a school, workplace learning can be better understood. Finally, the study recognizes the shortcomings on generalization of the findings. Secondly some of the findings from having applied Double-loop Learning may not be applicable in many types of students due to the intensive work with underprivileged students.

Keywords: human learning, open-loop learning, pedagogy, psychology, slow learners, joy of learning

INTRODUCTION AND BACKGROUND

Human learning has been one of the important terms cited to help highlight future performance management within an organization (Chan and Yung, 2015). Human learning can have tremendous impacts on innovation and creativity, human capital development, quality and productivity, and long-term competitiveness of an organization. In fact, the development of human capital is the foundation of a country's economic and social development (Zhu and Li, 2017).

Human learning involves many aspects such as stimulation, motivation, happiness or joy of learning, repeated behavior pattern, belongingness, reinforcement, and fear of punishment (Tabibian *et.al.*, 2019). Ongoing challenges for human learning have included more self-initiated actions and creative thinking. Meaningful learning is preferred instead of rote learning which implies an ability for a learner to relate what he/she learns to his/her experiences. Simply, meaningful learning highlights a learner's emotional commitment to blend and integrate new materials with existing experiences and knowledge. This is part of preparing a learner to build higher cognitive skills.

Human learning traditionally focuses on four issues: (1) learners, (2) learning contents, (3) learning/ teaching methods or pedagogy, and (4) learning support which includes the applications of digital technology. Note that these four issues are applicable for workplace learning and training as well as all stages in education and training- early childhood, basic, vocation (or professional), higher, and life-long education (Terentyeva *et al*., 2018).

For a learner, several investigations have been made into how a student or a learner fits and adapts into learning environment in order to strengthen the development of skills and knowledge. Learning contents for the learners have been brought up due to the changes in skills requirements, especially the need for higher cognitive, social and emotional, and technological skills (Deep *et al*., 2019). Learning support to ensure learning effectiveness has become a subject of several studies due to the availability of digital technology.[1]

Specifically, for science education, there are many specific problems that have continuously been examined over the past decade due to the importance of Science, Technology, Engineering, and Mathematics or STEM education. Instead of focusing on how to learn highly-complicated subjects relating to STEM alone, more recent research has focused on a process of learning by blending learners, learning contents, and learning methods to ensure joy of learning. Focusing on learners indicates the need to address the entire learning environment.

Examining how learners fit with their learning environment has been vital for the development of a lesson plan. Incorporating psychological-related issues such as psychological safety and Opportunity to Learn or OTL are essential to this development. Psychological safety is used to describe how a student can participate in a lesson, subject discussion, experiment, and creativity without the fear of negative consequences such as embarrassment, exclusion, and bullying and punishment[2]. It shows the feeling of being safe to learn, contribute, and challenge during class and within a school.

OTL refers to the construct of various dimensions which impact learning and development such as time, learning content, and quality. In other words, OTL has focused on the construct that focuses on how a teacher dedicates instructional time and content coverage within the context of the curriculum's objectives on a learner' skills[3]. Quality of learning takes place through the emphasis on high-order cognitive processes and experimental learning with the recognition into the combination of the tasks completed by an individual and a group. Positive and corrective feedback, praise, and clarity of instruction are some of the key contributors to quality of learning[4].

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[1] See https://www.weforum.org/agenda/2016/11/the-digital-economy-what-is-it-and-how-will-it-transform-our-lives/ as of October 2019.
[2] See https://www.worldpulse.com/community/users/kujamac12/posts/65258 as of November 2019
[3] See https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199935291.001.0001/oxfordhb-9780199935291-e-70 as of January 2020
[4] https://daizeabdao.wordpress.com/2015/03/22/learning-and-maturation/ as of January 2020

Engaging with students to identify their needs- continuing into higher education, pursuing vocation (or professional) training, and becoming an entrepreneur is important since STEM education should develop science skills. This engagement is necessary to gain the trust from the students. Trust, despite being an abstract in nature, has played an important role on both psychological safety and OTL. Gaining trust has been successfully made through better empathetic skills of teachers. Recognizing the diversity in students' learning capability is essential to designing and developing a lesson or an experimental plan.

Diversity in learning and development can be generally described as follows (Snowden and Halsall, 2017). In one extreme end, there is a teacher-directed and structured learning. On the other hand, there is a student-directed and flexible learning. In the middle ground, there is a guided learning. Without proper training, there is a strong possibility that teachers may assume the need for uniformed learning (i.e., standardization of learning and teaching). Thus, empathy has become more important in developing a way to help a student learn and develop. Empathy allows the recognition of the learners' diversity.

The next section focuses on one extensive case which essentially incorporates emerging conceptual frameworks, practices, applications on teaching and learning which involves underprivileged students in science education. This case demonstrates how various traditional and contemporary thoughts in teaching and learning are integrated which has led new discoveries for better applications and future research development. This case study is based on the continuous work from 2015 to the present. This case deals with underprivileged students with the focus on science education and has integrated several key concepts previously mentioned.

OBJECTIVES

The primary purposes of the case study are to map out how an underprivileged student learns and to discuss how this learning can become more effective.

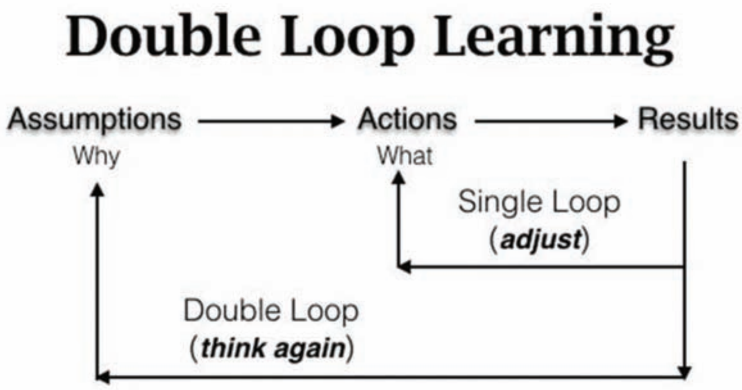
CASE DEMONSTRATION

For the case study, the focus has been on examining how underprivileged students learn. Their learning process has been extensively studied together with teachers since 2016. It is part of the educational reform in Thailand which aims to improve learning and development of the bottom 10% of the enrolled students in a country. The presentation of this case study is also part of the author's report for Organisation for Economic Co-operation and Development or OECD's initiative on Observatory for Public Sector

Innovation or OPSI on behalf of Royal Thai Government through Office of the Public Sector Development Commission)

In Thailand, there are various types of schools in basic education. They include international schools, university teacher training schools (also known as demonstration and laboratory schools), public schools and private schools that are under the jurisdiction of Ministry of Education, and public schools that are part of Ministry of Interior (e.g., local municipalities, Pattaya City Administration, and Bangkok Metropolitan Administration or BMA). It is important to point out that these Ministry of Interior' schools were created as part of expanding educational opportunity at the primary school level when Thailand experienced a rapid growth in population many decades ago. Ministry of Education could not accommodate the citizens' needs at that time. Later, these schools were requested to offer the secondary education (Fry and Bi, 2013). Since they were not initially designed to offer the secondary-level education, there is a shortcoming in a laboratory readiness for science education.

BMA is responsible for approximately 350,000 students and 15,000 teachers for a total of 437 schools. Presently, more than 850,000 students or approximately 12% of Thai student enrolment in basic attend the schools under Ministry of InteriorTo help deal with learning and development of underprivileged students, the concept of Open-loop Learning is applied. This application provides a framework in how learning takes place. The framework is also useful in pointing to experimenting different interventions which are later observed and recorded. See Figure 1.



Source: Keyser (2018) from Double Loop Learning: Things Right or Right Things- get It Right Fast

For the Open-loop Learning framework, the interpretations can be as follows. This framework is applied to help identify a learning process of a student and possible improvement interventions.

- Single-loop Learning: within the context of students, it focuses on feedback and assessment/ evaluation. This helps students become aware whether their actions (e.g., how they conduct an experiment) are properly correct which lead to expected or accurate results. Therefore, an experimental report is a typical evidence for the single-loop learning.

- Double-loop learning: within the context of students, it focuses on the underlying assumptions of students about their mindset on learning. It is important to identify these assumptions since they are expected to influence how students learn (e.g., reacting to new teaching materials or subjects).

FINDINGS AND DISCUSSION

To achieve the two aforementioned objectives, each loop needs to be examined extensively. Altogether, from 2016 to present, for the single or first loop, it is important to recognize the following premises and opposing views expressed by the group of underprivileged students. They are as follows.

- More classroom time should lead to more learning and development. Thus, students should have more skills and knowledge. [Is it still credible?]
- Teachers are provided with "everything" that is needed- texts, experimental manuals, materials, and instruments, etc. [If the condition is not "perfect", can teachers still plan and deliver the contents that achieve the desirable skills?]
- Learning is effective in a classroom and laboratory environment. [In the closed learning environment, students are not trained to examine uncontrollable variables which are important in science skills.]
- A teacher represents a source of needed knowledge students need to learn science. [Could there be other sources such as peer-learning in certain subjects or areas?]
- The aim of conducting an experiment is to prove/ verify a theory or concept and later put information on a report to be evaluated by a teacher. [Can concrete experiences and reflective observation take place with a closed experiment to prove/verify?]
- Science education is to prepare future scientists who will later pursue higher education in Medical Science, Engineering Science, and Basic Science. [Should science education lead to better science skills for the population?]
- Attending the upper secondary school indicates a plan to study in a university. [Students who attend the "opportunity extension" school may not be able to afford tuitions and fees at a university.]
- More examination can lead to more students' motivation (due to the previous premise that they will likely continue their study in higher education). [Difficult examinations likely demotivate students since they view them to be too difficult and do not fit with their future.]

For the double or second loop, through extensive observation and in-depth conversations, the following beliefs are prevalent among underprivileged students.

- Life as underprivileged students will not change so accept this premise
- Poverty and lack of future are part of life
- Competing with privileged students is impossible.

When the students' feeling and beliefs are uncovered, it is clear why underprivileged students have less academic achievement. No matter how many more examinations are given, how many more digital devices are provided, and how many additional classroom hours are arranged, it appears that underprivileged students have not shown any significant motivation and commitment to learning and development. This can be verified through a lack of attendance, aggressive behavior, school bullying, etc.

To further discuss about what has been revealed during the period from 2016 until the present, due to the presumption that students in science education would likely participate in higher education, the focus is on the intensive knowledge on individual science subjects. Most students perform well in an examination by attending special tutorial sessions. However, BMA students generally live in poverty with limited career opportunities. Jobs after-school hours become a necessity to maintain a minimum standard of living. Overwhelming these students with in-depth details on science subjects and payments to a special tutorial session are impractical. A combination of student fatigue from work, poor quality of science laboratory, inability to attend special tutorial sessions, and lack of sense of appreciation to rigid and standardized lessons have contributed to low motivation and poor behavior (Faikhamta and Clarke, 2015).

To strengthen the single or first loop, the innovation focuses on improving pedagogical practices in science education. Student-centric consideration should direct the attention to empathy and psychology. Student engagement, constructive feedback, team teaching, psychological safety, and creative experiment through product development should be the priority when working with underprivileged students. The highlight is the use a science experiment to develop a product while tackling waste, and water and soil pollution surrounding schools and students' communities (Faikhamta, 2011). Since the experiments are conducted outside a laboratory, this provides an opportunity for students to get to know each other better. Extra incomes earned from selling products from science experiments helps strengthen soft skills such as communication, teamwork, planning, entrepreneurship and financial literacy. These skills are essential in students' future employability.

There are two primary goals in this innovation. The first goal is to create a sense of belongingness which should lead to higher motivation and better behavior among students. This goal can address several social problems facing underprivileged students such as physical/ verbal/ cyber bullying, and teen pregnancy. The second goal is to build effective team- teaching practices for science subjects- Physics, Chemistry, Biology, and Mathematics. This team teaching is critical for joy of learning which science subjects should be integrated (and not independently taught) during an experiment. Joy of learning impacts students' learning process. Instead of more homework assignments and long lecturing hours, assuring that students can relate a lesson to their daily lives should stimulate more learning and development.

This joy of learning stems from: (1) teachers' understanding of their needs, (2) peer learning during science experiments, (3) overcoming psychological safety, (4) active participation, and (5) opportunity to interact with external stakeholders who are willing to share with them unique knowledge/ experiences and to recognize their hard work. The recognition from these external stakeholders (e.g., Kasetsart University and Joint Foreign Chambers of Commerce in Thailand or JFCCT) should have positive emotional effects. The benefited stakeholders include teachers, students, parents, school administrators/ directors, and residents in the surrounding communities. See Appendix A.

For the double or second loop, shifting students' mindsets and beliefs can be a challenge. Therefore, organizing the field trip to see the actual benefits and positive impacts from improving soil and water should reinforce the importance of sustainability in students' mindset and future career development. Students can appreciate the minimal cost of raw materials (which are gathered food waste- mainly jackfruits and waste from fresh markets, restaurants, and household) to produce fertilizers which can potentially generate a large sum of constant income. In other words, despite being in poverty, science education can help raise their standard of living. See Appendix B.

LESSONS FROM BMA CASE FOR FUTURE RESEARCH IN THE AREAS OF INNOVATION AND LEARNING

Based on the case study, despite the success in accessibility, Thailand's educational system has not succeeded in blending critical thinking and analytical skills for students' learning and development. Instead of writing a report on an experiment for theorical correctness, successful product development can also reflect students' understanding and knowledge. Conducting an outdoor experiment and producing a product after school hours for an extra income allow more students' interaction. This results in less reported bullying problems and teen pregnancy.

Also, an open-loop learning concept helps create students' hope and pride. This innovation reflects a drastic change from traditional stereotype and practices. A student-centric approach has had positive impacts on students' creativity (e.g., use of food waste for fertilizer, etc.). The innovation highlights that longer classroom time does not necessarily lead to higher quality teaching and better student learning.

Open-loop learning, based on the workshops and visits by the delegates from JFCCT and Spouses of Head of Mission or SHOM, has contributed to higher commitment. The workshops have focused on product development and entrepreneurship. The delegates have purchased students' products and provided valuable feedback, and have provided needed donations. Ongoing developments include: (1) active engagement with communities on food waste, (2) experiments on plastic waste, and (3) sharing the experiences with other schools.

Since 2015, integrated lesson plans have been developed and implemented for water and soil experiments. The success can be demonstrated by students' peer-learning community, behavioral improvement described by the parents, and various national awards and recognition relating to students' work on ecology and environment sponsored by Crown Property Bureau Foundation and Utokapat Foundation. Both are under the Royal Patronage of H.M. The King.

DEVELOPMENT OF INNOVATION AND LEARNING FROM BMA CASE

Kasetsart University is the primary partner for knowledge sharing. In addition to the donations of experimental instruments and financial assistance to help build a peer-learning community, the university has worked with external entities to provide teachers and students public recognition (e.g., their participation in the embassy's events). This provides a rare opportunity for them to interact with business managers and international dignitaries.

The parents, the surrounding communities, and other provincial schools have been benefited by the innovation. The parents feel better when they know that their children are at schools to work with their peers instead of working as a part time employee. For the community residents, polluted waterway and soil can be systematically tackled through the experiments by their own children. Other provincial schools realize that there is an effective wat to conduct science education.

The main result from the innovation is the improved pedagogical practices. The outcomes include better science understanding as well as enhanced future employability. Measuring the success simply involves national awards and students' creativity for new learning initiatives. The latest recognitions are two Outstanding Youth Awards given by National Council on Social Welfare of Thailand under Royal Patronage of H.M. The King, and Thailand's Rotary Clubs during 2018; and Outstanding School Innovativeness Award in 2019 by The Teachers' Council of Thailand.

Participating teachers are chosen for the 2018 Outstanding Teacher Award by BMA's Department of Education and the 2019 Princess Maha Charki Award for Outstanding Teachers. Finally, students have decided to extend their current experiments (e.g., engaging with local communities through mushroom from existing fertilizer), to improve current products (e.g., packaging), and to suggest a new idea to experiment with plastic waste.

FUTURE RESEARCH FOR INNOVATION AND LEARNING FROM BMA CASE

To design and improve social services such as education, the negative stereotype on a specific group of population needs to change. This is essential since the needs from citizens can be easily presumed. For instance, underprivileged students are presumed to have the following characteristics: (1) aggressive behavior in a classroom, (2) lack of academic interests and inquisitive mind, (3) tardiness and laziness, and (4) need of strict supervision and control. This is not entirely a correct narrative as most participating students were proactive when given an opportunity to participate. This stereotyping issue needs be recognized before undertaking any future initiatives on public services improvement.

Specifically, for education, paradigm shift from more lecturing time to empathy and psychology is proven to be an effective motivating factor. A general emphasis on uniformity of teaching and academic achievement have negatively impacted on both flexibility and ability for teachers to deal with many problems (e.g., slow-learning capability; bullying through physical, verbal, and cyber means; teen pregnancy; dropouts; and vaping epidemic). Hence, poorer performers are likely ignored while slower students are often snubbed from classroom's participation and activities.

Uniformity in education means more control and compliance which has become a school's norm. Thus, the use of the term "production" of students in the country has become prevalent. This term reinforces the notion of uniformity in teaching without recognizing individual potential and development. Participating teaches and students have experienced how thick teaching manuals and strict experimental guidelines with expected answers for science education could gravely harm creativity and critical thinking of students. Building (not producing) human capital should be the ultimate outcome of social services in education.

Finally, BMA case has shown how traditional (such as OTL) and contemporary (such as Design Thinking) can be blended in developing a lesson and experimental plan for underprivileged students. The case highlights how learners, learning content, and learning environment need to be effectively integrated- students' needs and career outlook, psychological safety and motivation, emerging practices of team teaching and experimental learning, and employability. The open-loop concept which allows external entities to compliment team teaching helps sustain learners' motivation due to public recognition and feeling of hopefulness.

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Appendix A: Use of External Entities to Help Ensure the Flow of Single or First Loop

Appendix B: Field Trip for Students (as part of the Double-loop Learning)