The Toyota Production System Principles and Behaviors in a Higher Education Institution Classroom

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Abstract

Several publications address topics such as continuous improvement, Lean, and Toyota Production Systems in manufacturing organizations. However, these same topics have not been addressed deeply for higher education institutions (HEIs). As an HEI business unit, a classroom is a small complex group of persons interacting during a short time to achieve an organizational/personal goal. Therefore, applying TPS principles in an HEI classroom could be a strategy to achieve stakeholder goals. This paper has two purposes: to traduce TPS into a classroom and define behaviors expected from main participants in a classroom for each TPS principle. To achieve these goals, the authors followed three steps: literature review, research method and data collection, and definition of the TPS principles and behaviors. Lastly, in the discussion section, the authors address topics such as research limitations and future works.

Keywords
Toyota Production System, TPS, higher education, classroom, Lean

1. Introduction

The Toyota Production System (TPS) principles, systems, techniques, methodologies, and tools have been applied in different service organizations (e.g., hotels, hospitals, and higher educations to improve their performance metrics). Recently, a high level of papers related to continuous improvement projects has been published to addressed multiple problems in higher education institutions (HEIs), such as improving the education system using Lean Six Sigma (Haerizadeh and Sunder, 2019), Lean Six Sigma methodology to improve service process (Li et al., 2019), defining state of the art in the application of Lean Six Sigma in HEIs (Cudney and Furterer, 2020), and increasing quality service in a master degree program (Gonzalez Aleu et al., 2021). However, from the authors' perspective, there are several topics that have not been addressed deeply in HEIs, as the implementation of TPS principals in a classroom, as well as students' and professors' behaviors to increase the dissemination of knowledge.

Dunlop and Weil (1996, p. 335) defined business unit as "the lowest level of a firm with responsibilities for the formulation of annual policies dealing with merchandising, planning, manufacturing distribution, and related activities

for a product line or lines, and that collects financial data for those activities." Therefore, a classroom could be understood as an HEI business unit. Then, a TPS could be used in a classroom to improve its performance metrics.

Therefore, this paper has two purposes: traduce TPS into a classroom and define behaviors expected from main participants in a classroom for each TPS principle. To achieve these goals, the authors followed three steps: a literature review (including TPS principles and HEIs quality definitions), research methods and data collection (classroom process mapping and inter-rater agreement), and definition of the TPS principles and behaviors. Lastly, in the discussion section, the authors address topics such as research limitations and future works.

2. Literature Review

2.1 Toyota Production System Principles

Currently, the ProQuest platform shows around 190 publications (only books, book chapters, professional magazines articles, proceedings, and journals articles) that mentioned in the abstract the search terms: ("Toyota Production System" OR TPS) AND (principle OR principles). It is hard to identify which are the TPS principles. The range of information goes from four to fourteen. Additionally, we have the 38 management workplace lessons from Onho (2013). Therefore, this literature review address TPS principles briefly, using four publications written by authors that work for Toyota or obtain their knowledge from former Toyota employees (e.g., Shingo).

First, the Shingo Model assesses organization excellence considering the following topics: total quality management (TQM), Just in Time (JIT), and Lean Manufacturing. The Shingo Model states organizational culture as a key component; therefore, this organizational excellence award assesses employee behaviors related to the implementation of ten guiding principles, work systems, tools, and results (Utah State University, 2020). These ten guiding principles are grouped in three categories: cultural enablers (respect every individual and lead with humility), continuous improvement (assurance quality at the source, improve flow and pull, seek perfection, embrace scientific thinking, and focus on process), and enterprise alignment (create value for the customer, create constancy of purpose, and think systemically).

Second, in his book, Liker (2004) describe 14 Toyota management principles: (i) base your management decisions on a long-term philosophy, (ii) create continuous process flow, (iii) use "pull" systems to avoid overproduction, (iv) level out the workload, (v) get quality right the first time, (vi) standardized task, (vii) use visual control, (viii) use reliable, thoroughly tested technology, (ix) grow leaders who understand the work, philosophy, and teach others, (x) develop exceptional people and teams, (xi) respect your extended network of partners and challenge them, (xii) go and see for yourself, (xiii) make decisions slowly by consensus, and (xiv) become a learning organization.

Third, Ohno (2013) resume his workplace management experience in 38 lessons (see Table 1). Although these lessons are more behaviors or recommendations than principles, these 38 lessons come from Taichi Ohno, a former Toyota CEO. Taichi Ohno was responsible for the creation of the TPS (Ohno, 2013).

Table 1. Taichi Ohno's Lessons

No.	Taichi Ohno's Lessons
1	*The wise mend their ways.* If you are wrong, correct yourself. And do not wait until the end of the day to change our orders.
2	*If you are wrong, admit it.* Be accountable for your decisions.
3	*Misconceptions reduce efficiency.* Misconceptions or paradigms reduce process efficiency.
4	*Confirm failures with your own eyes.* Go to the production line and see with your own eyes the failures and successes achieved from your orders.
5	*Misconceptions hiding within common sense.* The use of common sense is a misconception that difficult process improvement.
6	*The blind spot in mathematical calculations.* There are different interpretations from Profit = Price – Cost. However, costs do not exist to be calculated. Instead, costs exist to be reduced.
7	*Don't fear opportunity losses.* Do not think about the opportunities losses. Instead, think about the actual losses.
8	*Limited volume production is to produce at a low cost.* Limited production quantity should be focused on producing at a low cost.
9	*Reduced inventory, increased work in process.* Work in process is also inventory.
10	*The misconception is that mass production is cheaper.* Produce the amount that you need.

11	*Wasted motion is not work.* Unnecessary workers' movements is not work.
12	*Agricultural people like inventory.* Inventory was used by agricultural people to survey. However, this is costly.
13	*Improve productivity even with reduce volumes.* Only companies that could improve productivity with a reduced volume will survive. Increased productivity is not related to fired employees.
14	*Do Kaizen when times are good.* Kaizen should be done during good times to be prepared for the bad times.
15	*Just in time.* Deliver parts on time. This means not to early and not late for sure.
16	*Old man Sakichi Toyoda's Jidoka idea.* Automatization process with a human touch.
17	*The goal was ten-fold higher productivity.* Various small improvements will help you achieve your goal.
18	*The supermarket system.* Produce what you needed.
19	*Toyota made the Kanban system possible.* Kanban is a system that helps the worker to identify the following process needed. Kanban requires the participation of all the organizations.
20	*We learned forgiving changeover at Toyota do Brazil.* There are some processes more difficult than others to reduce changeover times, but this could be achieved with a leadership committee to achieve this goal.
21	*Rationalization is to do what is rational.* As it is said, rationalization is doing what is rational, simple, and not complicated.
22	*Shut the machines off!* Again, this is automatization with a human touch. Produce defect is not working. Therefore, workers have the faculty of stopping the production line under safety and quality-based, then fix the problem, and continue with the production. Cost is reduced when you reduce defects.
23	*How to produce at a lower cost.* Make what you need, at the time needed, with quality at first time, and a lower cost. These could be achieved using small lot sizes.
24	*Fight the robot fad.* Automatization should not be used for modernization purposes. Automatization should be used base on two premises: cost reduction and people safety.
25	*Work is a competition of wits with subordinates.* Work together with the front-line workers, give them the advice to improve or solve the problem, and recognize their achievement. As self-improvement, everyone should prepare to be a leader.
26	*There are no supervisors at the administrative Genba.* The supervisor should be focused on supervising the progress of orders; do not supervise how workers are moving. Supervisors should have the knowledge and abilities to train others to be supervisors.
27	*We can still do a lot more Kaizen.* Kaizen is a journey that never ends. When the hard work effort only produces a small improvement, it is time to analyze the production sequence.
28	*Wits don't work until you feel the squeeze.* Pressure or stress in workers will help them to come with good ideas. However, this will not work until you feel the same pressure or stress.
29	*Become a reliable boss.* The boss should find ways to make the work easier for their workers.
30	*Sort, set in order, sweep, sanitize.* Por sus siglas 4Ss: clasifica, ordena, barre y limpia (sanitiza). Otra "S" adicional fue añadida, la cual está relacionada con self-discipline; probably one of the most difficult to achieve.
31	*There is a correct sequence to Kaizen.* There are three Kaizen and should be conducted in the following order: manual work Kaizen, Equipment Kaizen (improve the machines), and process Kaizen (change process sequence)
32	*Operational availability vs. Rate of operation.* Operational availability is a rate, time that you have available to produce. The goal should be to have 100%. On the other hand, rate of operation (time that machine is not working), is determinated by external factors. There is no sense to run a machine if there is not an order to complete.
33	*The difference between production engineering and manufacturing engineering.* Manufacturing engineering, also known as genba engineering, determine methods for manufacturing. Strong genba engineering could help to conduct a kaizen. On the other hand, production engineering is separated from the genba, developing new products and using new materials.
34	*The Pitfall of cost calculation.* If a machine was fully depreciated, keep using this machine instead of buying a new one. Adapt this machine and keep using it.
35	*The Monaka system.* Create systems that help to reduce changeover. For example, presses are versatile machines, but dies are not. Then, Toyota created the monaka system.
36	*Only the Genba can do cost reduction.* Money is in the genba; therefore, workers could help to reduce cost.
37	*Follow the decisions that were made.* First, follow the rules. If you cannot follow the rules, then something is wrong with the rules. Second, if other have an idea, try it immediately. Then the decision is the new rule.
38	*The standard time should be the shortest time.* If you are taking several measures to calculate the standard time, do not use the average time, it is better to use the shortest time.

Lastly, Mexican Alumni from Japan ("Asociación de Exbecarios de Mexico en Japón" - ASEMEJA) and the Japan International Cooperation Agency (JICA), developed a certification program about TPS (include more than 100 training hours and plant visits in Japan). In their workshop includes only four TPS principles:

- Top management commitment and respect
- Quality as the first intention, which includes quality in the source, poka-yoke and jidoka

- Empowerment which includes hitozukury and monozukuri
- Business financial liquidity or business health

2.2 Quality in HEIs

HEIs are integrated with different stakeholders, such as faculty, administrative staff, students, parents, donators, the local community, and external organizations (e.g., government institutions and hiring organizations). Each of these stakeholders has a different meaning of quality (Harvey and Green, 1993):

a) Quality as exceptional. This concept of quality includes three variations: distinctive or exclusivity, exceed high standards, and pass a minimum set of standards.
b) Quality as perfection or consistency. This quality definition focused on process specifications and involved two statements: zero defects and getting things right the first time.
c) Quality as fitness for purpose. As the name stated, this definition suggests that the quality of a product or service will be assessed according to their fits its purpose.
d) Quality as value for money. This definition includes customer perception of product/service received vs. the value for money.
e) Quality as transformation. This definition of quality is based on the notion of fundamental qualitative change.

On the other hand, a quality classroom is defined "as one in which everyone in the class knows the objectives of the class and adopts a quality philosophy to continuously improve the work done to meet those objectives" (Cornesky and Lazarus, 1995, pp.1)

Although it is clear from these two definitions that quality should not be assessed from a single stakeholder point of view, from the authors' professional experience, HEI stakeholders use the quality definition that best matches their role in the organization, forgetting to have a holistic approach.

3. Research Method

Three research methods were used to achieve the purpose of this publication. First, a conceptualization of HEI classroom as business unit. The authors used their professional experiences. Together, they have more than 20 years in the industry and 20 years as faculty. Second, using the four TPS principles from ASEMEJA and JICA, the authors individually classify the information collected from Utah State University (2020), Liker (2004), and Onho (2013). An inter-rater agreement was calculated. Third, using the conceptualization of the HEI classroom and the classification of the TPS principles, the authors propose several behaviors for each TPS principle.

4. Results and Discussion

4.1 Conceptualization of HEI classrooms

Several processes are related to an HEI classroom, such as infrastructure updated and maintenance, knowledge dissemination, knowledge updated, faculty training, etc. However, from the authors' perspective, knowledge dissemination has a key role in an HEI classroom, with different quality definitions are applied (see Figure 1). Knowledge dissemination includes from faculty knowledge transmission to student knowledge assessment.

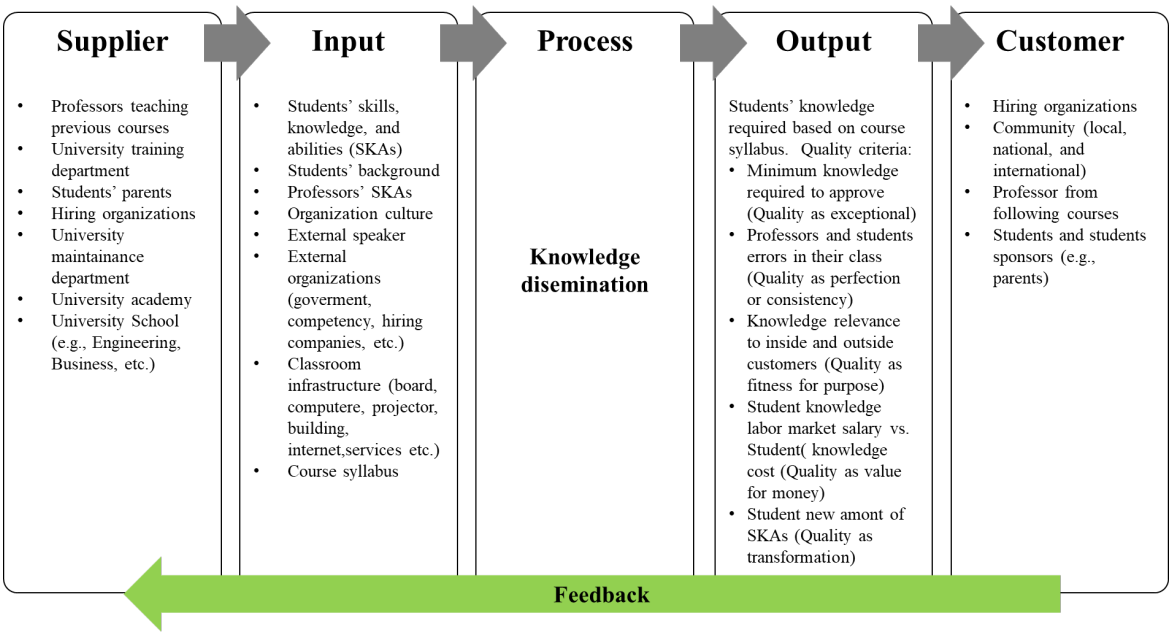

Figure 1. SIPOC Knowledge dissemination

SIPOC knowledge dissemination (see Figure 1) help us to understand the complexity of a classroom considering only one of the multiple processes conducted. The authors identified nine different inputs (independent variables), five outcomes (dependent variables), and four different customers. Therefore, to create value in the knowledge dissemination process, it is important to identify students' and faculties' behaviors.

4.2 Classification of Literature in TPS principles

Also, there are different TPS house models published; it is clear to the authors that the ceiling in the TPS house should be creating value for shareholders. This ceiling should be supported by several principles. For this research, the authors used the four TPS principles proposed by ASEMEJA: (a) top management commitment and respect, (b) quality as first intention, (c) empowerment, and (d) business financial liquidity

A list with 62 items was created using the 38 Taichi Ohno's Lessons, 14 TPS principles from Liker, and the 10 Shingo model guideline principles. Then, each of these two authors classified the 62 items in each of the four ASEMEJA TPS principles. The Cohen Kappa shows a level of 56.8% of agreement, which is considered by Landis and Koch (2016) as moderate strength of agreement. Table 2 shows the 62 items and the authors' 1 and 2 classification.

Table 2. Classification of the 62 items

No.	Principles List	Author 1	Author 2	Agree or disagree?
1	*The wise mend their ways.* If you are wrong, correct yourself. And do not wait until the end of the day to change our orders.	a	a	Agree
2	*If you are wrong, admit it.* Be accountable for your decisions.	a	a	Agree
3	*Misconceptions reduce efficiency.* Misconceptions or paradigms reduce process efficiency.	c	c	Agree
4	*Confirm failures with your own eyes.* Go to the production line and see with your own eyes the failures and successes achieved from your orders.	b	b	Agree
5	*Misconceptions hiding within common sense.* The use of common sense is a misconception that difficult process improvement.	c	a	Disagree
6	*The blind spot in mathematical calculations.* There are different interpretations from Profit = Price – Cost. However, costs do not exist to be calculated. Instead, costs exist to be reduced.	d	d	Agree

7	*Don't fear opportunity losses.* Do not think about the opportunities losses. Instead, think about the actual losses.	d	a	Disagree
8	*Limited volume production is to produce at a low cost.* Limited production quantity should be focused on producing at a low cost.	d	d	Agree
9	*Reduced inventory, increased work in process.* Work in process is also inventory.	d	d	Agree
10	*The misconception is that mass production is cheaper.* Produce the amount that you need.	d	d	Agree
11	*Wasted motion is not work.* Unnecessary workers' movements is not work.	d	b	Disagree
12	*Agricultural people like inventory.* Inventory was used by agricultural people to survey. However, this is costly.	d	a	Disagree
13	*Improve productivity even with reduce volumes.* Only companies that could improve productivity with a reduced volume will survive. Increased productivity is not related to fired employees.	d	b	Disagree
14	*Do Kaizen when times are good.* Kaizen should be done during good times to be prepared for the bad times.	b	d	Disagree
15	*Just in time.* Deliver parts on time. This means not to early and not late for sure.	b	b	Agree
16	*Old man Sakichi Toyoda's Jidoka idea.* Automatization process with a human touch.	b	b	Agree
17	*The goal was ten-fold higher productivity.* Various small improvements will help you achieve your goal.	d	b	Disagree
18	*The supermarket system.* Produce what you needed.	d	d	Agree
19	*Toyota made the Kanban system possible.* Kanban is a system that helps the worker to identify the following process needed. Kanban requires the participation of all the organizations.	b	b	Agree
20	*We learned forgiving changeover at Toyota do Brazil.* There are some processes more difficult than others to reduce changeover times, but this could be achieved with a leadership committee to achieve this goal.	c	a	Disagree
21	*Rationalization is to do what is rational.* As it is said, rationalization is doing what is rational, simple, and not complicated.	c	c	Disagree
22	*Shut the machines off!* Again, this is automatization with a human touch. Produce defect is not working. Therefore, workers have the faculty of stopping the production line under safety and quality-based, then fix the problem, and continue with the production. Cost is reduced when you reduce defects.	c	c	Agree
23	*How to produce at a lower cost.* Make what you need, at the time needed, with quality at first time, and a lower cost. These could be achieved using small lot sizes.	d	d	Agree
24	*Fight the robot fad.* Automatization should not be used for modernization purposes. Automatization should be used base on two premises: cost reduction and people safety.	b	b	Agree
25	*Work is a competition of wits with subordinates.* Work together with the front-line workers, give them the advice to improve or solve the problem, and recognize their achievement. As self-improvement, everyone should prepare to be a leader.	a	a	Agree
26	*There are no supervisors at the administrative Genba.* The supervisor should be focused on supervising the progress of orders; do not supervise how workers are moving. Supervisors should have the knowledge and abilities to train others to be supervisors.	a	a	Agree
27	*We can still do a lot more Kaizen.* Kaizen is a journey that never ends. When the hard work effort only produces a small improvement, it is time to analyze the production sequence.	b	d	Agree
28	*Wits don't work until you feel the squeeze.* Pressure or stress in workers will help them to come with good ideas. However, this will not work until you feel the same pressure or stress.	a	a	Agree
29	*Become a reliable boss.* The boss should find ways to make the work easier for their workers.	a	a	Agree
30	*Sort, set in order, sweep, sanitize.* Por sus siglas 4Ss: clasifica, ordena, barre y limpia (sanitiza). Otra "S" adicional fue añadida, la cual está relacionada con self-discipline; probably one of the most difficult to achieve.	a	b	Disagree
31	*There is a correct sequence to Kaizen.* There are three Kaizen and should be conducted in the following order: manual work Kaizen, Equipment Kaizen (improve the machines), and process Kaizen (change process sequence)	b	a	Disagree

32	*Operational availability vs. Rate of operation.* Operational availability is a rate, time that you have available to produce. The goal should be to have 100%. On the other hand, rate of operation (time that machine is not working), is determined by external factors. There is no sense to run a machine if there is not an order to complete.	d	b	Disagree
33	*The difference between production engineering and manufacturing engineering.* Manufacturing engineering, also known as genba engineering, determine methods for manufacturing. Strong genba engineering could help to conduct a kaizen. On the other hand, production engineering is separated from the genba, developing new products and using new materials.	b	b	Agree
34	*The Pitfall of cost calculation.* If a machine was fully depreciated, keep using this machine instead of buying a new one. Adapt this machine and keep using it.	d	d	Agree
35	*The Monaka system.* Create systems that help to reduce changeover. For example, presses are versatile machines, but dies are not. Then, Toyota created the monaka system.	b	b	Agree
36	*Only the Genba can do cost reduction.* Money is in the genba; therefore, workers could help to reduce cost.	d	d	Agree
37	*Follow the decisions that were made.* First, follow the rules. If you cannot follow the rules, then something is wrong with the rules. Second, if other have an idea, try it immediately. Then the decision is the new rule.	c	a	Disagree
38	*The standard time should be the shortest time.* If you are taking several measures to calculate the standard time, do not use the average time, it is better to use the shortest time.	d	b	Disagree
39	*Base your management decisions on long-term philosophy*	d	a	Disagree
40	*Create continuous process flow*	b	b	Agree
41	*Use "pull" systems to avoid over production*	d	b	Disagree
42	*Level out the workload*	a	a	Agree
43	*Get quality right the first time*	b	b	Agree
44	*Standardized task, (vii) use visual control*	b	b	Agree
45	*Use visual control*	b	b	Agree
46	*Use reliable, thoroughly tested technology*	b	b	Agree
47	*Grow leaders who understand the work, philosophy, and teach others*	a	a	Agree
48	*Develop exceptional people and teams*	a	a	Agree
49	*Respect your extended network of partners and challenge them*	a	a	Agree
50	*Go and see for yourself*	b	b	Agree
51	*Make decisions slowly by consensus*	a	a	Agree
52	*Become a learning organization.*	a	a	Agree
53	*Respect every individual*	a	a	Agree
54	*Lead with humility*	a	a	Agree
55	*Assurance quality at the source*	b	b	Agree
56	*Improve flow and pull*	d	b	Disagree
57	*Seek perfection*	b	b	Agree
58	*Embrace scientific thinking*	b	a	Disagree
59	*Focus on process*	b	b	Agree
60	*Create value for the customer*	d	d	Agree
61	*Create constancy of purpose*	a	d	Disagree
62	*Think systemically*	a	a	Agree

4.3 Behaviors for TPS in a classroom

The Shingo model state that to have sustainable results (e.g., create value for shareholders), the organization should promote ideal behaviors. Using the items as "agree" status from Table 2, the authors create and propose a set of students and faculties behaviors for each principle (see Table 3 – 6).

Every organizational change should be implemented by the top managers and their first-line team (see Table 3). A classroom should not be different; faculties should show a genuine interest and respect for each student. This attitude includes topics such as the interest for their knowledge acquisition and fair evaluation. On the other hand,

students should show respect for classmates and faculties, including actions such as do not arrive late and reduce comments that distract classroom from the main topic or lesson.

Table 3. Top Management Commitment and Respect Principle

No	Faculty	Students
1	The faculty does not judge or discriminate against students, offering fair treatment in each during the Q&A session and assessment process.	The student respects their classmate's time, avoiding ask questions for not paying attention to faculty instructions.
2	The faculty accepts when they do not know the answer to every student's questions, but they investigates and offers an answer to the students.	Students created their own studying and working teams to increase classroom performance.
3	The faculty is not a fear to accept when he/she gives a wrong/unclear instruction or made a mistake in the assessment process; modifying their instructions or assessment.	Students are capable to learning course material by themself and offer new course material to the faculty.

Several situations and actions could impact quality as the first intention principle (see Table 4). Faculties and students should be focused on deleting mistakes such as wrong grades, upload wrong homework, and offers low-quality knowledge. Poka-yoke is a technique used to eliminate errors and defects. Here there are three examples of the application or potential application of poka-yoke. First, a cover page in a homework includes the following information: university name, school, department, class name, homework name, professor name, student name, student ID number, date, and honor code. These 10 data could be created automatically using information available in the system. Then, an error in a cover page will be eliminated. This type of poka-yoke is known as "design poka-yoke (level one)," and the goal is to eliminate errors from the design process.

Second, the homework rubric could be used as a customer (faculty) requirement. Rubrics could also be used as poka-yoke level two (detect errors), forbidding that a student uploads homework until rubric requirements are checked. The goal of a poka-yoke level 2 is to identify errors instead of defects. Third, poka-yoke level three is used to identify defects; all the manufacturing or service processes were finished, and the defective product is detected before arriving to the customer. An example of this could be the process of reporting students' grades. Once that the faculty includes students' grades in the system, it is not possible to change until the next month. Therefore, an error in the system is considered as a defect. A report grades with poka-yoke level three could be the following: (1) faculty calculates students' grades, (2) faculty review one on one student's grade, (3) faculty uploads students' grade in the system, (4) students confirm that their grades are correct, and (5) students' grades are published in the system. Step four will be the poka-yoke level three.

Table 4. Quality as First Intention Principle

No	Faculty	Students
1	Faculty has a rubric for each assignment or assessment, and this rubric is available to each student.	Students review their assignments and assessments at least one time previously to submit the final version to the faculty.
2	Faculty prepare their courses using high-quality documentation (books, journal articles, etc.)	Students use high-quality information to document their assignment, as well as sustain their ideas.
3	Faculty gives homework, project, and test information just in time; not early in the semester and not late.	Students use technology (e.g., computers, cellular phones, etc.) as a supporting tool, but their learning is based on traditional tools, such as pen, pencil, notebook, hard books, etc.

Course topics to be covered during the semester are scheduled in the course syllabus; however, sometimes, faculties need to adapt this schedule based on HEI classroom progress. This concept is known as Empowerment, which includes two concepts. First, develop people's skills, knowledge, and abilities (SKAs); also, known as hitozukuri. Second, create products, parts, or services for customer benefits, improve a profession, and workplace. This concept is known as monozukuri. Table 5 shows some examples of behaviors related to the empowerment principle.

Table 5. Empowerment (Hitozukuri and Monozukuri) Principle

No	Faculty	Students
1	Faculty updates the initial topic syllabus schedule and activities considering weekly classroom progress.	The student completes teammate feedback in every project to improve team performance.
2	Faculty promotes or supports students' extra-academic activities that help to create an integral development.	The student uses additional learning platforms to increase his/her SKAs.
3	Faculty develop hi/her own homework and projects to stimulate student learning.	The student develops presentations, activities, and projects to develop a deeper understanding of a topic.

In the end, we have to remember that several of the TPS principles, systems, and tools were created or implemented to guarantee Toyota´s financial health. Universities used metrics like the number of students per faculty to assess an HEI classroom profitability; however, to authors' knowledge, there are not metrics to measure HEI classroom financial health in terms of knowledge dissemination. An economic quantification of waste in an HEI classroom could be used as an initial approach to assessing HEIs classroom financial health. Table 6 shows different behaviors that could help to impact on HEI classroom business health.

Table 6. Business Health Principle

No	Faculty	Students
1	Faculty offers useful and opportune feedback to the student to create value to their work.	Student offers useful and opportune feedback to the faculty to create value to their work.
2	Faculty design homework, projects, and test that help to develop students' outcomes required in the industry.	Student offers useful and opportune feedback to their teammates to create value to his/her work.
3	Faculty assigns most value to those activities that have more knowledge value.	Students conduct self-assessment exercise to identify not value activities.

5. Conclusion

Ideal behavior from professors and students could improve the performance of the knowledge dissemination and outcomes from this process (see Figure 1). To achieve the initial research goal, the authors used the following steps: define the HEI classroom as a business unit, study for the different quality meanings in education, use four publications from authors that had firsthand TPS knowledge, map HEIs classroom process, and group the TPS factors or lessons in the four main TPS principles.

An initial list of behaviors was documented using the author's academic experience. Although this research has some limitations, such as among of literature included in the research, HEI classroom mapping, and behaviors definitions, the authors believe that this could be used as initial work to conduct future work with more research methodology research. For example: a SLR of TPS principles, identification of faculty and student behaviors observing a full day of work, and complement TPS application in HEI classroom with other educational concepts, as excellence in higher education.

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Biography

Fernando González Aleu received a BS in Mechanical and Management Engineering at UDEM, an MS at ITESM in 1999, and both an MS and Ph.D. in Industrial and Systems Engineering from Virginia Tech in 2015 and 2016, respectively. His research is focused on continuous improvement projects and performance excellence models, producing one book, four journal papers, and 13 proceedings. He is a member of the Institute of Industrial and Systems Engineers, the American Society for Engineering Management, and the American Society for Quality, and Industrial Engineering and Operations Management. He has more than 15 years of experience in higher education organizations as a part-time undergraduate professor and thesis advisor (10 years), Industrial and Systems Engineering Program Director (2 years), and currently as a full-time Associate Professor in the Department of Engineering (4 years). Currently, Fernando is teaching the following courses: Quality, Productivity, and Competitiveness (undergraduate level) General Systems Theory (undergraduate level), Senior Project (undergraduate level), and Research Seminar (graduate level). Prior industry experience includes 15 years implementing quality systems, environmental systems, and management systems in Mexico and Chile. Overall, academic and practitioner, Fernando has been led/facilitated more than 30 continuous improvement projects and co-advise other 15. Some of the honorary and services positions developed by Fernando include Board of Director of the Quality and Patient Safety at Christus Health (2018 – Currently), Board of Director at Society for Engineering and Management Systems (2018 – Currently), and Research Candidate at Mexico's National Research System (2017 – Currently).

Jesús Vázquez Hernández is an Industrial and Systems Engineer, with a Master's Degree in Business Administration and postgraduate studies in Prospective and Strategic Intelligence, as well as a Doctorate in Strategic Planning and Technology Management. He collaborates as a Master Level Instructor at APICS and the Project Management Institute. He has more than 20 years of experience in application projects in the industry with the TLS methodology (ToC + Lean + SixSigma) and research on Industry 4.0 in the Supply Chain. He has held management positions in companies such as Vitro, Ingersoll Rand, Owens-Illinois and has been a graduate and undergraduate professor in engineering and business careers from 2008 to date at various private universities such as Tecnológico de Monterrey, Ibero and UdeM. He is currently an independent consultant and advisor in various companies.

Mario Alberto del Valle Velez is an Industrial and Systems Engineer who graduated from the University of Monterrey (UDEM, 1995) and TPS Sensei Level 1. Mario has postgraduate studies from the Japan International Cooperation Agency (JICA 1997), The Central Japan Industry Association (CHU-SAN -REN, 1998), and by the Japan Agency for Industrial Development and Human Resources (HIDA, 2015). Mario is a consultant with more than 20 years of experience implementing Management Systems Based on the Japanese Kaizen Philosophy and the Toyota Production System. He has developed projects in Mexico, U.S.A, Canada, Guatemala, Colombia, El Salvador, the Dominican Republic, and others. Currently, Mario is President of JICA ASEMEJA NORESTE Association of Alumni Mexico and responsible for the Taiichi Ohno Award organization.