

# Replicating Lean Six Sigma Green Belt Education

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## Replicating Lean Six Sigma Green Belt Education

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### Abstract

**Purpose** – This paper describes the intricacies and possibilities of replicating a Lean Six Sigma Green Belt (LSSGB) education model from a pilot program to other universities—employing ‘replication as strategy’—based on a validated ‘business model.’

**Study design/methodology/approach** – This work is grounded in a case study on the ESTIEM LSSGB educational method and draws on the replication literature. Specifically: (1) replication as strategy (Winter and Szulanski, 2001) to replicate stimulating learning environments, and (2) replicating sets of teaching practices (Baden-Fuller and Winter, 2007). These theories are practiced using data obtained from various sources: Participant-observer data, interview data, and secondary case data.

**Findings** – To replicate this educational program, a thorough understanding of the ‘business model’ of the LSSGB course is required. This includes a clear understanding of what is valued in each local environment, what configurations of practices create such value, and what environments contain the inputs that stimulate such value creation. Moreover, the replicating speed is substantially affected by the replicators’ knowledge on recognizing course locations for replication and successfully implementing a new course with a suitable configuration. In conclusion, replication of teaching practices between courses is mediated by predefined high-quality course content.

**Originality/value** – The LSSGB course in ESTIEM shows how blended learning opportunities can be configured to deliver impact on a European scale. Decomposing a course to teaching practices and analyzing their inputs identifies the environmental requirements for a course.

**Keywords** Lean Six Sigma, blended learning, replication, replication as strategy, ESTIEM

**Paper type** Research paper

## Introduction

This paper focuses on replicating an educational model for Lean Six Sigma Green Belt education. Replication in organization literature has also been dubbed the ‘McDonalds Approach.’ It entails creating and operating a large number of similar organizational units that deliver a product or perform a service (Winter and Szulanski, 2001). The growth of such organizations is often regarded as repeated exploitation of a simple formula that is known perfectly by the replicator – as such, little effort is likely required to replicate the formula to a new location or to maintain its local operation. In this respect, this view misses the ‘exploration’ aspect of replication by considering it a rigid form of ‘exploitation,’ thereby considering the term in a narrow sense, at least relative to March’s understanding based on organization science (March, 1991). Such a view clouds the strategic subtlety of the exploration efforts in replication. Replicators create value by discovering and refining a singular business model, choosing the necessary components to replicate that model in suitable geographical locations, developing capabilities to routinize knowledge transfer, and maintaining the model in operation after replication (Winter and Szulanski, 2001).

Replicators benefit from remarkable sustained growth. This model has, therefore, been adopted in over 60 industries like fast-food, coffee bars, hotels, banking, furniture, and information technology (Winter and Szulanski, 2001; Jonsson and Foss, 2011; Jensen and Szulanski, 2007). However, few applications of replicating educational models are known. For a notable example, see Beth et al. (2011), who describe replicating a STEM education program. Professional education for operational improvement methods like Lean Six Sigma is regularly facilitated by experienced instructors, making them a scarce resource in teaching this content and, therefore, difficult to replicate.

Under the supervision of Dr. Gregory H. Watson, students have developed a LSSGB course program that has been deployed in the ESTIEM network. ESTIEM is a non-governmental student organization consisting of independent local university groups that form a collective student association – the European Students of Industrial Engineering and Management. Since winter 2016, over sixty courses have been provided at 31 universities in fourteen European countries. Students must apply the theory and skills learned in the program to an industrial project to become a fully certified ESTIEM LSSGB.

Turtiainen and Rajala (2018) summarize the different development and deployment phases of the course. In the last phase, called “Expanding the network of green belts,” they identify the next challenge for the program development: “How to decrease the workload per new course to keep the overall workload at a reasonable level?” This indicates that the program is transitioning from a regime of exploration where a viable ‘business model’ has been created and refined to a phase of exploitation in which the business model is stabilized and leveraged through large-scale replication. Winter and Szulanski (2001) remark that this transition between these regimes is a critical period in which the pivotal task is to create and refine the capabilities that can support the more routine replication activities that follow. Therefore, the research question addressed in this paper is: How can the ESTIEM LSSGB program sustain future expansion while maintaining high-quality courses?

The paper proceeds by offering an approach to replicating education by analyzing how to replicate stimulating learning environments and teaching practices. Then, this theory for

replicating education is tested against the ESTIEM LSSGB course program. The paper concludes with practical guidance on how to replicate education for LSSGB education.

## **Replicating education**

Education is the process of facilitating learning. As a facilitator in such individual learning processes, one cannot directly replicate the actual learning of students. However, as a facilitator, one can determine the teaching practices and the environment that best stimulate the students' learning process. Replication literature offers two approaches on how to replicate such elements. Firstly, Winter and Szulanski (2001) describe replication as strategy where they focus on replicating complete organizational units. Secondly, Baden-Fuller and Winter (2007) describe contingencies on replicating sets of organizational practices via either principles or templates. To speak of replication, it is required of the knowledge transfer to be of broad scope. Moreover, Winter and Szulanski (2002) identified three theoretical dimensions next to the scope for characterizing a replication process: intended/unintended, spatial/temporal, and true/faux replication.

### *Replicating stimulating learning environments*

A replicator should acquire dynamic capabilities to configure the practices for the successful implementation of stimulating learning environments. Practices implemented locally should deliver value in different geographies. To do this, a good understanding of the 'business model' that is to be replicated is mandatory as well as knowledge about the capabilities that influence the replication speed. This is necessary to reach the large-scale exploitation phase as quickly as possible to reap the benefits of the replication method.

Winter and Szulanski (2001) define three types of knowledge that make up a business model: Understanding what is valued, what practices create this value, and in what kind of environments these practices successfully operate and create the desired value. These knowledge types are interrelated since the inputs for certain practices can vary per environment, like personnel, sites and buildings, specialized equipment, and raw materials. Similarly, what is valued in each environment may require a different configuration of practices to be delivered. Given this interrelatedness, it is suitable for a replicator to understand what features are valued in its business model. Good valued features in products or services appeal in many local environments and whose local production practices are insensitive to minor environmental variations and errors (Winter and Szulanski, 2001).

The replication speed depends on the replicators' capacity to successfully implement a suitable configuration of practices that deliver the value in an outlet. For this, firstly, outlets have to be carefully designed and constructed, staffing has to be arranged, and specific procurement and production practices to the personnel need to be conveyed. Secondly, the replication speed is influenced by the replicators' ability to recognize potential locations for new outlets, considering site characteristics and site-specific supply and demand information that jointly determines the added value of a potential site. In the transition towards large-scale replication, a replicator must utilize its limited experience with an evolving business model to understand what is replicable and worth replicating.

In education, the value lies in learning about a topic for an individual student, which can be achieved through a mix teaching practices. For these practices to ‘produce learning,’ several inputs have to be acquired in the environment so that learning can be stimulated. Broadly speaking, a match has to be made between students, instructors, and an environment prepared for learning activities. The following section will analyze how to replicate sets of teaching practices to identify the inputs required from an environment to stimulate learning activities.

### *Replicating sets of teaching practices*

For teaching to result in a valuable learning experience, the right mix of practices must be configured. Baden-Fuller and Winter (2007) identified two approaches towards replicating practices that emphasize the use of templates and principles. A template is a working example of an organizational process in use, considered a repository of process knowledge potentially subject to copying. “Observe very carefully how this is done; then try hard to copy it exactly – but do not ask why” (Baden-Fuller and Winter, 2007: p. 4). However, principles indicate what factors can produce anticipated effects and an appreciation of why. “Let us explain why this works and the reasons why it should be done this way and then try to make it work yourself – we will comment on any mistakes we see” (Baden-Fuller and Winter, 2007: p. 4).

Replication of practices can be supported by knowledge sources that follow a template or principle design. Baden-Fuller and Winter (2007) argue that codified knowledge (in the form of manuals) should contain the answer to the “*how to*” questions for replication. With a *template dominant* approach to replication, a manual emphasizes the detailed steps and how to accomplish them. On the other hand, with a *principle dominant* approach to replication, a manual seeks to impart understanding and provide a sense of orientation with important sub-goals to be achieved on the way to full replication.

Willems (2018) introduces a definition of mediators as tangible and useable knowledge sources that individuals can exploit. Two main categories of mediators are artifacts and communication/interaction (see Willems, 2018; figure 4-8 on p. 210-211). Examples of mediators are guidelines, hands-on demonstrations, or individuals like mentors or supervisors (Willems, 2018). Other examples of knowledge sources are, for instance, trainings, audits, benchmarking, and site visits where practices occur (Demeter and Losonci, 2019). Note that mediators refer to both explicit knowledge sources, like artifacts, and tacit knowledge sources like communications and interactions with people who carry more knowledge than the receiver. To quote Demsetz (1988: 157): “Those who are to produce on the basis of specialized knowledge, but not do possess it themselves, must have their activities directed by those who possess (more of) the knowledge. Direction substitutes for education.” In this case, those who direct the inexperienced are the mediators and serve as a knowledge source in replicating the practices.

Ultimately, the goal of learning should be to apply the knowledge in a real-world context that goes beyond any classroom setting. Baden-Fuller and Winter (2007) call this the flexible use of principles since they capture broad commonalities in causal structures that facilitate knowledge transfer and problem-solving across a range of diverse situations.

Before this level of flexible use of principles is reached, sufficient background knowledge needs to be present to comprehend the context and proper application of the principles. In education, such background knowledge can be built up by using knowledge sources based on templates. An initial direction is provided with such learning, which resonates with Demsetz (1988), as described above. At the same time, a student builds up more background knowledge and becomes a master who can use the principles in a flexible context.

For different learning activities, the approach to replicating the teaching practices should thus be designed to stimulate students to learn in an optimal manner. Baden-Fuller and Winter (2007) identified four contingency areas between templates and principles: External context, ease of control and monitoring, process uniqueness and sensitivity, and motivation of actors involved. For a summary of the contingency analysis, see the appendix. To classify the different learning objectives, a hierarchical taxonomy, like Anderson and Krathwohl (2001), can be used to understand what kind of design will be most beneficial to replicate a specific teaching practice.

In hierarchical learning models, one can only ascend to a higher level of learning once sufficient background knowledge in the lower levels is obtained. Therefore, it is plausible that learning activities on the lower levels, thus relatively little background knowledge, are best replicated by teaching practices that utilize templates. While higher learning levels likely benefit from teaching practices that are replicated utilizing principles.

### **ESTIEM LSSGB program: An example of replicating education**

This approach for replicating an educational program is illustrated by using the ESTIEM LSSGB program. Initially, its teaching practices are analyzed to identify the inputs required to stimulate learning in different courses. The course is set up with a blended learning philosophy: The theory is taught in an online format while learning about and working with the lean six sigma tools is done via an in-person format by students. Before instructing, these students must have completed a preparation process to instruct predefined training content (Rajala, Jarrett, and Turtiainen, 2017).

The curriculum is structured hierarchically and includes five learning levels – Defining, Understanding, Applying, Synthesizing, and Usage in real-life – based on Bloom’s taxonomy (Anderson and Krathwohl, 2001). Analyzing the learning levels with the contingency analysis of Baden-Fuller and Winter (2007) shows that the learning levels ‘Defining’ and ‘Understanding’ are best replicated utilizing templates. The teaching practices belonging to these learning levels are offered in an online format. While the teaching practices belonging to the higher learning levels ‘Synthesizing’ and ‘Usage in real-life’ are better replicated utilizing principles. Interestingly, in the ‘Applying’ learning level, the contingency analysis shows a mix of templates and principles that best replicates these teaching practices. Initially, the templates should set the direction to apply the knowledge. Once sufficient knowledge has accumulated, students will form causal relationships to advance their learning to the next step.

To deliver a high-quality and scalable course, the knowledge sources utilized in the replication process have to be designed according to the preferred replication approach. Thoroughly examining the relationship between the replication approach and the design of

the knowledge source that should mediate the replication process of the teaching practice exposes a clear understanding of what inputs are required in the environment to stimulate the learning. Table 1 shows an analysis of teaching practices to identify environmental requirements for the LSSGB program.

Once the inputs are determined that allow for a high-quality, scalable educational model, the next challenge is to manage the resources required – the inputs for the teaching practices – to sustain the growth with high-quality. Some of these inputs can be centrally produced by a replicator organization, like an online platform, session slides, workshop materials, and certification guidelines. However, prepared instructors will have to be ‘produced’ per course. The replicator can, however, produce a standardized preparation process to prepare the instructors. Managers to guide projects in the industry will have to be acquired by each student. Besides inputs directly related to teaching practices, other inputs for a stimulating learning environment have to be sourced locally, like students, facilities like rooms, and hosting to have a course.

| <b>Teaching Practices based on Rajala, Jarrett, and Turtiainen (2017)</b>  | <b>Learning level</b>            | <b>Replication approach</b> | <b>Knowledge sources (Mediators)</b>                          | <b>Input required to stimulate learning</b>  |
|--|----------------------------------|-----------------------------|---|--|
| Actual LSSGB project after the course (offline after the course)           | Usage in real-life               | Principles (flexible)       | Company resources, Course materials, Certification guidelines | Manager willing to guide a project<br>Certification guidelines & process                       |
| A simulated case study covering a complete DMAIC cycle (offline),          | Synthesizing, Usage in real-life | Principles                  | Prepared Instructors as team mentors and sponsors             | Case flow guidelines for Instructors & Catapult building materials & instructions for students |
| Recaps during training (offline)   | Synthesizing, Understanding      | Principles/ Templates       | Prepared Instructors & DMAIC Recap slides                     | Prepared Instructors & Recap slides  |
| Practical exercises covering DMAIC step-by-step (offline)                  | Applying, Synthesizing           | Principles/ Templates       | Prepared Instructors & Exercises in the Session slides        | Prepared Instructors & Session slides<br>Materials for Catapult exercises                      |
| Nine training modules (offline)  | Applying, Synthesizing           | Templates/ Principles       | Prepared Instructors & Session slides of the modules          | Prepared Instructors & Session slides  |
| Questions related to videos (online), quizzes (online), Exercises (online) | Defining, Understanding          | Templates                   | Questions/exercises in an online platform                     | Online platform prepared   |
| Videos by Gregory H. Watson (online)                                       | Defining, Understanding          | Templates                   | Videos on YouTube   | Online platform with videos embedded   |

**Table 1.** Input analysis of teaching practices to identify environmental requirements for the LSSGB program.

## Conclusion

Replication literature offers a process to expand an educational program with high-quality in a sustainable manner. Here, transitioning from an explorative regime to an exploitative one requires an educational replicator to re-examine the educational model and configure it for large-scale expansion. This can be done by utilizing the Baden-Fuller and Winter (2007)

contingency analysis to ensure that the knowledge sources utilized in the replication process are replicable without losing quality. This examination has shown the environmental inputs that are required to replicate practices that can deliver value. The transition towards large-scale exploitation thus starts with a re-examination of one's 'business model.'

Understanding the required environmental inputs is beneficial in recognizing locations for further expansion. The re-examination of how the practices deliver value sharpens the capability to implement suitable configurations. These factors affect the replication speed and make it possible for the replication to reach the large-scale exploitation regime sooner.

This work shows how a predefined curriculum and directed preparational processes allow student-to-student education at scale for the ESTIEM LSSGB program. A bigger scale can only be sustained via continual investments in product and process improvements. The replicator is uniquely positioned for this since it learns and builds experience after each course instance. By developing more students, over time, the impact this program makes throughout Europe accumulates and delivers results in the development of many students and in the organizations they work.



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**Appendix: Contingency analysis summary to approach replication**

There are different considerations to approach replication primarily via templates or principles. Baden-Fuller and Winter (2007) have identified four contingency areas to consider: external context, ease of control and monitoring, process uniqueness and sensitivity, and motivation of actors involved.

A summary of this contingency analysis between templates and principles is given in table 2. A disclaimer must be made since the contingency analysis is largely based on the definitional contrast between the two replication approaches, empirical observations of Baden-Fuller and Winter, and prior work of selected authors (Baden-Fuller and Winter, 2007).

| <b>Replication approach</b>         | <b>Templates</b>   | <b>Principles</b>  |
|-------------------------------------|--|--|
| <b>Definition</b>                   | A working example of an organizational process in use, considered as a repository of process knowledge that is potentially subject to copying.   | Indication of what factors can produce which anticipated effects, and an appreciation of why.  |
| <b>Approach to replication task</b> | “Observe very carefully <i>how</i> this is done; then try hard to copy it exactly – but do not ask why.”   | “Let us explain <i>why</i> this works and the <i>reasons why</i> it should be done this way and then try to make it work yourself – we will comment on any mistakes we see.”   |
| <b>External Environment</b>         | <ul style="list-style-type: none"> <li>▪ Identify in advance with high confidence units where template assures threshold success</li> <li>▪ Favored when the unit is not expected to adopt immediately</li> <li>▪ Demand for minimal context differences by a selection of locations and employees and close copying of structures and equipment</li> <li>▪ If local circumstances force adaptation in the planning stage, the template is no longer tested but becomes untried and is so of little value</li> <li>▪ Low risk if the new site is similar: differences in local context do not intrude with the boundaries of the replicated operation to hinder the consistency. E.g., the required quality of inputs like labor is more difficult to procure locally</li> </ul> | <ul style="list-style-type: none"> <li>▪ Where context different too much so template assurance is unavailable</li> <li>▪ Preferred when the new unit has to evolve quickly</li> <li>▪ Causal understanding guides towards coherence</li> </ul>  |
| <b>Control and monitoring</b>       | <ul style="list-style-type: none"> <li>▪ When <i>processes</i> to be replicated are easy to monitor, but not the <i>outcomes</i>, Templates are favored</li> <li>▪ When monitoring inputs is easier than monitoring outputs, templates are likely more effective for replication. Deviations of practices can be immediately identified and checked.</li> <li>▪ Methods of process assessment are developed in conjunction with the development of replication methods, and they do not exist in independent form.</li> <li>▪ Replication of practices via a template may cause machines to be modified to facilitate easier</li> </ul>  | <ul style="list-style-type: none"> <li>▪ When <i>outcomes</i> are easy to monitor, but the <i>processes</i> are difficult, Principles are favored</li> <li>▪ When the outcome is customer satisfaction, employees can adjust to the demanded customer’s circumstances within a wide range of situations to deliver the outcome.</li> <li>▪ Measurement of customer satisfaction may be developed alongside the refinement of the practices.</li> </ul> |

|  |   |   |
|--|---|---|
|  | monitoring, or procedures may be perfected to isolate work skills   |   |
| <b>Process uniqueness and sensitivity (regarding the nature of the background knowledge of the front-line workers and its relevance to both methods)</b> | <ul style="list-style-type: none"> <li>▪ Templates are more appealing when <i>details matter</i> and they are idiosyncratic (unique to the context)</li> <li>▪ The template approach may be favored when workers come from a low-wage pool with few specialist skills.</li> <li>▪ The emphasis of template users is on accepting the direction of productive work over individual problem solving. According to Demsetz (1988:157), “Direction substitutes for education (that is, for the transfer of the knowledge itself).”</li> <li>▪ A high amount of idiosyncratic detail and lack of agreed understanding of causes, often in complex and sensitive processes, favors templates. (sub)processes can then be carefully replicated.</li> <li>▪ At the boundary (e.g., for semi-conductor production), the local context of productive activity can be engineered and rigorously controlled. Such engineering creates a local context so similar to the source that is practically unknown for service organizations</li> </ul>   | <ul style="list-style-type: none"> <li>▪ Principles emphasize providing the causal frame for learning, which works when details are already known or readily learned, e.g., by having required actions as common background knowledge or features of familiar, institutionalized skill sets.</li> <li>▪ Much of the detailed “how” knowledge is maintained in the heads and hands of the practitioners (e.g., construction/architects)</li> <li>▪ Principles can be used to explain the “know why” that adds to the “know-how” of experience to improve outcomes</li> </ul> |
| <b>Motivation of the actors involved in the practices</b>  | <p>Replication of practices requires the front-line workers to be careful. Deviations from intended practices (either causal logic of Principles or actual practice of the template) may result in total replication failure. Close attention is necessary to ensure the <i>required practice</i> is replicated correctly. The motivation of the workers required for both is quite different for the approaches</p> <ul style="list-style-type: none"> <li>▪ Templates can be pursued by workers with a greater sense of detachment from the organizational hierarchy, but the <i>template’s reputation itself</i> assumes greater importance than the organizational attachment.</li> <li>▪ Front line workers have to pay careful attention to the important details of practices to avoid deviations even when they seem sensible</li> <li>▪ An appropriate worker stance is not to overthink too much (i.e., avoid “why”). Such attitudes and behaviors will be much easier to induce when the template’s authority is secure because it has a positive reputation.</li> <li>▪ Using an outlet with a successful track record in terms of profits and visibility as the specific template for replication. Template reproduction is <i>not only possible inside an organization</i>. It can be extended to loosely-coupled organizations such as franchise chains or merged firms. Employees operating the replicated unit are not closely aligned in history or identity to the originating location. Nevertheless, they are often well aware of its reputation.</li> </ul> <ul style="list-style-type: none"> <li>▪ Principles require actors to be fully and emotionally engaged in the practice, and the challenge of establishing such engagement falls on the leadership of the organization</li> <li>▪ Principles have no similar reputational value in the extant working example, and such examples serve, at best, as inspiration.</li> <li>▪ Principles require the front-line worker to make an effort <i>beyond</i> that which can be monitored.</li> <li>▪ Authority and reputation of management is more critical in goading the effort. When top managers are committed, charismatic, and can provide authoritative guidance in the methods and sub-goal structures, Principles will work better.</li> </ul> |   |

- Many parallels with organizational change motivation: doing things different from the past requires unusual personal effort and personal risk-taking. Vision from the leadership is vital because it reinforces the need for the front-line workers and managers to take such risks and encourages them to do so.
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**Table 2.** Summary of the template and principles contingency analysis for replication of Bader-Fuller and Winter (2007)