Case study: using value stream mapping in the educational process – how focusing on student actions can help depict the teaching process

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Abstract: Although many lean higher education efforts have focussed on administrative/support services and processes, only a few actual applications of lean methods have been meant for teaching, which is the core business of higher education. The absence of experiments and research in these contexts has challenged us to apply lean to our own undergraduate course. We have paid special attention in this experiment to the use of Value Stream Mapping (VSM) to depict teaching process, the shortcomings of VSM and the use of service blueprinting.

Keywords: lean; higher education; value; VSM; value stream mapping; service blueprinting; educational process; improving teaching; student-centred approach; information flow; rich informational nature; co-production; synchronicity in communication; six sigma.

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Case study: using value stream mapping

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1 Summary

The applications of lean in Higher Education (HE) that have been conducted on teaching thus far mostly involve one lecturer teaching one graduate course (Emiliani, 2004). Researchers so far have not paid attention to undergraduate and graduate courses and programs that involve multiple teaching staff. The absence of experiments and research in these contexts has challenged us, as lean lecturers and researchers, to apply lean to what we teach our students, and to observe how far we can go in applying lean methods to our own undergraduate course at the HAN School of Engineering in the Netherlands. The course is developed and is taught by seven lecturers (i.e. it is a multi-lecturer setting). Each of us was responsible for the quality and completeness of his/her module; when teaching the course modules sequentially, we were very much interdependent: the lecturing and quality of learning the content of the second course module was partially (and dependent) on the quality and completeness of the first module, and so on.

The complexity of the educational process,¹ which is characterised by co-production, diversity in students’ learning styles, a rich informational nature, the alternation of synchronicity and asynchronicity in communication, and (in our case) by multi-lecturer setting, forced us to limit our case study to the analysis of the information flow in teaching process, as this is the part the lecturer can influence the most. By doing this, we aimed to specify value of information, organise value-creating actions in the best sequence, conduct these activities without interruption whenever teaching and perform them more and more effectively. The case study shows the following:

a Traditional Value Stream Mapping (VSM) fails to capture the structurally and semantically rich information flow in the teaching process; and

b Service blueprinting (SB) depicts the information flow in the teaching process in a more effective and richer way, and provides a good starting point for improvements.

The rest of the paper is organised as follows. In Section 1, we explain in brief the lean principles we refer to in the case study, and provide a short overview of the current practices of lean in HE. Section 2 describes the complexity of the educational process, and the reasons for focusing on information flow in this case study. Section 3 covers the analysis of VSM tool when applied to teaching. We explain our choice for a more student-centred approach, and therefore the use of SB. Based on the experiment, we draw a few tentative conclusions in Section 4, and we suggest further research on this topic.

2 Lean in HE

Lean methods have been sporadically used as a process improvement technique in Higher Education Institutions (HEI) for more than a decade. An examination of several examples and research studies demonstrates that in the most cases the focus of these studies has been on HE support and administration services (Balzer et al., 2010; Antony et al., 2012; Barroso et al., 2010). Emiliani (2004, 2013) was one of the few to address
curriculum design, development, teaching and research as fundamental educational service. He argues that the thoughtful application of lean principles and practices in education could result in more effective teaching process, higher student engagement and better learning outcomes. It is thus interesting to see that instead of process improvement, teaching and research in HEI have undergone almost no fundamental changes over the years (Barroso et al., 2010).

The idea for this study arose when we, as lean practitioners and (HE) lecturers, asked ourselves if (and how) we could apply lean methods to our teaching activities, and by doing so teach more effectively and enrich the pedagogy we used. We teach our students lean, we actively coach them in continuous improvement projects and we consult small- and medium-sized enterprises on lean implementations. It was thus a natural next step for us to research if we could ‘practice what we preach’ in our core business: teaching. Lean methods and lean thinking, as Womack and Jones (2003) described, can be summarised in five principles:

1. Specify the value for the end customer in terms of a specific product (a good or a service, and often both at once) which meets the customers’ needs at a specific price at a specific time.
2. Identify the value stream for each product, as it is a set of all the specific actions which are required to bring a specific product in the customer.
3. Allow value-creating steps flow without interruptions.
4. Let the customer pull value from the producer, and pull the product as needed, rather than pushing (which is often unwanted).
5. Pursue perfection.

In order to execute the experiment during the course delivery, we decided to focus on (1) defining the value of information in our teaching for the students (the customer of our undergraduate course) and (2) identifying the teaching value stream.

3 The educational process

One of the first questions we asked ourselves in this study was how to approach the educational process: What were the input, throughput and output we were focusing on in the case study and what variables influenced the process and its outcome? In Section 3.1, we provide a short overview of the influence variables we encountered in our case study when understanding the characteristics of the educational process.

3.1 The process characteristics

The process we are trying to apply lean methods to is not as simple as (to pick one example) the production of chairs. When producing a chair, the input and output are clearly defined, and there is no communication or intermediate verbal interaction between producer, consumer and product. If each chair is produced according to specification, each chair will be the same. What we have observed when delivering the course is that the process (i.e. teaching) and its outcome (i.e. knowledgeable students) are never exactly the same. Instead, the outcome is characterised and influenced by (1) diversity in students’ learning styles, (2) lecturer–student co-production, (3) rich
informational nature, (4) the alternation of synchronicity and asynchronicity in communication and finally (5) the multi-lecturer setting. In order to understand the process and to refer to these five process characteristics later in this paper, we will briefly describe them here in turn.

1. **Diversity in students’ learning styles.** As explained by Felder and Brent (2005), students have different levels of motivation, different attitudes towards teaching and learning and different responses to specific classroom environments and instructional practices. In their research on student differences, Felder and Brent (2005) state that there are three categories of diversity that have been shown to have important implications for teaching and learning: differences in students’ learning styles, different approaches to learning and different intellectual development levels. In addition to these three categories, we have also found in our practice that the attitude towards studying method also has to do with students’ different backgrounds, gender, interests, ambitions, senses of responsibility, levels of motivation, and strengths and weaknesses. We argue that no two students are alike in the way they process and learn the information.

2. **Lecturer–student co-production.** Because we mainly deliver our undergraduate course in a traditional classroom environment based on face-to-face interactions when transmitting the course information, we consider it to be a co-production or joint production between lecturers and students (Larsson and Bowen, 1989). If we consult the work of Balin and Giard (2006), we can say that providing spoken or written information during the lecture could be described as co-production, as not only can the students (and often do) express their needs, but also information is partially created during the lecture in co-production with the students (Wiegel and Brouwer-Hadzialic, 2015). In this case, because it is not possible to separate the consumption and the production when lecturing, no lecture can be produced and delivered in the same way.

3. **Rich informational nature.** When analysing the typology, content and information dimension in our undergraduate course, we conclude that we provide information on different levels, and at different moments; information can be learning and learning support related; individual or group oriented; and it can be presented verbally, in writing, or it can be visualised. Throughout the course development and delivery, we create, transform and transmit information in all of these dimensions and typologies. Information is also ambiguous in nature in varying degrees, as described by Wiegel and Brouwer-Hadzialic (2015).

4. **Alternation of synchronicity and asynchronicity in communication.** When teaching – and therefore interacting with – students, we exchange information. This interaction is characterised by the time sequence and level of collaboration between the lecturer and student; this is described as the ‘synchronicity’ of communication. According to Raymond et al. (2005), traditional education goes through three phases of interaction, as shown in Figure 1.

When lecturing in the traditional classroom environment, we carry out the activities and co-produce the information and knowledge through collaborative communication with the students. In this process, as pointed out earlier, we deal with diversity in students’ learning styles. We argue that the synchronous phase in teaching can never be carried out twice in the same way, and is characterised by co-production, since the production and consumption in such cases happen simultaneously.
5. **The multi-lecturer setting.** Finally, the multi-lecturer setting in our case means that we have to deal with the diversity in teaching styles and approaches to teaching methods, and lecturers’ different backgrounds, interests, ambitions, senses of responsibility, and strengths and weaknesses, just as in the case of student diversity. The multi-lecturer setting influences teaching, since course-related information is delivered through every phase as described in (4) in a slightly different way (mostly depending on the lecturer’s personal style).

All five of these process characteristics make it difficult (if not impossible) to carry out teaching twice in the same way; two teaching sessions will never have the same outcome. These characteristics (among other process characteristics) are very common for the service sector, but are less common for the manufacturing sector.

**Figure 1** Alternation of synchronicity and asynchronicity based on the work of Raymond et al. (2005)

<table>
<thead>
<tr>
<th>Asynchronous phase</th>
<th>Synchronous phase</th>
<th>Asynchronous phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of the activity</td>
<td>Carrying out the activity</td>
<td>Review of the activity</td>
</tr>
<tr>
<td>- time lag between sending and receiving</td>
<td>- real-time communication</td>
<td>- time lag between sending and receiving</td>
</tr>
<tr>
<td>- whenever student has the time to complete it</td>
<td>- immediate interaction</td>
<td>- whenever student has the time to complete it</td>
</tr>
<tr>
<td>- less/no immediate</td>
<td>- collaborative communication</td>
<td>- less/no immediate</td>
</tr>
</tbody>
</table>

3.2 **Focus on information flow**

We know that education is much more than just an information exchange between lecturers and students. As described in Section 3.1, because teaching and learning are both influenced by many factors, we argue that the educational process is complex. For the purposes of this study, we approach education as a process of transmitting information that can create knowledgeable students. This simplifies the process for the case study, puts students in the consumer’s corner and characterises them as co-producer of their knowledge; the process also helps us focus on information when mapping the value stream.

4 **Analysis**

In this section, we will go through a few course facts, and explain how and why we failed to use VSM to depict the teaching in our course.

4.1 **Undergraduate course facts**

In order to earn a bachelor’s degree, each student at the HAN University of Applied Sciences has to complete a minor within his/her program. The minor is a half-year undergraduate course of 30 credits that can be completed at HAN or other HEIs in the Netherlands or abroad.
For the purpose of this case study, we applied lean methodology to the minor ‘World-class Performance/Lean Management’ at the HAN Faculty of Engineering. The minor was executed during the first semester of academic year 2013–2014. The case study is unique in that it is one of the first studies of the application of lean methodology to a course in a multi-lecturer setting.

<table>
<thead>
<tr>
<th>National student survey score</th>
<th>7.5 out of 10</th>
</tr>
</thead>
<tbody>
<tr>
<td># students</td>
<td>57</td>
</tr>
<tr>
<td># lecturers (excl. guest lecturers)</td>
<td>7</td>
</tr>
<tr>
<td>Average # (contact) hours per week</td>
<td>21</td>
</tr>
</tbody>
</table>

The course consists of ten modules, mostly sequentially interdependent (Wiegel and Brouwer-Hadzialic, 2015), as each module requires input from the previous module in order to be carried out successfully. The case study focuses on information exchange during the first five weeks of the course, as all the modules were delivered right there. During those weeks, students engaged in roughly 110 hours of lectures and workshops that prepared them for the project assignment of the following 13 weeks. Seven lecturers, including the course coordinator, were involved in the course development, teaching and evaluation.

4.2 Value stream mapping

According to the five lean principles described by Womack and Jones (2003), once value of the teaching has been specified (in our case study, the value is transmitting the information to create knowledgeable students), the current state value stream for the teaching process should be mapped. Data about the process were collected through direct observations, by student questionnaires and by semi-structured interviews with ten course students. Drawing the value stream map was a moment of truth for us, as we had struggled with the limitations of the traditional VSM, combined with the process characteristics as described in Section 3.

The first obstacle we encountered when drawing the VSM was the question of where to picture the student as a consumer of our lectures. The traditional consumer’s place in
the VSM (the upper-right corner of the picture) was not satisfying for us, since we had concluded before that the student is to some extent a co-producer in teaching process; teaching and learning in the traditional classroom setting happen synchronously, and cannot be clearly separated. We thus started picturing the student throughout the process, which made the mapping less easy and the map less clear to read.

The next obstacle was dealing with the rich informational nature of teaching. Womack and Jones’s (2003) definition of VSM states that the value stream is the set of all the specific actions that are required to bring a specific product through the three critical management tasks of any business:

1. The problem-solving task, which runs from conceptualisation through detailed design and engineering to production launch.
2. The information management task, which runs from order taking through detailed scheduling to delivery.
3. The physical transformation task, which proceeds from raw materials to a finished product in the hands of the customer.

A valuable part of the process is the flow of information going back from the consumer (student) to the producer (lecturer), along with the transforming actions on the product (information in our case) in response to this information. In this method of portraying material and information flow, information is used to control and manage the production process.

In the case of developing and teaching the course as we see it, the informational nature of the process colours all the three management tasks. Whereas in traditional VSM, material and information flow are mapped, in our case we mostly mapped the information flow. This means that in the process of creating knowledgeable students, information is the following:

- the **product** (e.g. study guides, written course material, projected presentation, spoken lectures);
- the **control tool** (e.g. schedules, tests and exams to check if and how the information is processed by students, and if and where the reworking is needed);
- the **feedback and response** to the producer (lecturer) (e.g. discussions and questions to clarify and process the information).

In addition to co-production as described earlier, the rich informational nature of the process, as pointed out in Section 3.1, made it even more difficult to clearly depict the process using only the traditional set of the VSM symbols. We aimed for VSM to somehow capture the student–lecturer interaction, which was characterised by the time sequence, collaboration and synchronicity in the communication, as explained previously. We have also struggled with information diversity, as we did not succeed in distinguishing the tangible from non-tangible information or content, or the feedback from instruction and support information.

Based on this experiment, we concluded that the VSM as it is traditionally conducted is not the most suitable tool for identifying the value stream for teaching process, since we discovered that:

1. we needed to draw the student throughout the most of the VSM;
2. the set of the VSM symbols was not rich enough to capture all the informational dimensions and their structural differences.
These findings led us to seek an alternative, and challenged us to approach the process mapping differently. If student is a consumer and a co-producer, then our process mapping should be more student activities oriented and should be based more on a service approach than on a manufacturing approach.

4.2 Service blueprinting

We chose SB as an alternative approach in order to visualise the process of service delivery in a way that would highlight the roles and relationships of the service user within the service-delivery system (Radnor et al., 2013). SB is a graphical representation of a service, and is very consumer oriented (Bitner et al., 2008). As argued by Verboom et al. (2004), the most important aspect of a service design is to make the processes that lead to customer interactions transparent. They describe this graphical representation of a service as the following:

“the mutual relationships between the activities in a process over time. Moreover, this technique provides the flowchart with additional information about actors, moments of interactions and contact with costumers, and the information flow within the organization. […] The customer’s path (the way in which the customer thinks and behaves) is the starting point of the notation of the process.” (p.497).

We used SB to model the information exchange between lecturer and students during the first five weeks of the course; this allowed us to visualise the information production and consumption, and the level of the communication synchronicity.

As described above, the starting point for our process mapping was the student’s path. The information transmission was modelled as the path was perceived by the student, and based on student’s course actions, and the tangible and intangible course evidence that goes along with those actions. The interaction between the lecturer and student is made visible by means of different ‘lines of interactions’. The lecturer’s actions and his or her interactions with a student are often visible to a student, while other actions and interactions occur behind the ‘line of visibility’, as shown in Figure 3 and Table 1.

**Figure 3** The structure of our service blueprint
Table 1: The main elements of the blueprinting used and adjusted for the case study

<table>
<thead>
<tr>
<th>Blueprint elements</th>
<th>Characteristics</th>
<th>Drawing (see also Figure 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tangible and intangible course</td>
<td>For each student learning action, the course evidence that students come in contact with. These are all the tangible and intangible products that students are exposed to that can influence their quality perceptions of the teaching process.</td>
<td>Described at the very top of the blueprint</td>
</tr>
<tr>
<td>course evidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student actions</td>
<td>All of the steps that students take as part of the teaching (delivery) process. The student actions are central to the creation of the blueprint.</td>
<td>Laid out first Depicted chronologically across the top of the blueprint All other activities support the value proposition offered to or co-created with the student</td>
</tr>
<tr>
<td>Onstage (visible) lecturers’ contact</td>
<td>Lecturers’ actions that occur as part of a face-to-face encounter/interaction with the student.</td>
<td>Separated from the student by the line of interaction Visible to and seen by the student</td>
</tr>
<tr>
<td>actions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backstage lecturers’ contact actions</td>
<td>All other lecturers’ actions in relation to the course (not involving face-to-face interactions), including e-mail, phone and online (e.g. ‘HAN-Scholar’) contact with students, as well as anything else that lecturers do to prepare those teaching activities that are part of their role responsibilities</td>
<td>Separated from the onstage actions by the very important line of visibility Invisible to the student</td>
</tr>
<tr>
<td>Support processes &amp; IT</td>
<td>These are all of the activities carried out by individuals and units within the university who are not lecturers (e.g. scheduling &amp; IT employees); these activities need to happen in order to deliver the course (facilitating the teaching process).</td>
<td>Separated from lecturers by the internal line of interaction Vertical lines from the support area connecting with other areas of the blueprint show the inter-functional connections and support that are essential to teaching</td>
</tr>
</tbody>
</table>

Note: ‘HAN-Scholar is the electronic learning environment for HAN lecturers and students, in which the students’ learning process is placed centre stage. Students can initiate and carry out learning activities and collaborate online with lecturers and fellow students.

Source: Based on Bitner et al. (2008)

Table 1 summarises the main service blueprint elements, the degree of student–faculty interaction characteristics and the drawing steps as we used it to depict teaching.

Figure 4 shows the mapping of teaching process for the case study using the SB, based on our previously explained assumptions.
Figure 4   The service blueprint applied on the course’s current state of teaching process (see online version for colours)
5 Conclusions

Based on the case study findings, we may conclude the following:

1. Due to the high level of co-production and rich informational nature of teaching, traditional VSM falls short when graphically presenting the value stream in teaching.

2. Service blueprinting is a good alternative to VSM for graphically modelling the teaching process, because it shows the student–lecturer interaction and collaboration when creating the knowledgeable student, and it makes it possible to depict the tangible and intangible information; it thus helps us to gain insights into the information flow and exchange.

We suggest that further research be conducted to develop service blueprinting as a good equivalent to a VSM for the purposes of lean methodology as used in HE.

References


Notes

1. We see the educational process as a combination of teaching and learning.

2. From www.nuffic.nl: Bachelor’s degrees at universities of applied sciences in the Netherlands consist of 240 credits; depending on the institution, students will focus primarily on one specialisation, or on a primary and subsidiary subject; this is known as the major/minor structure.

3. ‘Faculty’ includes lecturers and support staff.