Article

Towards Lean Teaching: Non-Value-Added Issues in Education

Silvia Martínez Sanahuja [ORCID]

Department of Mathematics, Universidad de Castilla-La Mancha, 02071 Albacete, Spain; Silvia.MSanahuja@uclm.es

check for updates

Abstract: Lean Thinking is a methodology based on improving the efficiency of productive processes by removing non-value-added issues. This methodology was firstly applied in the manufacturing industry, but it has also been applied to many service companies, bringing very good results. In the last decade, some works have tried to research the adaptation of Lean principles and practices to teaching, especially in technology and other STEAM subjects. In this sense, the aim of this work is to deepen this new trend by establishing what issues are non-value-added (waste) ones in education and classifying these kinds of waste in order to be able to analyze how to eliminate them. For this purpose, we adapt the classification made in other kinds of processes and extend other authors' findings regarding this topic.

Keywords: new trends; Lean education; Lean Teaching; learning process; non-value-added issues

1. Introduction

Education research community agrees, without doubt, that a deep analysis of the education system in general, and of teaching–learning processes in particular, is indispensable in order to improve them [1]. In this sense, it is reasonable to think that bringing highly effective ideas and methodologies from modern industry to the educational context could be helpful [2]. In particular, from the beginning of this century, there has been a tentative initiative consisting of adopting an interesting methodology coming from manufacturing businesses, known as Lean Thinking, into the educational environment [3–8].

This new trend is specially indicated for the teaching–learning process of the most of the STEAM subjects (science, technology, engineering, art, and mathematics), where many difficulties for the motivation of students and the acquisition of abstract concepts appear, demonstrating that traditional techniques are not efficient enough [9].

Lean Thinking is a methodology first known as Lean Manufacturing, which was used by the automotive industry [10]. Thanks to the great improvements achieved as a result of its application, this methodology was also adopted by other sectors of the manufacturing industry, service companies, and public administrations [11]. However, its application in education is quite novel and undeveloped. So far, only some universities and colleges have begun to experiment with Lean principles, although fundamentally for their administrative or institutional processes, while the teaching–learning process has been overlooked or directly eluded [12].

Specifically, Lean is a systematic approach that focuses on customer demand and tries to have more efficient processes and procedures by removing waste from them. Lean aims to be more efficient without becoming less effective in satisfying customer requirements. This efficiency is mainly achieved by removing or minimizing all the issues that do not add any value to the customer (waste sources), such as wasting time, labor, money, and other resources [13].

From the educational point of view, Lean can be seen as a methodology that lets universities, schools, and teachers be equally effective in providing learning to all students, and more efficient by eliminating or minimizing wastes or losses of the educational process. In the last decade, some works have tried to research the adaptation of the principles and practices of Lean Thinking to teaching. However, this research line has been poorly explored and developed until now. In this sense, the aim of this work is to deepen the research on this topic by establishing what non-value-added issues are in education and classifying these kinds of waste in order to be able to analyze how to eliminate them. For this purpose, we adapt the classification made in other kinds of processes and extend other authors' findings regarding this topic [14,15].

2. Lean Thinking

Lean Thinking had its origins in manufacturing businesses and appeared in order to fight the manufacturing crisis provoked by the Second World War [10]. Specifically, this approach aligned all elements of the production system to better meet customer demand by reducing superfluous activities or processes such as inventories and movements [16]. Due to the excellent results achieved, Lean Manufacturing principles have been translated to many other types of companies. Thus, Lean Thinking was also adopted in the service sector, taking the particularity of the product into account (for instance, services cannot be stored as manufacturing products) and the special role that customers have to service businesses [17–19].

Lean Thinking is a (business) philosophy that aims to provide a new way to think about how to organize (business) activities to deliver the required value to customers (effectiveness) while being more efficient through the elimination of wastes [20]. Lean aims to increase the productivity of the organization by analyzing the processes in order to identify non-value-added issues and removing or minimizing them.

From the customer perspective, an activity adds value if the customer is willing to pay for it, i.e., if it transforms the product or service following the customer requirements (the required quality with the required cost in the required time). On the other hand, an activity is said to be non-value-added or waste if the customer is not willing to pay for it. Those are activities that do not contribute directly to building customer requirements of the product, such as, for instance, transport, bureaucracy, and breakdowns. In such a case, these kinds of activities must be removed or minimized.

Assuming that the goal of Lean is to provide customers exactly what they want, how they want it, and when they want it, the methodology to implement Lean Thinking is

- Determine which are the non-value-added issues (waste); that is, those activities that do not increase the worth of what is delivered to the customer. For the purpose of identifying these waste sources, a very good tool is value stream mapping (VSM), among others. VSM is a tool that displays the chain of processes (both those that add value and those that do not) for producing a specific product or family of products. VSM helps us to quickly visualize the entire process, understand the value-added and non-value-added activities by identifying bottlenecks or inefficiencies, and where the processes can be streamlined or improved [16].
- After this analysis, elimination or minimization of these non-value-added activities must be led. For this purpose, projects must be led, involving, on the one hand, different Lean tools depending on the type of waste and, on the other hand, the participation of the involved people.
- Once the projects are implemented, a new analysis of where the new non-value-added issues are must be developed. The practice of improving all the elements in the process by eliminating waste is an ongoing effort to pursue perfection. Consequently, processes must be analyzed continuously (to see what adds value or not) and improved by using Lean tools and the commitment of the people to finally convert a Lean project into a Lean culture [21]. Lean culture encourages people to participate in all the initiatives of continuous improvement, and think about which of their routine activities add (or not) value to the system.

The goal of this work is to face the first step of bringing into play this methodology in the educational system. As aforementioned, this first step consists of determining what value is and, consequently, what waste is. Thus, once the requirements of the customer are clearly defined, the non-value-added activities of the system (waste) should be identified in order to eliminate or minimize them. Thus, the main challenge is to identify the waste sources.

Typically, Lean Thinking considers seven wastes sources [22].

- Overproduction: It is defined as producing more than the customer requires or producing something before it is needed.
- Inventory: It is the excessive storage of raw materials, in-process products, or finished products, which the customer does not need. An extra inventory provokes unnecessary costs because it uses valuable space, it consumes financial resources, extra time is needed for controlling it, and it is a source of product losses since it can become obsolete or suffer damage.
- Overprocess: It means to do more processes than the customer requests due to internal needs, such as bureaucratic procedures, or to produce better quality than the customer requires, or to pack better than necessary.
- Defects: They are associated with those products that do not meet quality requirements and, consequently, must be repeated, processed again, or thrown away.
- Transportation: It is the movements of products needed to pass between processes, e.g., to storage or to send them to the customer.
- Motion: It refers to all the movements of people without producing anything, e.g., because they have to inform someone, clean an area, or they need a tool, an order, instructions, or even paper.
- Waiting: It is associated with people not producing and waiting for something to proceed, such as, for instance, to repair equipment, to get permission, or to receive information.

In addition to these typical seven wastes, another waste is lastly considered [23]. This is

- Unused creativity: This waste refers to the fact of not using the help or the knowledge of people involved in the processes in order to improve the processes, or to have people working in jobs where their capabilities are underutilized.

3. Lean Education Approaches

Lean Thinking, applied to education, can be seen as a philosophy that aims to provide a new way to think about how to organize education processes to be more efficient (through the elimination or minimization of those aspects which do not add value to the learning process), while remaining equally effective [13].

In this context, two different perspectives can be distinguished: Lean education, where Lean initiatives are applied in an educational system or one of its stages (primary education, secondary education, or, specifically, universities), making it work as a Lean enterprise, and Lean Teaching, where Lean techniques are implemented in the classroom, that is, in the teaching–learning process of a subject, where a transmission of knowledge goes from teachers to students [13]. In the rest of the paper, for the sake of concreteness, we focus on Lean Education applied to universities when referring to Lean Education.

In the context of Lean Education, we can distinguish some nuances regarding the model of business. In private education, the degrees can be considered the products, while the students can be seen as the customers since they pay fees and the process starts on enrolment and finishes upon graduation [24]. However, in public education, we can assume that the products are the (graduated) students and the customer is the State (or, more properly, its society) since it assumes the most important part of the educational costs [13]. In this sense, it is worthwhile to emphasize the active role of the students in both approaches, whether students are considered as products or customers. That is, they

have a very active role in the production process and must be integrated into it, as happens in all service processes [15,25,26].

On the other hand, when we put the focus on just the academic processes, another different perspective in applying Lean Thinking to education arises, namely, Lean Teaching. Emiliani [5] coined this term to define the application of Lean principles and practices to teaching. Thus, Lean Teaching can be understood as bringing into play Lean Thinking in the teaching–learning process, that is, in the process where the teacher is transmitting knowledge to students and guiding them to acquire the corresponding skills. In this approach, the students can be considered as the customers, the contents and skills to be taught can be assimilated as the products, and the methodology used to teach can be comprehended as the process.

In summary, the main difference between them is the process to be analyzed; for example, just the teaching–learning process, a course, a degree, or the entire educational system (see Figure 1). In fact, Lean Teaching can be seen as a part of Lean Education [7]. The idea of using different labels comes from the fact that it is difficult to convince university managers to implement Lean to the whole system. Therefore, Emiliani [5] used the term Lean Teaching for the part of the educational process that depends mainly on teacher commitment, i.e., the teaching–learning process. This notion is very interesting because it would be easier to start the Lean transformation of educational systems from this point.
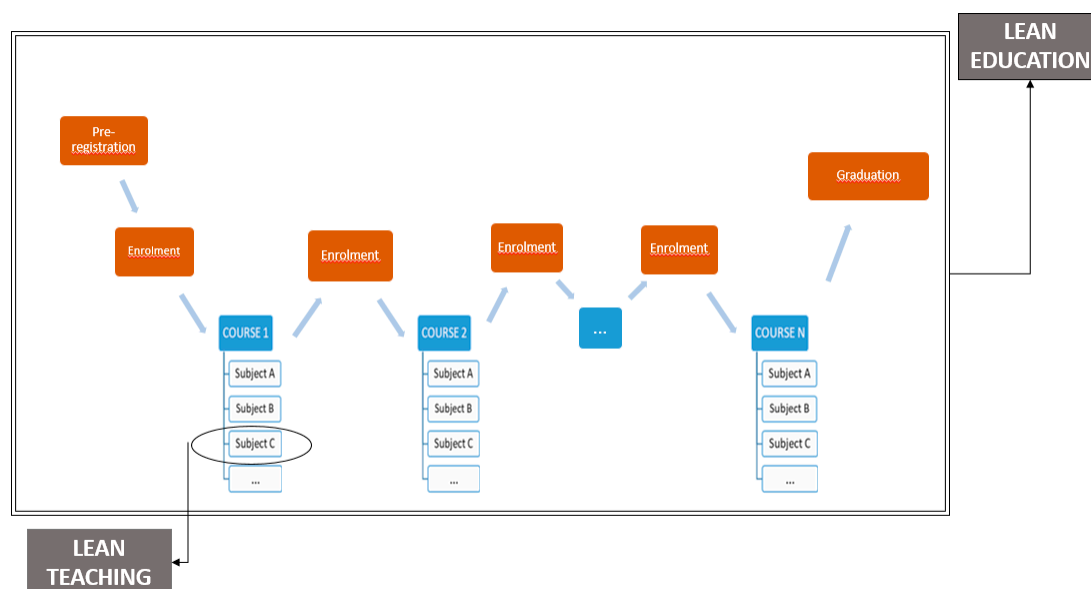

Figure 1. Different focuses of applying Lean Thinking to education.

4. Lean Education and Lean Teaching: Non-Added-Value Issues

Attending to customer demand in time is the highest priority of any Lean company. The customers have expectations on the product or service required, that is, the utilities that they are willing to pay for. It is fundamental that the producer sends the customer the product with the proper requirements (quality) in the required time.

In the context of universities, although customer demand is slightly different in the several approaches already mentioned, normally, the requirements of the customers are similar to other sectors' customers. That is, to have a product with the required quality at the required amount and in the required time. In a Lean University, this expectative can be understood as obtaining a degree that will be useful in the future and paying an appropriate cost (time, resources, and so on). Normally, this usefulness refers to having degrees of quality, which let students join the labor market in well-reputed and remunerated positions in the lowest amount of time. On the other hand, an appropriate cost

means adequate academic prices, no repeating of subjects, and reasonable living and travel expenses while studying,

As in any Lean context, in the educational one, value- and non-value-added activities (waste) from the customers' point of view (expectations) must be analyzed. From the students' point of view, value is the contents, procedures, and methods that allow them to develop the knowledge and skills needed for getting to the next step, with a proper cost (normal time). On the contrary, non-value-added issues are those that are superficial, irrelevant, or redundant to achieve their course or degree.

Specifically, at universities, value is associated with those content, procedures, and methods that allow students to develop the knowledge, skills, and attitude needed to become the right professionals in the right amount of time, and, consequently, to have success in their working lives. On the contrary, non-value-added issues are those that do not contribute adequately to their capability to pursue their desired profession.

From this definition of value-added and non-value-added activities, a classification of the different types of waste can be stated by adapting the ones coming from an industrial context.

- Overproduction:

In the university (education) approach, overproduction means to offer and/or teach more degrees than the labor market needs, which can finally imply more graduated students than the labor market can absorb. This overproduction provokes unnecessary costs, e.g., administration control or teacher workload imbalance. In this sense, the offer of STEAM degrees must be higher to cover social demand, while there is an overproduction or excess of other kinds of degrees since the labor market cannot absorb these graduate students.

In addition, when Lean is applied in the teaching–learning process (Lean Teaching), overproduction can be comprehended as offering more subjects, content, resources, or knowledge than the students need. Usually, this means to teach more content or knowledge than the curriculum or course planning establishes, to use more (technological) resources than needed, or to prepare activities or to elaborate materials that will not be used in the teaching–learning process. Examples of overproduction can be, e.g., to offer language courses that students do not need when they enter in a specific labor market, or to teach other content that does not appear in the guide of the subject, or curriculums that are not well adapted to job requirements. In particular, in the case of mathematics, although it is interesting to use a computer algebra system, it should be adequate to choose one of them, either for mobile phones or personal computers, instead of working with many different systems.

- Inventory:

Again, in the education approach, as the product is, or is related to, a service (knowledge), it cannot be stored in a physical sense [19]. Therefore, inventory can be understood as unemployed university graduates. This inventory is caused by the overproduction waste, that is, by the excessive offer of degrees, subjects, or courses that schools and universities suggest to their students, without good perspectives. This inventory provokes, for instance, frustration and migration.

From the point of view of the teaching–learning process, inventory will be all the content, activities, materials, and (technological) resources that, although prepared, are not taught in the corresponding course or lesson.

- Overprocess:

It means to have more processes than the customer requires. From the education point of view (public or private), overprocess can be to provide more teaching and/or administrative processes than the customer requires, for instance, repeat subjects and tedious enrolment processes.

In the teaching–learning context, overprocess implies to work on content that students already know or to repeat explanations on content because they do not understand or simply do not pay

attention. In particular, overprocess means to perform superfluous or redundant activities, such as practical activities repeated excessively or to employ methodologies that are not adequate (and consequently not successful). In this approach, to avoid overprocesses, it is fundamental to adapt the content, activities, and resources to the knowledge and skills that the students have to acquire. That is, it is essential to elude very easy or very difficult pieces of knowledge, practical activities, and evaluation elements, i.e., inadequate content, inappropriate methodologies, and unfair assessments, since they can provoke a lack of motivation and failure, which finally lead to more overprocesses. In order to do this, it is necessary to evaluate the previous knowledge of the students and to properly plan the teaching process [27], going from the simplest concepts to the most difficult ones, incorporating adequate practical activities, and performing adjusted assessments.

- Defects:

In the educational context, defects are those degrees, courses, subjects, content, or skills that students do not learn, which is what leads them to fail. Thus, they must repeat the teaching–learning process, so causing overprocesses or, worse, abandonment, therefore producing important losses.

Also, defects can be those degrees, courses, or content that do not accomplish customer requirements. That is, they cannot be used in the future because they are not properly homologated or do not have enough employment opportunities.

To avoid defects, a very good Lean tool is total quality management (TQM), which is in charge of improving the effectiveness of the processes. TQM approaches can help to have "meaningful learning" by using, for example, active methodologies, EduScrum, cooperative learning, and project-based learning.

- Transportation:

Literally, transportation waste would mean courses and content that have to be transported to the students. However, similar to other services, they cannot be physically transported, and, in the educational context, as in any other service, the customer has an active role and must be integrated into the service creation [25]. Therefore, this waste implies the transport of students from home to university/school. Many times, students avoid these costs by renting a flat or living in a different residence than their homes. This type of accommodation costs, although they are normally not directly paid by the producer but by the customer, must be taken into account in this waste source.

In the Lean Teaching approach, physical movement of students could seem irrelevant, since movements are limited to the classroom context. In this sense, this waste concerns the excess movements of content, activities, and resources, both virtually and physically. Examples of this kind of waste can be, for instance, uploading content, activities, or materials on various platforms (teachers' websites, corporate websites, Facebook (if used), email, paper), put them in photocopies, and give the content one by one to students.

In any case, this topic is associated with the availability of different resources to the students and the possibility of giving online assistance or virtual teaching resources to them. Then, the use of this kind of online technology is a very good option to avoid unnecessary transportation and to get a continuous flow in the teaching–learning process [28]. Moreover, the introduction of ICT and the internet in classrooms provides the use of social media, social networks, and other communication apps in classrooms. Nevertheless, the use of several apps different from an integrated virtual learning environment could represent a transportation waste since it would suppose an unnecessary transport of the concerns from one platform to another.

- Motion:

Motion indicates all these movements of workers (teachers and other staff) without producing education. In the educational context, if we took this waste literally as physical motion, it may not

have much relevance [25] since the production context can be reduced (e.g., small universities and schools). However, it could be understood as the time that workers employ to do other activities different from those which are not needed to properly develop their jobs. Therefore, in the educational context, this waste can refer to the time that teachers are doing other kinds of tasks other than teaching, and they are not contributing to the teaching–learning process (bureaucratic tasks, research in different contents, photocopying).

In addition, motion has two different perspectives: a physical one (displacement to different buildings and offices) and a virtual one (displacement into different applications and websites to obtain or publish resources). In this sense, to reduce this type of motion, it is interesting to have a system of alerts or notifications which allow the action of "Just In Time" for the process.

- Waiting:

Literally, waiting refers to workers that are stopped from producing, that is, workers (teachers and other staff) waiting for the development of their tasks. As in other cases, students must also be taken into account in this kind of waste due to their special role in the teaching–learning process. Specifically, in Lean Education, waiting waste refers to students who are not learning and teachers who are not teaching because they are waiting for something. For example, teachers and students waiting for the beginning of the course, exams, and delays in the enrolment process.

When applying these ideas into the classroom context (Lean Teaching), this waste implies delays of teachers and all or some of the students at the beginning of the classes, technical problems or system breakdowns, and students waiting for teacher feedback. An important point to remark on is that when the group is very heterogeneous, the different learning rhythms of the students can produce waiting for the more advanced students, while the teacher clarifies the doubts of the remaining students. This indicates the suitability of addressing measures to attend the needs of diversity and/or working with homogeneous groups, where the learning can maintain a steady pace.

To avoid these kinds of waste, a very good Lean tool could be 5S, which is in charge of having all resources organized and everything ready (clean and tidy) in the process to avoid waiting for teachers (operators) and students.

- Unused creativity:

This waste refers to the fact that the education system does not involve workers (teachers and other staff) to improve it or that the system has people working in jobs where their capabilities are underutilized (e.g., researchers as teachers, teachers as researchers, administrative staff as concierges).

In the same way, as with waiting waste, the students' unused creativity also has to be considered since teachers have to involve students in the improvement of the teaching–learning process, getting not only their continuous feedback but also their ideas and concerns.

It is worthwhile to remark that this waste is mainly due to having all the components of the process pre-established by the curriculum (or in Lean Teaching, by the guide of the subject, adjusted to the curriculum). That is, the content, skills, and attitudes to be achieved, the methodology to be employed, and the assessments to be applied by the teachers are predetermined. In this sense, the participation of students and teachers in order to enhance the process is limited. Although some universities have course and degree coordinators to exchange ideas, the proposals of teachers (and students) are rarely considered and transferred to the course of the degree curriculum.

Table 1 summarizes the Lean waste sources adapted to Lean Education.

Table 1. Summary of Lean Education and Lean Teaching waste sources.

Waste Source	Lean Education	Lean Teaching
Overproduction	To offer and produce more degrees than needed	To teach more subjects and content, and to endow with more skills than required
Inventory	To have more graduate students than required	To have content, activities, technological resources, and materials prepared but not used
Overprocess	To do or repeat academic or administrative processes that are excessively complex, redundant or unnecessary	To teach content that is already known. To repeat the teaching or assessment of content due to the use of an inappropriate methodology or because of difficulty (poor planning) Excess of practice activities.
Defects	Degrees (graduate students) without the proper knowledge, skills, and attitudes	Erroneous or low-quality content, activities, or materials. Inappropriate technological resources. Inadequate methodology and assessment system.
Transportation	Excess movement of the students from home to the university	Excess movement of the content, activities, and materials, physically or virtually
Motion	Teachers and other staff doing tasks that are irrelevant for the flow of the education system	Teachers doing tasks other than teaching
Waiting	Teachers and students waiting for the start of the course or degree (e.g., due to lack of flow of information, administrative processes, social events)	Teachers and students waiting for the start or continuation of the class, to receive feedback or attention (e.g., due to technological breakdown, slow technological systems, delays of people, heterogeneity of students)
Unused creativity	Teachers, staff, stakeholders, and students not involved in the improvement of the educational system. Teachers and staff working in underutilized jobs.	Teachers and students not involved in the improvement of the teaching–learning process. Teachers in underutilized jobs; students' creativity not considered.

5. Discussion

In view of the good results in other sectors, Lean Thinking gives the impression of being a good option to analyze education systems in general, and the teaching–learning process in particular, in order to improve them [7]. The idea is to provide a new way to think about how to organize education activities to be more effective and efficient through the elimination or minimization of those aspects which do not add value to education and can be considered waste [13].

Thus, in this work, a classification of those non-value-added activities in education is presented, using the Lean Thinking approach that other sectors have established. Previous works have set out some classifications of wastes [14,15], where no differences were considered between the whole education process and the teaching–learning process. In this sense, we clarify and extend such results, detailing the nuances that differentiate these two different perspectives.

This classification is fundamental for the Lean transformation of education since this methodology aims to lead customer demand through reducing and eliminating the non-value-added activities present in the process. For this reason, identifying the waste sources is essential and constitutes the first step in this transformation.

The study of the non-value-added issues in Lean Teaching not only corroborates the importance of teacher planning, but it also encourages a continuous analysis of the increase of efficiency in the process due to the incorporation of any new methodology or technological resource in teaching. In this sense, it also reveals that teachers should be up-to-date in relation to these new methodologies and technological resources, both general ones (such as learning virtual environments, communication tools) and particular ones (such as computer algebra systems [29], mobile apps [30], 3D-drawing systems [31]). Thus, Lean Teaching advocates for the analysis and elimination of methodologies and resources that lead to a lack of motivation or understanding of abstract concepts. This produces wastes, especially in the teaching–learning process of STEAM subjects.

The study also shows the relevance of considering the creativity of students and involving them in the learning process, as an active part of the design and progress of their own learning, whose commitments with their professors and other classmates should be fluid. This leads to a model of cooperative and collaborative learning [32], instead of a competing one, which is fundamental to the homogeneity of a group of students in a classroom. This brings to light that many Education for

Sustainable Development (ESD) competencies, such as working creatively and innovation, dialog, critical thinking, self-motivation and motivating others, planning and implementation, interdisciplinary work, managing emotions and concerns (respect), are also related to this model of Lean Learning.

Since in Lean systems, the processes must be analyzed continuously as an effort to pursue perfection. In Lean Teaching, teachers have to ask themselves constantly: Is this part of the content a non-value-added issue? Is this practical activity or material a non-value-added issue? Is this new teaching method a value-added issue? Is this new (technological) resource a valued-added issue? Is this new assessment method a value-added issue? Moreover, they should show an increase in efficiency, in any case.

Among the limitations, we have to say that, many times, to develop a project to improve a whole system is difficult since many people are involved and/or management commitment is not easy to obtain, especially if we want to involve different levels of education. However, to start the Lean transformation from Lean Teaching, that is, just in the teaching–learning process, could be quicker and easier since it mainly depends on every teacher's commitment. Therefore, it is important that teachers analyze their teaching process from this point of view.

References

1. Marina, J.A. *Despertad al Diplodocus. Una Conspiración Educativa para Transformar la Escuela y todo lo Demás*; Ariel: Barcelona, Spain, 2015.
2. Martinez, S.; Valverde, J.C. University-Industry Collaboration for the Continuous Update on the Manufacturing Process. In *INTED2010 Proceedings*; IATED: Valencia, Spain, 2010; pp. 2–6.
3. Alp, N. The lean transformation model for the education system. In Proceedings of the 29th Computers and Industrial Engineering Conference, Montréal, QC, Canada, 1–3 November 2001; pp. 82–87.
4. Alves, A.C.; Flumerfelt, S.; Kahlen, F.J. (Eds.) *Lean Education: An Overview of Current Issues*; Springer: Berlin/Heidelberg, Germany, 2016.
5. Emiliani, B. Improving business school courses by applying lean principles and practices. *Qual. Assur. Educ.* **2004**, *12*, 175–187. [CrossRef]
6. Emiliani, B. *Lean Teaching: A Guide to Becoming a Better Teacher*; The CLBM: Wethersfield, CT, USA, 2015.
7. Emiliani, B. *Lean University: A Guide to Renewal and Prosperity*; The CLBM: Wethersfield, CT, USA, 2015.
8. Womack, J.P. Lean Thinking for Education. In Proceedings of the LEN/LAI EdNet Meeting, Worchester, MA, USA, 16–18 October 2006.
9. Valverde, J.C.; Martínez, S. Methodology ideas for improving the learning in Mathematics in multidisciplinary settings. In *ICERI2011 Proceedings*; IATED: Madrid, Spain, 2011; pp. 5225–5229.
10. Ohno, T. *Toyota Production System: Beyond Large-Scale Production*; Productivity Press: Cambridge, MA, USA, 1988.
11. Seddon, J. *Freedom from Command and Control: Rethinking Management for Lean Service*; Productivity Press: Portland, OR, USA, 2005.
12. Balzer, W.K. *Lean Higher Education: Increasing the Value and Performance of University Processes*; Productivity Press: New York, NY, USA, 2010.
13. Martinez, S. Lean Teaching: A New Trend in Education. In *Didactics of Mathematics: New Trends and Experience*, 1st ed.; Magreñan, A., Ed.; Nova Sciences: New York, NY, USA, 2020.
14. Douglas, A.; Douglas, J.; Antony, J. Gold in the Mine: Recognizing Waste in UK HEIs using Lean Thinking. In Proceedings of the First International Conference on LSS for Higher Education, Glasgow, UK, 24–25 June 2013.
15. Andrés-López, E.; González-Requena, I.; Sanz-Lobera, A. Lean service: Reassessment of Lean Manufacturing for service activities. *Procedia Eng.* **2015**, *132*, 23–30. [CrossRef]

16. Womack, J.P.; Jones, D.T.; Roos, D. *The Machine That Changed the World*; Rawson Associates: New York, NY, USA, 1990.

17. George, M. *Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions*; McGraw-Hill: New York, NY, USA, 2003.

18. Liker, J.K.; Morgan, J.M. The Toyota Way in Services: The Case of Lean Product Development. *Acad. Manag. Perspect.* **2006**, *20*, 5–20. [CrossRef]

19. Radnor, Z.; Boaden, R. Editorial: Lean in Public Services—Panacea or Paradox? *Public Money Manag.* **2008**, *28*, 3–7.

20. Womack, J.P.; Jones, D.T. Lean Thinking—Banish waste and create wealth in your corporation. *J. Oper. Res. Soc.* **1997**, *48*, 1148. [CrossRef]

21. Tilfarlioglu, F. A New Method in Education: Lean. *Turk. Stud.* **2017**, *6*, 811–816.

22. Hines, P.; Taylor, D. *Going Lean*; Lean Enterprise Research Centre Cardiff Business School: Cardiff, UK, 2000; pp. 3–43.

23. Smith, S. Muda, Muri and Mura. *Lean Six Sigma Rev.* **2014**, *13*, 36.

24. Chibaira, B.; Haittingh, T. Applying Lean Principles in a School Environment to Reduce Lead Time and Improve Quality. In *SAIIE25 Proceedings*; Stellenbosch University: Stellenbosch, South Africa, 2013.

25. Liker, J.K. *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*; McGraw-Hill Education: New York, NY, USA, 2004.

26. Gupta, S.; Sharma, M.; Sunder, V. Lean services: A systematic review. *Int. J. Product. Perform. Manag.* **2016**, *65*, 1025–1056. [CrossRef]

27. Martínez, S. Teaching innovation projects: Fundamental features to their design, implementation and evaluation. *Rev. Cienc. Pedagog. E Innov.* **2019**, *7*, 95–103.

28. Jordan, C.; Magreñan, A.; Orcos, L. Considerations about Flip Education in the Teaching of Advanced Mathematics. *Educ. Sci.* **2019**, *9*, 227. [CrossRef]

29. Valverde, J.C.; Martínez, S. Blended-learning based on presentations made with the aid of a computer algebra system. In *ICERI2009 Proceedings*; IATED: Madrid, Spain, 2009; pp. 3764–3772.

30. Valverde, J.C.; Martínez, S. A mobile assisted blended-learning experience. In *EDULEARN12 Proceedings*; IATED: Barcelona, Spain, 2012; pp. 288–291.

31. Orcos, L.; Jordan, C.; Magreñan, A. 3D visualization through the Hologram for the Learning of Area and Volume Concepts. *Mathematics* **2019**, *7*, 247. [CrossRef]

32. Martinez, S.; Valverde, J.C. University-Industry Collaboration for Coaching and Transferring Teamwork Skills. In *EDULEARN10 Proceedings*; IATED: Barcelona, Spain, 2010; pp. 5076–5080.