A Systematic Review of the Use of Agile Methodologies in Education to Foster Sustainability Competencies

Abigail López-Alcarria [1,†,‡], **Alberto Olivares-Vicente** [2,*,‡] **and Fátima Poza-Vilches** [1,†] (ID)

[1] Department of Research Methods in Education, University of Granada, 18071 Granada, Spain;
     abigail@ugr.es (A.L.-A.); fatimapoza@ugr.es (F.P.-V.)
[2] Independent Scholar, 18014 Granada, Spain
[*] Correspondence: aolivares@ugr.es
[†] Current address: Facultad de Ciencias de la Educación, Campus de Cartuja s/n, 18071 Granada, Spain.
[‡] These authors contributed equally to this work.

✓ check for updates

Abstract: Life-long learning and Education for Sustainable Development (ESD) in the current fast-evolving and ever-changing society requires modern pedagogical tools and methodologies that help the transmission of key competencies such as coping with uncertainty, adaptability, creativity, dialog, respect, self-confidence, emotional intelligence, responsibility and systemic thinking. The recent trend of the application of Agile methodologies for the management of projects in different fields can be a valuable tool to convey these competencies due to the participative, collaborative and constructionist principles in which they are deeply rooted. Some experiences of the application of Agile Methodologies in education—originating what is known as Agile Education—are, therefore, starting to appear in the literature. This work carries out a systematic review to analyze how this modern pedagogical tool is being used to foster key sustainable development competencies in the field of education. Results are presented for 11 out of 121 analyzed studies which present a direct link between key ESD competencies and Agile Education. It is shown that Agile Education creates a learning environment favorable for the creation of responsible and sustainable citizens while improving the performance, satisfaction and motivation of both faculty and students.

1. Introduction

The world is in permanent change. People, processes and environments change and evolve at an increasing speed in a world characterized by marked interconnections and externalities. It is therefore rather naive to think that projects, and individuals participating and managing them, will not need to adapt and embrace change and uncertainty in order to successfully achieve the outlined objectives. The labor market is not an exception; agility in processes and the need for continuous training are essential requirements for any worker and any organization. To assess this new scenario, Agile methodologies were conceived as an alternative to traditional project and organization management methodologies based in thorough and sequential planning (waterfall models). These methodologies' tenets are based on the fact that any project, no matter the size, has a high degree of complexity due to the large number of variables and inputs that can affect its course. Instead of dedicating the efforts of the participants to forecasting events and associated tasks that may affect the project in the long-term and fight change to stick to a series of rigid requirements and predefined functionalities, Agile methodologies praise adaptive development by means of short continuous cycles of planning, action, correction and adjustment to produce valuable increments in outcomes.

Education, as the key process for generating sustainable and responsible citizens and prepare them for their insertion in the labor market, is also affected by new challenges from our ever-changing society. "Recognizing and responding to change therefore becomes one of the main responsibilities of education alongside developing adaptable self-motivated lifelong learners and developing their capabilities in order to live a life that they value [1]". "[...] As learning becomes more personalized and requires adjustment to changing conditions and requirements while fulfilling stringent accreditation standards, new pedagogical methods are required that can reduce the cost of change" [2]. It is noticeable then, how "education is faced with the challenge of developing our social, cultural, and economic future, but lacks pedagogical approaches or structures capable of efficiently and effectively responding to a world in which the underlying constant is change. [...] pedagogic practices within formal learning environments need to be examined and innovative practices that support learning in a connected, collaborative way need to be modeled and legitimized" [1].

Education is thus a large life-long project that needs effective management. So far, "in many ways, traditional education design (following an ADDIE Analysis-Development- Evaluation-Design-Implementation model developed by the Center for Educational Technology at Florida State University for the U.S. Army [3] in 1975 and later employed to manage projects in multiple subject areas) maps onto the waterfall model: (i) the course is specified according to intended learning outcomes (requirements); (ii) the syllabus of subjects is planned (design); (iii) the teaching materials are produced (development); (iv) the materials are delivered to students (implementation); (v) the course is evaluated by students (testing); and (vi) any changes from the evaluation are incorporated before the next round (maintenance)" [4]. When analyzing evaluation, one of the most important phases of education, we can see that "traditionally, students perform a course evaluation that feeds into future course improvements [...] this does not directly benefit these students, but it does provide valuable insights into their learning experience. Clearly, if this evaluation can be integrated into the course at multiple points, students may actually see the benefits more immediately" [4]. In order to produce valuable changes during the teaching of a course, Agile Education implements a series of techniques that promote continuous and significant feedback between both faculty and students.

On the other hand, one of the key challenges for Education for Sustainable Development (ESD) is to define pedagogies and tools that permit the transmission of competencies in a transversal and holistic way and allow sustainability to expand out of teaching scenarios that are traditionally bounded to subject areas related to nature sciences and environmental studies [5].

With this systematic review, we aim to analyze the relationships between Agile methodologies and Education that have given birth to Agile Education, as well as the competencies that are empowered through its application and their relation to ESD. We aim to confirm whether Agile Education conforms a valuable educational framework that helps education in modern societies in a more efficient and sustainable way.

The rest of the article is structured as follows: a comprehensive description of the theoretical principles of Agile methodologies and their application in education is presented in Section 2. This section has been written to produce a self-contained manuscript which provides enough context to readers new to this type of methodology, thus possibly leading to a longer theoretical framework description prior to the analysis of the results when compared to other systematic reviews in the ESD field. The research questions and objectives of the review are presented in Section 3. The review methodology, including the literature screening process and selection criteria, is described in Section 4. Analyzed experiences and results of the qualitative review are, included in Section 5. Finally, conclusions are outlined in Section 7.

2. Theoretical Framework

2.1. Agile Methodologies

From a general standpoint, Agile methodologies—normally simply referred to as Agile—are the structured methods and tools employed to put into practice the Agile Mindset [6] in every aspect of life. Agile is, in turn, "the ability to create and respond to change. It is a way of dealing with, and ultimately succeeding in, an uncertain and turbulent environment. [...] It is really about thinking through how you can understand what is going on in the environment that you are in today, identify what uncertainty you are facing, and figure out how you can adapt to that as you go along" [7]. Agile methodologies are a group of project management approaches which oppose, in many ways, traditional waterfall style project management techniques in which the project is wholly defined before starting to execute it. This means that in traditional project management styles all the specifications, resources (both human and financial), tasks and timing need to be defined before starting the actual work.

On the other hand, "Agile methodologies are in general oriented to the quick obtaining of results and customer satisfaction. This is accomplished by embracing changing requirements, delivering products frequently, using human-centric methods, and engaging the customer in regular collaboration. Special emphasis is put on articulating goals, facilitating interactions, improving team dynamics, supporting collaboration, and encouraging experimentation and innovation" [2].

As with many different techniques, there is no formal publication or work which could be considered as the conception of Agile methodologies. Different experiences with quick incremental definition-execution-evaluation-correction production cycles can be tracked back to the 1950s based on a publication from 2003 by Craig Larman and Victor Basili [8] in which they describe having worked with incremental development technologies at IBM in 1957 [9]. It was only in 2001 that a group of 17 software developers and Agile practitioners gathered together to define the Manifesto for Agile Software Development, which reads:

> **Individuals and interactions** over processes and tools.
> **Working software** over comprehensive documentation.
> **Customer collaboration** over contract negotiation.
> **Responding to change** over following a plan.

This manifesto puts in words the four main principles of the Agile Mindset applied to software development. From this moment, there was a quick adoption of methods such as Kanban or Scrum (described later in the section), which translate these principles into elaborated practical methodologies to improve the efficiency [10] of software production projects.

Why have Agile methodologies become so popular? Different studies such as the CHAOS Report by the Standish Group [10], in which the success rate of thousands of projects worldwide from different sectors is measured, have provided evidence that this type of methodology triples the success rate (understood as delivering a project complying with the requirements with no or minimal budget and delivery deviations) of waterfall-based projects. Practitioners from fields other than software development [11–14], including education, as we will later see, have approached and embraced the methodology with similar success rates.

Education is based on planning and executing multiple projects, which are, in turn, based on a series of specifications (competencies). Programs, courses, didactic units, sessions and assignments are all projects of different magnitude in which both instructors and students participate. It is very important, then, to select a method that allows them to properly steer each project. To do so, both students and instructors should know beforehand the main differences of the two most employed project management trends, that is, Traditional Waterfall-based methodologies and Agile methodologies. As mentioned above, they present important differences in the main aspects of project management (uncertainty, change, team and time management). These differences are presented in Table 1.

Table 1. Differences between Traditional Project Management and Agile Methodologies.

Dimension	Traditional Methodologies	Agile Methodologies
Uncertainty Management	Aim to harness uncertainty from the beginning of the project to palliate it. The project is wholly defined since the beginning. A project plan, with strict contracts is defined. All control parameters of the project such as quality, time, cost, etc. are continuously tracked. KPIs are defined at the beginning and maintained during all the project.	Accept uncertainty and do not try to minimize it. Instead they propose mechanisms to quickly adapt to it and easily readjust the course. This is possible since a refactoring model is followed. Small incremental changes are released on top of a minimum viable product/solution and feedback from customers is gathered before long deviations are produced.
Change Management	Consider that the project is perfectly defined since its conception and that no major changes should take place nor accepted. If changes are forced by customer, the project is brought back to the conception and definition phase, consequently leading to delays.	Change is accepted and considered inevitable and necessary. It is considered as the core of a continuous learning process. The project is open to feedback from customers to adjust it to their needs.
Team Management	Teams are controlled by a rigid hierarchy with multiple levels of management. Project managers define the tasks to do and most importantly, how to do them and the required time. This micromanagement strategy reduces the autonomy of the rest of the team members. Customers are not included in the team so their visibility on the project's partial outcomes is reduced.	There is a flat hierarchy. The team is multidisciplinary and self-organizes. The customer is included in the team to increase transparency. The task assignees determine how to execute them and estimate the effort required. Effort is estimated taking into consideration the time employed to complete the task, the complexity of the actions involved and the risk of the tasks. Tasks with higher risk of causing issues to the system and the project usually require from additional testing time, which contributes to increasing the final effort.
Time Management	Based on the waterfall technique and Gantt Charts. The definition of all tasks and subtasks and the time necessary to complete them is defined at the beginning of the project. The model is very rigid and, thus, sensitive to changes and dependencies between tasks. Any change in an intermediate task affects the subsequent ones.	Accept that humans are not good at estimating duration of tasks accurately. Time is substituted by the concept of effort. A general list of tasks is generated at the beginning of the project (customer needs) and then particularized at the beginning of each incremental work cycle.

Examples of Agile Methodologies

Different methods following Agile principles have originated within the last two decades, including Scrum, Kanban, eXtreme Programming (XP), Crystal, Dynamic Systems Development Method (DSDM), Feature Driven Development (FDD). Among them, Scrum and Kanban are arguably the most popular and extended ones. Given that, as will be explained in Section 5, most experiences in education are based on these two methods, we will, for the sake of clarity, briefly describe their principles.

- **Scrum:** The Agile Scrum Methodology is probably the most popular application of the Agile principles. It was proposed by Jeff Sutherland and Ken Schwaber [15,16] in the context of software production, but has since been applied in different contexts [17–20]. Its popularity resides in the simplicity of its application. Projects are divided in *Sprints*, which are time-boxed cycles that typically last between 2 and 4 weeks, and which are repeated over and over until the project is finalized (or indefinitely if a product which is continuously updated is being produced). Teams are

divided into different roles: (i) *developers*, carrying out the actual development tasks, (ii) a *Product Owner* which is in contact with the customer and is in charge of creating the *project* and *Sprint Backlogs* which are composed of *User Stories* and (iii) the Scrum Master who acts as a facilitator of the development team, helping to remove all the blockers that may arise and ensuring that the Scrum Framework is followed. Scrum Masters are also responsible for holding daily *stand-up meetings* and helping the developers understand the *definition of done* of a User Story. This role might be rotative and is normally held by a developer or a former developer. The customer can also be considered as a member of the team.

The workflow is structured as follows:

(i)   At the beginning of the project, the roles are assigned and the team is assembled.

(ii)   A meeting is held between the Product Owner and the customer to extract the project backlog. The Project Backlog is a list of User Stories. User Stories are self-contained entities which define a functionality required by the customer for the project or the service. They can be grouped into a *Epics* which define a higher-level functionality of the system that cannot be delivered in a single *sprint*, and which are normally divided into smaller User Stories. For every User Story, a series of *Acceptance Criteria* are agreed between the customer and the Product Owner (occasionally they might also be written between developers and Product Owners to increase transparency).

(iii)   A Sprint kick-off meeting is held between the Product Owner, the Scrum Master and the Development team. During the Sprint kick-off meeting the team decides which User Stories will be implemented during the sprint. The selected User Stories compose the Sprint Backlog.

(iv)   After the kick-off meeting, the sprint is initialized and the development team starts working on the User Stories. Typically, different tools such as Jira [21], Version One [22] and Pivotal Tracker [23] are used to allow the team keeping track of the progress of the tasks. User Stories have typically 4 status: "To do", "In Progress", "To Validate" and "Done". When a User Story is finished by a developer, it is labeled as "To Validate" and a member in charge of checking the compliance of the Acceptance Criteria tests it and transfers it to "Done" if they are all met.

(v)   Everyday, a 15 min *Stand-up meeting*, or *Daily Scrum* is held between the Scrum Master and the development team. During this short meeting, the Scrum Master asks three questions to each one of the members of the development team: (1) What did you do yesterday?, (2) What will you do today? and (3) Are there any impediments in your way? With this information the Scrum Master can track the *health* of his team and the sprint progress and help them solve the blocking points.

(vi)   Prior to the finalization of the Sprint, a *Sprint Review* meeting is held between all members of the team in which the results of the Sprint are presented to the customer to receive their feedback.

(vii)   Normally right after the Sprint Review, a *Sprint Retrospective Meeting* is held between all the members of the team in which an internal assessment of the results of the sprint are analyzed. Team members agree on what should start, stop and continue to be done in order to keep improving the process and obtain better results in the subsequent Sprint. The cycle, shown in Figure 1, is then restarted.

- **Kanban:** Kanban (*visual card* in Japanese) is the simplest Agile Project Management Methodology. The main idea is to keep a Kanban board (see Figure 2) with the list of tasks do be done and their status (typically divided in three columns: "To do", "Doing" and "Done"). Tasks are moved along status to show the progress of the work. The main difference with respect to Scrum is that it does not define time-framed work intervals and, therefore, all the *ceremonies* (meetings) held in Scrum are not defined. Also, a differentiating characteristic between both methods is that

Kanban praises the limitation of the work in progress to prevent overloads, allowing the team to focus on a reduced number of tasks, also helping to identify bottlenecks before they become a blocking element. Kanban might be a good approach for projects with a reduced team (even for solo projects). Kanban is also often seen as an intermediate step in the transition from traditional methodologies to fully Agile methodologies like Scrum. "Kanban is a method to manage the creation of products with the vision of continual delivery while not oversubscribing development teams. Kanban is meant to be an enhancement to existing organizational processes for continued improvement while not totally changing organization's existing systems" [24]. Kanban boards can be both physical (board with sticky notes) or virtual, in the case of remote collaborative work. Trello [25] is a widespread tool allowing the creation of shared virtual Kanban boards.
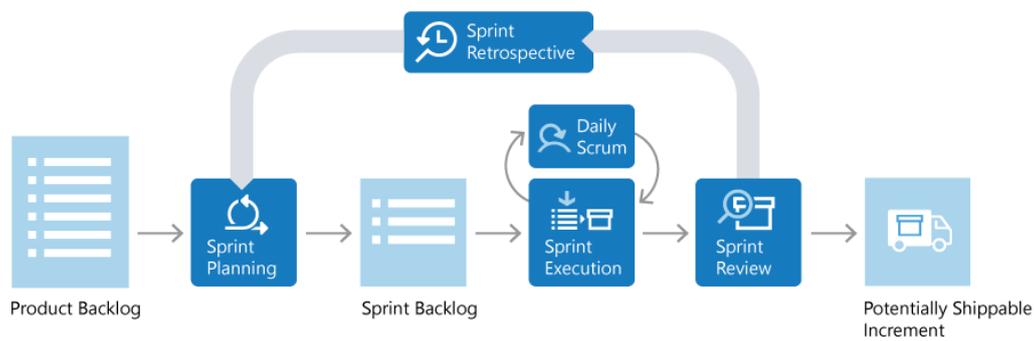

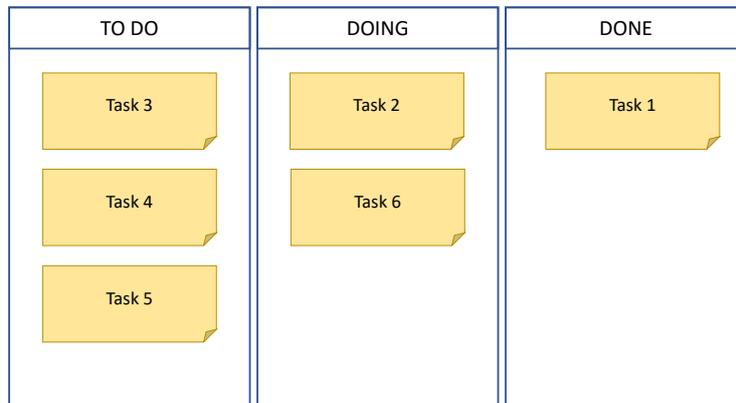**Figure 1.** Scrum Life cycle. Source: Microsoft Azure [26].

Figure 2. Representation of a classical Kanban board. Source: Own elaboration.

2.2. Agile Education: Agile Methodologies in Education

As stated by Stewart [27], "the correspondence between elements seen in the agile software development environment and the academic environment are striking. At first glance, the similarities can be easily seen. Both teaching and software development require detailed planning and scheduling. Each requires management and constant assessment and feedback from all involved. Making sure a course is delivered correctly and on time presents similar difficulties to those encountered in software development projects".

The parallelism between different elements in private or public organizations executing projects to generate products or services and an educational environment are presented in Table 2. Notice how most important elements and terms have a counterpart in educational environments.

Table 2. Parallelism of terms and concepts between project management (PM) environments and educational environments.

Term/Concept in PM Environments		Term/Concept in Education Environments
Customers as beneficiaries of a product or a service	⇔	Students as beneficiaries of an education service, and in lower degree, parents and other stakeholders.
Project product	⇔	Knowledge, competencies, attitudes and skills acquired by the student.
Partial Releases	⇔	Completed didactic units.
Final Releases	⇔	Final result delivered to the student when the educational program or course is over in terms of achievement of predefined requirements.
Detailed plan	⇔	Syllabus and didactic units and their execution.
Strict contracts	⇔	Over-specified and rigid syllabus and course planning leaving little autonomy to instructors.
Control Parameters	⇔	Assessment parameters (both external and internal).
Refactoring model	⇔	Plans to continuously improve the educational programs (ideally applied during the courses).
Basic functionality	⇔	List of competencies and basic objectives of the educational program, course, didactic unit, course session, assignment or activity.
Minimum Viable Product	⇔	Minimum expected result of every educational program, course, didactic unit, course session, assignment or activity (in terms of grades and Competencies obtained by students).
Scope of the project	⇔	Scope of every educational program, course, didactical unit, course session, assignment or activity.
Providers	⇔	Providers of educational services (public administration, legislators, instructors, other staff, etc.).
Partner	⇔	Students and their families, other stakeholders collaboration in the educational service such as private companies, foundations, NGOs, etc.
Project delays	⇔	Delays in the execution of didactic units, course sessions, assignments or activities that are finished without meeting the predefined objectives. Any deviation when putting into practice an educational program or a course.
Disagreements between providers and customers	⇔	Conflicts between students and/or their families and faculty about the quality and misalignments between the expected results and the final outcome.
Resisting the change	⇔	Rigid syllabus and educational plans hard to modify. Complex bureaucratic process, slow administration, instructors reticent to adopting new pedagogies, non-participative students.
Agreed Specifications	⇔	Communication between instructors and students about the objectives of the educational program, course, didactic unit, course session, assignment or activity so that the objectives and expected results are clear and known by all stakeholders.
Team structure	⇔	Composition of teams inside an educational project (teams of instructors, teams of students, teams of parents).
Hierarchical teams	⇔	Hierarchical classrooms with instructors as omnipotent and inaccessible figures.
Project manager	⇔	Instructor, program coordinator, Principal.
Micromanagement	⇔	Over specification by the instructors of the syllabus and students' way to work and learn.
Project/Company Quality Standards	⇔	Education quality standards of the instructor, department, school, city, region or country.
Waterfall Project Management	⇔	Educational project management model based on the exhaustive definition of the courses, didactic units, course sessions, assignments and activities prior to the execution, leaving little or no space to modification of the time-boxed sessions and their content. Typically outlined using a Gantt chart.

It is clear then that education is in general composed of multiple projects of different magnitudes that require a management methodology to warrant the achievement of the objectives. Therefore, it is reasonable to hypothesize that the introduction of agile methodologies, which have been shown to be highly effective in improving the success of project and product delivery in private industry, as well as in different public institutions [28,29] when compared to traditional project management methodologies (see Figure 3), will benefit the teaching/learning processes in education.
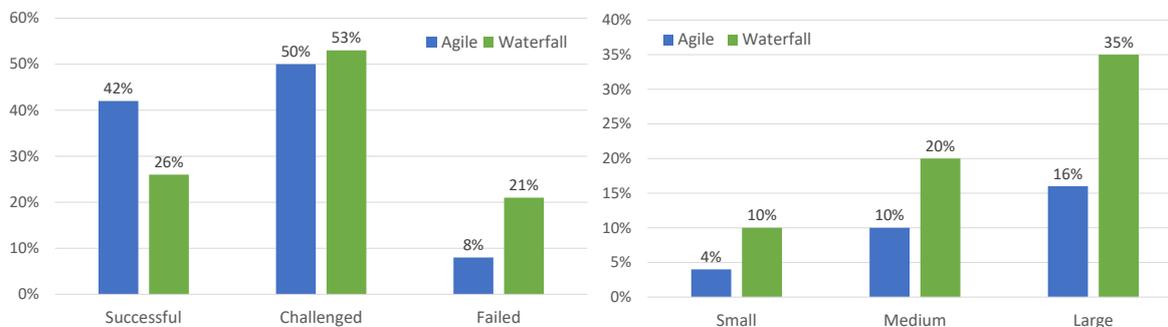

Figure 3. Project success rates depending on project management methodology employed (**left**). Project failure rate depending on project management methodology employed and project size (**right**). Source: Standish Group Chaos Studies 2013–2017 [10].

In the same way we can find traditional project management methodologies in different fields, we can also find equivalent traditional educational methodologies which have multiple points in common. Typically, learning designs based on conductive education which consider the figure of the instructor as the immediate source of learning [30] (the professor's role is to "profess", while students are only present to "absorb it all" [31]) present similarities to traditional project management methodologies in which the project manager has the equivalent role to "herd" his hierarchically inferior colleagues. Additionally, professors are also bound by their superiors and have little range of action due to the over specification in the educational institution ordinances that leaves very little flexibility during implementation [32]. Table 3 shows some of the differences between traditional behavioral learning and Agile constructivist learning.

As in private industry, different problems derived from the application of traditional learning methodologies or traditional methodologies to manage the design and application of educational programs can be identified. As stated in Reference [33], education, especially at higher levels, fails to provide students with strategies and necessary skills to work in groups in an effective way, which is a key competency demanded by the labor market. Students are not taught to work collaboratively nor communicate in an effective way. They do not receive training either on how to manage their emotions and actively listen and respect others' opinions and proposals or to work with individuals with different sets of skills. They show large deficiencies as well when managing time to self-organize or to complete individual or group assignments. The author also provides five reasons for which Agile Methodologies, and more specifically Scrum, might be a good method to apply to higher education:

- Most courses include group works in their syllabus.
- Most university degrees are oriented to the creation of a product or a service. Scrum may help to create innovative and creative environments.
- Students should have the capacity to acquire knowledge, be critical and self-reflective, know to manage themselves, solve problems, be creative, collaborate in group. These are competencies that are empowered by Scrum.
- Group projects have two agents: instructor and students. Scrum has the same structure and adds a third one, the Scrum Master that is the link between the professor and the team.

- Assessment and evaluation are normally done after the work is turned in. In most cases the projects presented by students are partially incomplete and lack quality. In Scrum, projects are continuously inspected by professors, leaving no space for delays in the delivery and misalignments with the required specifications.

Table 3. Main differences between traditional behavioral learning and Agile constructivist learning.

Element	Traditional Learning	Agile Learning
Syllabus	Over specified. Rigid. Little opportunity to introduce changes during course execution. No discussion of content with students.	Defined in a general way. Open to modification to adjust it to students' motivations interests and performance. Agreed and communicated at the beginning of each block/unit.
Schedule and Timing	Over specified. Waterfall approach. Difficulty to allocate extra time when needed.	Divided into blocks. Not directly associated to syllabus in a rigid way.
Roles	Professor: source of knowledge, micromanages students. Students: passively absorb knowledge.	Professor: facilitator of the learning process, one of multiple sources of knowledge. Students: active learners, self-organized, autonomous.
Communication and interaction	Reduced.	Encouraged. Open discussion about course content, progress and organization.
Education theory and learning design	Behavioral theory and other professor-centered approaches.	Constructivist theory. Problem based learning. Connectivism, Cooperative and Colaborative learning.
Class structure	Highly hierarchical. Individual learning.	Flat hierarchy. Both group and individual learning.
Evaluation	Reduced (pre-post evaluation in best case scenario). Evaluation of students' performance.	Continuous evaluation of students' performance and course execution.

Similarly, Lembo and Vacca [34] identify four issues in traditional learning that can be palliated or corrected by the application of Agile Learning:

- "Effectiveness of documentation and plan revision: The project plan related to each subject is made at the beginning of the course; each time that some problem happens imposing the plan revision, the new project plan should be rewritten in order to make this document effective".
- "Time scheduling of the project: It is well known that projects are often delayed; it can happen that, in order to meet deadlines, the realization of some activities could be accelerated, yielding problems in student understanding skills and increasing the workload."
- "Marginal role of students and their parents in the design of course: Students and their parents have little space in the course design. They participate a few times a year to teachers' team meetings. Their contribution is often limited to the discussion about general problems arising. From an engineering point of view, the students and parents' role is essentially limited to the validation of the instructional contract".
- "Unbalanced student workload among the disciplines and the term: because each discipline produces its own work plan applying the more appropriate method and without a detailed verification of the relations among the modules or activities of the different disciplines, it could be possible that in some period the student workloads results unbalanced or unbearable, producing negative results on the quality of learning".

2.2.1. The Agile Education Manifesto

Using the Agile Manifesto for Software Development presented in Section 2.1 as a reference, Kamat [32] and Peha [35] presented different adaptations of the manifesto to the context of education. Other authors have, since, proposed their own adaptations since [1,27,34,36–38]. The goal of the manifestos is to synthesize the key principles of Agile Education and serve as an inspiration to educators willing to design and apply different experiences on their way to going full Agile. The Manifesto reads as follows:

> **Kamat's Agile Education Manifesto**
> **Teachers and Students** over Administration and Infrastructure.
> **Competency and Collaboration** over Compliance and Competition.
> **Employability and Marketability** over Syllabus and Marks.
> **Attitude and Learning skills** over Aptitude and Degree.
>
> **Peha's Agile Education Manifesto**
> **Individuals and interactions** over processes and tools.
> **Meaningful learning** over the measurement of learning.
> **Stakeholder collaboration** over constant negotiation.
> **Responding to change** over following a plan.

2.2.2. Agile Education and Education Theories and Design

When analyzing the educational principles and theories that instill Agile Education we observe that the perceived benefits of adopting an agile approach in education can be linked to the experiential learning theories of Dewey, Kolb and Piaget, which all state that knowledge develops as a result of direct experience [39]. Agile methodologies are therefore deeply rooted in constructivism as individuals are considered an active agent of their own learning [40–43]. Additionally, the following key competencies of constructivism are fostered in Agile Education [44]:

- Autonomy in the generation and construction of knowledge.
- Evaluation of alternative solutions.
- Collaboration: merging learning with social and relational context of the individual.
- Critical thinking: meta-cognition and reflection in the process of knowledge construction.
- Systemic thinking: individuals have a general mind map of the knowledge they generate since it springs up from their own experience.
- Use and management of different sources of knowledge.

Moreover, Agile methodologies scaffold connectivism, as they are a good approach to managing on-line distance learning programs [45–47]. The use of Agile collaborative work tools such as the aforementioned Jira, Version One, Pivotal Tracker or Trello [21–23,25] can be considered as examples of digital platforms for collaborative management of learning projects which are considered in the expansion of Vigotsky's Zone of Proximal Development proposed by connectivism. Connectivism, in turn, fosters the following competencies [43,48,49]:

- Ability to understand and visualize connections between different areas, ideas and concepts that generate knowledge.
- Decision making.
- Ability to innovate and generate revolutionary ideas.

Additionally, it is possible to see how Agile Education has connections to active learning and cooperative and collaborative learning theories. Active learning is a strategy focused on learning by means of a collaborative experience and continuous individual reflection. The application of active and self-directed learning requires the collaboration of both instructors and students to develop competencies such as Reference [50,51]:

- Comprehension.
- Critical thinking.
- Reflection.
- Reconstruction of knowledge.
- Collaboration.
- Search, analysis and synthesis of information.
- Active problem solving.

On the other hand, collaborative and cooperative learning are based on the generation of knowledge by way of consensus and cooperation between the members of a group [52]. In collaborative learning, the authority is shared between the team and every member is responsible for the actions of the group and requires structuring positive interdependences to achieve group cohesion [53,54]. Cooperative learning is, in turn, based on the interaction of the team members to achieve a goal or a final specific product and there is a clear division of tasks.

As stated by D'Souza [55] "collaborative learning promotes deep learning, encourages self-esteem and the acceptance of others, as well as improving interpersonal effectiveness". Therefore, by means of applying cooperative and collaborative learning, students develop competencies such as [56]:

- Self-regulation of learning.
- Open-mindness to others' ideas. Identification of strengths of team members.
- Learning to learn, building effective knowledge and mental models.
- Creative problem solving.

Instructors, as well, need to possess skills and competencies to facilitate the learning process in small groups such as being able to provide students independence to become self-directed apprentices [57] while not losing perspective on the evolution and evaluation of the groups. Agile Education offers a simple way to instructors to scaffold control and not lose sight of the intended learning outcomes [58].

2.3. Agile Education and Sustainability Competencies

Educating for sustainability implies the development of a series of key competencies that must favor responsible and constructive social participation of the students [59–61]. These competencies are connected to conceptual, methodological and socio-affective aspects that are entailed by the development of an innovative methodology merging knowledge acquisition with efficient and effective teaching addressed from ethic criteria of social justice, equity, solidarity and respect for the environment. In this sense, tackling educational reality from the development of competencies linked to sustainability implies a multidimensional process of this educational reality encompassing "knowing", "understanding", "behaving" and "being" [62]. Various authors have proposed different lists of key competencies for ESD [59,60,63–67]. Every list has subtle differences and one should not try to compile the ultimate ESD competency lists since, as stated by Barth et al., "the attempt to compile a comprehensive scheme about all possible and necessary key competencies is bound to fail right from the start since such a list must end in arbitrariness" [65]. Acknowledging this, we have compiled a

list with the common competencies that are shared by authors in the literature and linked it to Agile Education principles and competencies that have been described in the previous sections (see Table 4). It is easy to see at a glance, then, that many ESD key competencies are also key competencies which are fostered by Agile Education.

Table 4. Selection of key ESD Competencies and links to Agile Education Principles.

Key ESD Competency		Agile Education Principles
Coping with uncertainty	⇔	Agile accepts and thrives in uncertainty. It provides a means to both instructors and students to harness it and become adaptive.
Working creatively and innovation	⇔	Agile fosters autonomy and liberty to propose creative solutions without being bounded to over specified tasks and outcomes.
Dialog	⇔	Agile fosters dialog by means of the multiple ceremonies (kick-off meetings, daily meetings, review and retrospective meetings) in which all the stakeholders gather together and discuss status, issues and solutions.
Critical thinking	⇔	In Agile team members are encouraged to continuously challenge what has been done in order to refactor it and improve it.
Self-motivation and motivating others	⇔	Scrum Masters act as Agile coaches to motivate and empower the team.
Planning and implementation	⇔	Agile offers a superior planning and implementation framework in many fields.
Interdisciplinary work	⇔	Agile fosters multidisciplinary teams to increase autonomy [68].
Manage emotions and concerns	⇔	Agile exposes all stakeholders' opinions and points of view. This requires critical thinking to reach efficient and optimal solutions that are agreed while conveying and acceptinig criticism in a constructive way.
Responsibility	⇔	The concept of ownership of the work is paramount in Agile. Team members are responsible for the timely completion and the quality of the tasks they are carrying out. This develops a sense of responsibility towards the rest of the team.
Systemic thinking	⇔	Agile tackles complex problems by starting from a Minimum Viable Product and incrementally adding value in every work cycle. All parts of the system are addressed, instead of working separately, to have a finalized part of the system that will, at some point, be connected to other parts developed in the future.

Agile Education not only fosters by itself multiple key ESD competencies, but it offers useful techniques to effectively and efficiently define them. Key competencies provide the reference scheme for transparently evaluating student learning and teaching effectiveness [59], therefore it is utterly important that these Competencies are clearly defined and conveyed to students at every moment. "We must differentiate competencies from expected learning outcomes, the former being fairly abstract and therefore in need of translation into specific learning outcomes to be operational" [59]. For instance, in Scrum, we can see how accurately the concepts of *Epics* and *User Stories* described in Section 2.1 match competencies and learning outcomes. In the context of Education, *Epics* are equivalent to competencies which are, therefore, composed of *User Stories* that define the desired educational outcomes.

In summary, strategic competencies are about being able to "get things done" which, in turn, requires methods and methodologies of designing, testing, implementing, evaluating, and adapting policies, programs, and action plans [59]. This is where Agile Education comes into place as a pedagogical framework to put into practice different strategies to convey competencies in general, and ESD competencies in particular due to the common links between the theoretical foundations in which they are both grounded.

3. Research Questions and Objectives

In light of the theoretical foundations presented so far in this article, we aim to carry out a systematic review to explore works in the literature presenting different experiences of the application of Agile Methodologies in an educational context. We hypothesize that Agile Education is an optimal means of developing key ESD competencies in a transversal and multidimensional way, allowing students to build on these competencies even in programs and courses not directly related to ESD.

- RQ1: Is there any empirical evidence in the literature of the application of Agile Methodologies in Education?
- RQ2: Does this application improve the transmission of key ESD competencies?
- RQ3: If so, is this transmission deliberate and intended or is it a result of the application of the pedagogical framework which Agile Education builds on?

The specific objectives related to these research questions are to: (i) obtain a selection of relevant works in the literature embracing Agile Education; (ii) examine whether an analysis in the transmitted competencies has been done; and (iii) determine whether both instructors and students are fully aware of the benefits of the acquired competencies for Sustainability and Development.

4. Methods

The systematic review presented in this article follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) selection rules [69] to determine the works which possess a minimum scientific soundness and quality to be considered. In the first place, we carried out a raw search of papers in Scopus and ERIC (Education Resources Information Center), two well-known meta-search engines which index thousands of papers o multiple journals and publishers. Among them, ERIC is especially relevant as it is oriented to the field of Education Sciences, so the results are expected to be more bounded. On the other hand, Scopus has a generalist purpose, but it searches all the most important databases from largest publishers.
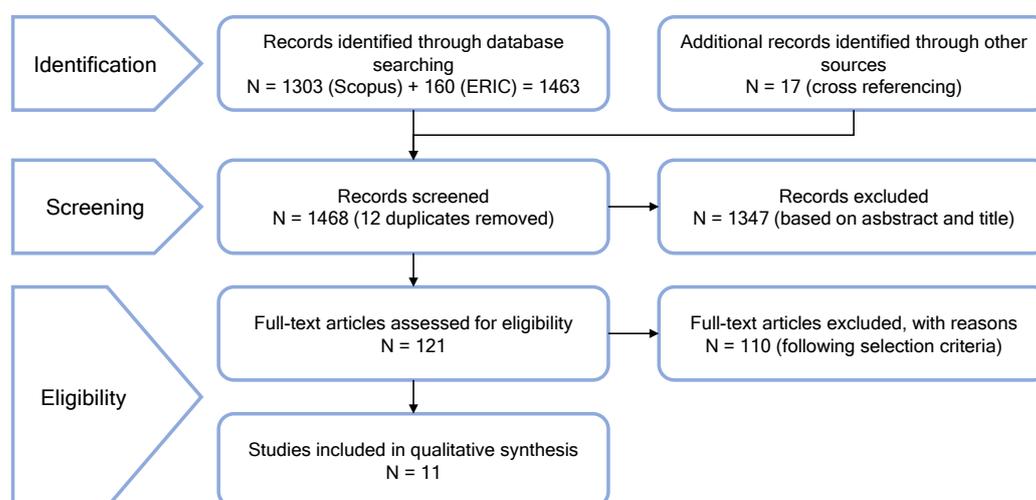
The same query was employed in both databases, aiming to obtain results including the three pillars of this review: (i) Agile Education, (ii) Competencies and (iii) Sustainability. Two different versions of the query were built as ERIC search engine does not support the '*' regular expression:

- *Scopus Query:* ((agile AND educati*) OR (agile AND educati* AND sutainab*) OR (agile AND environm* AND educati*) OR (agile AND competenc* AND educati*) OR (agile AND competenc* AND learn*) OR (agile AND educati* AND sustainab*) OR (agile AND educati* AND environm*))
- *ERIC Query:* ((agile AND education) OR (agile AND education AND sustainability) OR (agile AND environment AND education) OR (agile AND competency AND education) OR (agile AND competency AND learning) OR (agile AND education AND sustainability) OR (agile AND education AND environmental))

The search in Scopus yields 1303 results from 1991 to 2018, while the same query returns 160 hits on ERIC for the same period of time. Results from Scopus were less bounded but included valuable works published on IEEExplore, arguably the largest database in Computer and Software Engineering Education. On the other hand, ERIC's results were more relevant to the topic under study but lacked from the vast majority of IEEExplore results. All search results were subsequently screened based on the title of the work and, when in doubt, the abstract was read by all three authors. This first filtering step narrowed down the results from 1463 to 121 works which were entirely read and analyzed. A second selection step, aiming to find works presenting Agile Education experiences while explicitly mentioning the development of ESD-related competencies, reduced the final number of works to be considered in the systematic review to 11. The criteria employed for this selection are shown in Table 5 and the screening sequence is presented in detail in PRISMA's flow diagram depicted on Figure 4.

Table 5. Selection criteria applied during the screening process.

Element	Selection criteria
Agile Methodologies	Agile applied in the classroom context.
	Agile used to manage capstone projects and group assignments.
	Agile used to define the syllabus.
	Agile used to organize the course sessions.
Competency-based learning	Evidence of competencies transmitted by means of Agile.
Education for Sustainability	Evidence of ESD competencies transmitted by means of the application of Agile.
Education Level	All levels with special emphasis on higher education.
Location	Worldwide.
Language	English and Spanish.
Paper length	4 pages minimum.
Subject Area	All subject areas.

Figure 4. PRISMA's flow diagram describing the screening process of the systematic review.

In order to obtain statistics of the search results, ERIC hits not present on Scopus were manually added to this platform. Figure 5 shows the distribution of results by year, type of publication and subject, respectively.

As can be observed, there is growing interest in the topic under study within the last 10 years, especially in the areas of Computer Science (42.5%), Social Sciences (27.5%) and Engineering (18.6%). The cases of Computer Science and Engineering are not surprising since the use of these Agile methodologies is widespread in these fields within the last decade. It is also relevant to see that most of the works are published on proceedings of conferences, which are a typical scenario in which experiments with new pedagogical frameworks are presented and which, in turn, indicates the need to continue defining formal experiments which go beyond the presentation of isolated experiences.

During the in-depth reading of the articles, the aspects listed below were inspected for.

Agile Methodologies

- What Agile method is employed?
- What Agile roles are defined within the students and the instructors?
- What Agile ceremonies and processes are held?
- Is the syllabus defined following Agile principles?
- What are the evaluation tools used during Agile cycles?
- Is there a proposal of an Agile Education Manifesto?

Competencies and Sustainability

- Are any competencies explicitly mentioned as acquired by the students and instructors?
- Which of them are key competencies for Sustainability Education?
- Do students consciously acquire these competencies?

Experiments

- What is the sample size?
- Is there a control group?
- What course is being analyzed?
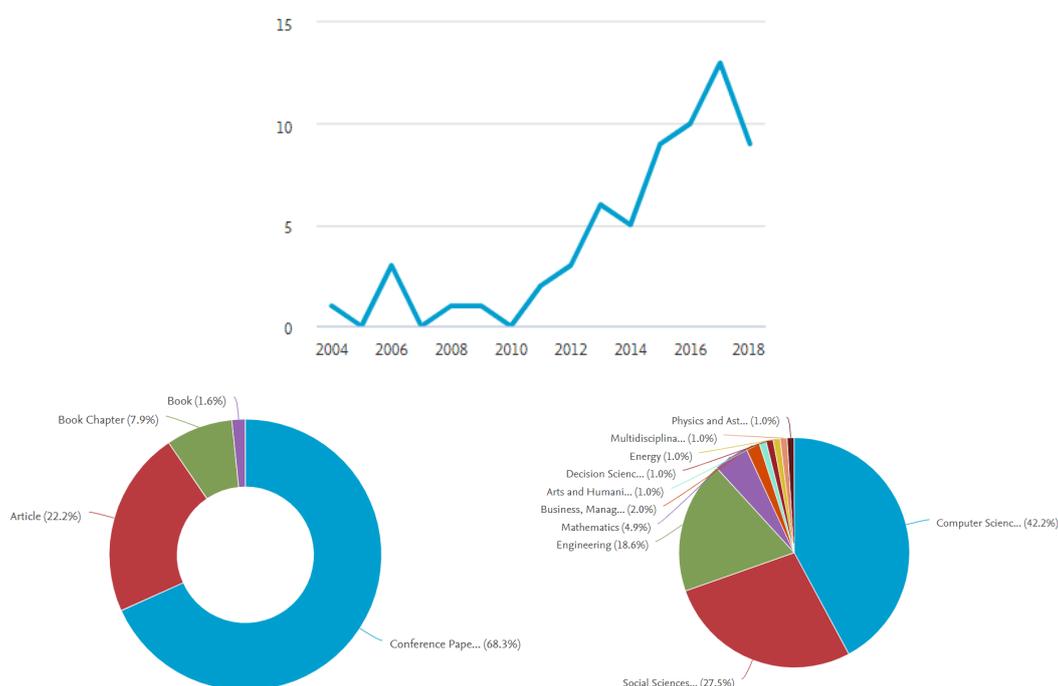- What are the employed research tools?

Figure 5. Distribution of results by year (**top**), type of publication (**bottom-left**) and subject area (**bottom-right**). Source: Scopus.

5. Results

For each one of the 11 selected studies we present a description of the experience with special emphasis on the developed competencies that are identified by the authors.

Fernández [70] presents a program that is articulated around Agile PDCA [71] to improve the employability of students of Vocational Training by the transmission of 10 selected competencies that are required by companies in the current labor market. The Agile process they follow for the design and execution of a Business and Entrepreneurship course is based on five phases: (i) definition of the training, in which the 10 key competencies (motivation, enthusiasm, initiative, result-oriented, customer-oriented, team work, empathy, conflict resolution, adaptability and change management, self-confidence and communication) are defined; (ii) design and planning of the training using Problem Based Learning (PBL), in which the students work also following an Agile approach; (iii) teaching of the course using Moodle as a collaborative learning tool; (iv) evaluation of the training results; and (vi) improvements in the program based on assessment. Therefore, Agile is used by both the instructors to design, impart, assess and improve the course, and the students to carry out the tasks derived from PBL. A sample of 122 students is analyzed, in which 75 students follow the standard program (and are,

therefore, the control group) and the remaining group of 47 students follows the new Agile approach. Results show that in 7 of the 10 competencies there are no statistically significant differences in the perceptions of the students about the efficiency of the program to acquire them. However, when it comes to initiative, self-confidence and communication competencies, the study revealed that the hypothesis of the superiority of the experimental Agile program to transmit them, was validated.

Cubric [39] presents an experience of using Agile methodologies to teach an Agile project management course in a business school. The paper presents a table in which the Agile Manifesto values are matched with Chickering and Gammson's [72] and Dalton and Tharp [73] principles. From this matching, an interpretation in a learning and teaching context referred to as the "Agile Learning & Teaching (L&T) method" is proposed. The agile L&T method is based on two premises: learning results from concrete experience and learning as a collaborative process. The agile L&T model is based, as well, in Experiential Learning theories based on the four stage cyclic learning model by Kolb, Boyatzis and Mainemelis [74] because of its iterative and incremental nature. The method is put into practice using wikis as a means of collaboratively sharing knowledge. The Agile L&T method follows a similar structure to Scrum. There is a product backlog in which the topics to study are set by the leader at the beginning of the semesters. The course is structured in 5 sprints of 2 weeks and students are divided into groups of 4-5 members in which the role of the Scrum Master rotates. Additionally, the teacher acts as the Product Owner and is responsible for selecting the topics to be included in each Sprint Backlog, which is, in turn, published every two weeks after the lecture. Sprint planning, daily stand-up meetings and sprint reviews are scrupulously respected. The course requires students to create wiki articles about the topics indicated by the professor along the course.

The author uses a survey composed of 43 items and secondary data sources such as wikispaces' usage statistics, student grades and qualitative data from students' reflections and module feedback. Two cohorts of 34 students taking the course in 2011 and 2012 were considered. The study aims to analyze different indicators and dimensions such as the initial uncertainty, impact on learning, engagement, performance, type of learning satisfaction, teamwork and the role of the teacher.

The study finds that students value regular and prompt feedback, the engagement of the professor to improve their motivation and cohesion, and the practical applications of the methodology for other subjects and aspects of life. It also indicated that students' learning was enhanced with constant review of the subject and early engagement with the module. Additionally, the perceived learning was not restricted to learning the content (preparing students for life-long learning).

Students showed a high degree of perception and awareness of how the learning method has significantly contributed to improving key ESD competencies such as time-management, negotiation, respecting classmates and growing self-confidence in face-to-face communication. Regarding negative outcomes derived from the use of Agile Methodologies, teamwork issues were found in some cases; some students had difficulties when forming groups as they were not able to select a balanced team in terms of skills homogeneity; some members of the groups stablished themselves as leaders, disregarding, hence the flat hierarchy in which Agile Methodologies is usually based on; finally some communication issues between team members also arose.

Razmov and Anderson [75] present an experience of an Agile teaching methodology applied to project-based software engineering courses. The authors reflect on the importance of feedback for adaptation and learning, and how increasing its frequency leads to more opportunities for both students and instructors. For the authors, not all students follow the same learning path and pace since each of them has their own background and learning style. Therefore, they can benefit from a personalized approach to teaching which is applicable by means of Agile teaching methodologies, which are considered to be all teaching approaches which have emphasis on the continuity of the learning process, are goal orientated, seek feedback from students, show flexibility in responding to student needs, present a short feedback cycle, and allow demand-based personalization of what is being taught. The authors make special emphasis on developing effective assessment and feedback tools that have direct and real impact on the progress of the course and improve critical thinking, self-assessment

and communication. To do so, they use artifacts like: (i) post-milestone 30-minutes project discussion meetings in which the instructors and teams clarify issues; (ii) post-milestone in-class retrospectives in which aspects to be improved are discussed; (iii) post-milestone anonymous peer reviews in which students rate the usefulness of the peer review they have received; (iv) reflective papers; (v) anonymous feedback forms; and (vi) a digital interaction system to allow students to provide quick feedback during course sessions. At the end of the three editions of the course that compose the study, students answered a questionnaire to rate the learning experience, the incremental delivery approach and the feedback mechanisms. The study reveals that instructors feel that Agile teaching reorganizes their time to focus on areas that matter the most and that there is less guesswork about what students may be thinking. Therefore, the competency to deal with uncertainty is built by implementing mechanisms to request and obtain regular feedback. Moreover perceptions of the students were highly positive, specially about the incremental delivery approach and the learning experience.

Kastl and Romeike [76] present a qualitative case-study in which they analyze 11 interviews with 6 teachers on their observations from 20 Agile projects with over 400 students of secondary education computer engineering courses. Their aim is to gain insight into how Agile practices (and more specifically, the AMoPCE—Agile Model for Projects in Computing Education) assist individual learning processes in heterogeneous courses, and how it helps teachers to design and organize projects in order to support students individually. The work aims to answer five research questions: (i) how homogeneous vs. heterogeneous group forming in agile projects influences the performance of the individual students; (ii) how agile projects help the teachers to identify the individual strengths and weaknesses of their students with respect to such skills and to provide them with meaningful individual goals that fit their prerequisites; (iii) how agile projects support teachers to provide adequate individual guidance or coaching throughout projects that start early on in the student's learning process; (iv) how agile projects foster the kind of interactions that support individual learning-processes; and (v) how agile projects foster the ability of the individual student to reflect and provide, receive, and implement feedback. Results show that competences like the enhancement of soft skills (communication), self-organization and ability to work in teams are strengthened via Agile. Additionally, the authors conclude that Agile projects can be an effective method to foster self-managed cooperative learning in heterogeneous classes since they enable all learners to construct flexible, generalized cognitive structures and to acquire fluid and crystallized abilities.

An interesting experience to analyze the development of competencies to work in a global project involving countries with cultural differences by means of Agile Education is presented in Reference [46]. The study describes an experience of application of Scrum to manage a distributed software project course between a Canadian and a Finnish university involving 16 students by means of using Agilefant [77], an open-source backlog management system. Apart from the technical objectives of the project, the main goal of the experiment is to expose students to cultural differences in a global context. The authors identify competencies like teamwork, work estimation and planning and effective communication across large time zone differences as the desired outcome of the application of the Agile Education experience. Results show that despite the existence of some challenges in the way ideas are conveyed, students rate positively the experience of developing a real product, the methodology employed and the global context of the project. Moreover, students also develop competencies to have fluid communication and team work habits with their peers.

An Agile-based methodology is employed in Reference [78] to leverage soft-skills required in the international labor market. The experiment involves the implementation of Scrum in four research departments at the University of Manaus, Brazil and 23 projects involving 34 students. Results revealed that competencies such as communication and story telling, responsibility and commitment, leadership, transparency and honesty and time management were successfully improved based on the perceptions of the participants and the completion of the syllabus' goals.

Another analysis of the competencies that are developed through Agile Education can be found in Reference [79]. In this work, an experience of the application of the "Learning Methodology + Service (L+S)" by means of Agile is presented. It proposes the combination of Agile practices with the framework proposed by the authors (L+S), which is based on carrying out practical projects to solve a real problem or case of the community. This way, the learning process also serves a public service to the community. In this case, Agile methodologies are applied to create a web portal to promote the local bookstores association. Additionally, an analysis of the competencies obtained both by means of applying Agile and L+S are derived. Examples of competencies observed by the instructor during the project include communication skills, complex problem solving skills, empathy with the community, teamwork, collaborative work, working under pressure, self-management skills, and self-organization. Analogously, students: (i) experimented the concept of social responsibility by providing the local community with a valuable service; (ii) understood the importance of listening and talking to their peers; (iii) assumed the responsibility of working in areal challenge; (iv) valued differences and tolerance; and (v) learned in a collaborative way. The combination of Agile Learning with a community service served as a powerful combination to raise awareness about the importance to sustain local communities and developed key ESD competencies.

Agile Education experiences can also be developed in virtual environments. In Reference [80] a framework for designing virtual learning environments based on Agile Learner-centered approach is presented. The proposed Agile Learning Design is an iterative model that focuses on collaboration and rapid prototyping. The learning environment is based on: active users participation, collaborative development, architecture/design envisioning, iterative modeling/design, model/design storming and early and continuous evaluation. The learner-centered approach develops competencies and benefits such as personalized learning and advanced participation, increases retention of knowledge, improves problem-solving skills and encourages collaborative learning.

Scrum is applied to structure a full Computer Engineering Degree program in the work by Soto et al. [38]. An adaptation of the Scrum framework to the processes, resources and results of teaching-learning process is described. The goals of the Agile Education approach are to: (i) apply the Scrum framework to academic activities such as planning, development and follow-up; (ii) obtain self-managed student teams with high level of interaction; (iii) actively involve students and teachers in the different stages of the teaching-learning process following the practices of the Scrum framework; (iv) use Agile practices as mechanisms to develop competencies such as: organizational capacity, teamwork, communication and leadership; and (v) improve the efficiency and satisfaction of the work team. The usual rules, roles and artifacts of Scrum are followed. An experiment, based on student surveys, to analyze the application of the framework by 6 teachers and 250 students during 3 semesters is conducted. Results show a high satisfaction with the model among students and high rates of completion of course objectives and tasks to be implemented. Moreover, other qualitative objectives such as optimal organization of students and teacher work, acquisition of students competencies and learning, motivation and increased interest in the participation of academic activities were achieved. Regarding the competencies that were initially outlined, students developed the ability to work collaboratively, discuss different points of view, develop critical thinking and reach consensus, communicate effectively and lead projects.

In Reference [36], Krehbiel et al. propose an alternative Agile Manifesto for Teaching and Learning based on 6 principles materialized in the form of competencies (see Table 6) which are part of the backbone of ESD.

An experiment is presented to validate their approach, in which 109 students participating in courses structured using Agile Education from different subject areas, such as computer science and programming, technical writing, supply chain management, early childhood education and civic studies, are surveyed in relation to their satisfaction with the use of Agile methodologies and its ceremonies and artifacts. Students acknowledge that the inclusion of Agile methodologies leads to a more effective learning experience and a more efficient use of their time while enhancing

teamwork and communication. Also they appreciated the fact that it simulates real-world conditions of team-based work. Faculty noticed that the use of Agile led to increased quality in the work delivered by students and they expressed their willingness to continue using Agile in their future courses. However, they highlighted the fact of needing to carry out some adaptation of the lexicon and terminology of Scrum in non-technical courses to avoid confusion and rejection of students. As a conclusion, the authors state that the application of Agile methods in education leads to better learning outcomes for students, greater student buy-in for group-based projects, more authentic forms of group collaboration and greater opportunities for creativity and leadership by members of student groups.

Table 6. Agile Education principles and competencies proposed in [36].

Principle		Competencies
Adaptability over prescriptive teaching methods.	⇔	Ability of students to operate in an environment of uncertainty. Generate abilities to navigate in the midst of ambiguity and thrive in a dynamic world.
Collaboration over individual accomplishment	⇔	Transparent communication, ability to listen effectively and to provide positive feedback, engagement, cooperation, collaborative work. Work effectively in teams.
Achievement of learning outcomes over student testing and assessment.	⇔	Encourage students to be learning-driven rather than test-driven, create self-motivated, lifelong learners. Pitfall of learning for the test: the retention of the knowledge is very low and therefore, it does not promote lifelong learning.
Student-driven inquiry over classroom lecturing.	⇔	Student empowerment, deep learning, develop applicable skills.
Demonstration and application over accumulation of information.	⇔	Self-confidence by means of demonstrating knowledge and skills in a tangible way. Knowledge retention.
Improvement over the maintenance of current practices.	⇔	Risk-taking, creativity, innovation.

In Reference [33], Onieva discusses in a thorough and explicit way the competencies that a professor must possess and that can be obtained by means of Scrum and which, consequently, can also be transferred to the students by means of Agile Education in general. Among these competencies, the author considers: (i) competency to plan, develop and evaluate education for the reinforcement of human values; (ii) competency to create and maintain open, flexible, democratic and culturally rich environments where a positive learning climate is stimulated; (iii) competency to promote professional development and training of learning communities with education stakeholders; (iv) competency to develop critical thinking; (v) competency to learning to learn, (vi) competency to develop communication skills; (vii) competency to develop autonomy and self-organization; (viii) competency to adapt to changes; (ix) competency to present ideas in an argued way; (x) competency to reach consensus; (xi) competency to foster and accept diversity; (xii) competency to optimize time effectively; and (xiii) competency to develop creativity.

As an example, the author considers some core competencies of the degrees imparted in the Education College, such as the elaboration and defense or arguments and problem resolution, issuance of judgments including reflection on relevant social, scientific and ethics topics, transmission of information, ideas, problems and solutions to both specialized and non-specialized audiences, development of learning skills to become autonomous and last, but not least, group working, collaboration and respect of diversity and discrepancy. These competencies are all related to communication, social relationships, creativity and personal, emotional and academic development and are all, again, key competencies of ESD. Moreover, they are hard to learn for students using a learning strategy purely based on lectures. As a result, the author defines these competencies as part of the learning objectives of an experiment in which Scrum is applied to manage a class project in the

context of a course in a Primary Education Teaching degree. The 85 enrolled students, divided into 11 groups, showed high motivation and produced quality works. Additionally, the number of conflicts between them was considerably reduced when compared to other course editions and the desired outcome in terms of competencies was achieved by means of creating a work environment in which students respected and trusted their peers.

To finalize the presentation of the works considered in this review, a summary of the key aspects of each work has been included in Table A1 in Appendix A. The table reflects the education level in which the experience is carried out, the employed Agile methodology, objectives and results, ESD competencies that are transmitted by means of the experience and the employed methodology.

6. Discussion

6.1. RQ1: Evidences of Application of Agile Methodologies in Education

After having gone through hundreds of search results, we can conclude that there is, indeed, empirical evidence in the literature of the application of Agile Methodologies in Education (RQ1). Multiple studies ([4,81–103]) were left out of the systematic review since they did not explicitly find a direct link between key ESD competencies in the context of Agile Education, however they reflect how agile Methodologies are a topic of growing interest in many fields including education, and how the number of experiments and experiences is exponentially growing within the last years. Most importantly, its application is starting to flourish in non-engineering fields where the methodology was conceived, being a pedagogical framework with great potential to be used in any educational context and subject area.

6.2. RQ2: Application of Agile Methodologies to Improve ESD Competencies

Regarding the application of Agile Education to foster and improve the transmission of key ESD competencies, it has been shown that many competencies stated by the authors as either the initial objectives of their Agile Education experiments, or collateral observed outcomes, are indeed competencies that have been listed by multiple authors as key competences for the successful development of Education for Sustainable Development. Therefore, we have observed how the application of the artifacts defined in the methodology implies putting into practice key ESD competencies such as critical thinking, uncertainty management, communication and respect for others' opinions, collaborative work, dialog, responsibility, systemic thinking and so on. The acquisition of all these competencies has been evidenced by the authors as the main positive aspects of the application of Agile in the classroom environment.

6.3. RQ3: Deliberate Transmission of Competencies

It has been shown that in some cases the transmission of these competencies is deliberate, as they are part of the outlined objectives of the educational program to be imparted by means of Agile methodologies. In other cases, these competencies are a positive outcome observed by both students and faculty. In all cases, authors did not design specific programs for the development of competencies in the context of ESD but, interestingly enough, they ended up working these competencies in a transversal and multidisciplinary way, which is one of the factors resulting in a more relevant and durable learning [104].

6.4. Other Observed Results

Agile methodologies are employed for different purposes such as designing courses, controlling class projects and work, tracking the progress of the students, adjusting the course pace, manage heterogeneous and globalized classes and improving the employability of the students by developing their soft skills.

The experiences are mostly carried out in Higher Education environments and only two works are deployed in other education levels such as Vocational Training and Secondary Education. As we have seen Agile methodologies were developed in work environments so their application is easier and straight forward in higher education levels. However, with the adaptation of some of their processes and concepts, it can also be employed at lower education levels.

An initial increase in the workload of professors has been identified when designing and implementing Agile Education experiences, however it seems to derive a more efficient use of their time when consolidated.

All studied experiences have shown a positive perception and acceptance from both students and instructors. Students have appreciated the strong bonds developed between their peers and the availability and down-to-earth culture of the faculty. By showing that the students' feedback is considered and cared for, a greater degree of engagement is achieved.

Moreover, it has been observed that there is a clear link between key ESD competencies and key Agile Education Competencies, as summarized in Figure 6, and that Agile Methodologies can be customized to build powerful pedagogies based in collaboration, participation and practice to build competencies which scaffold pro-environmental attitudes in students, as future citizens.
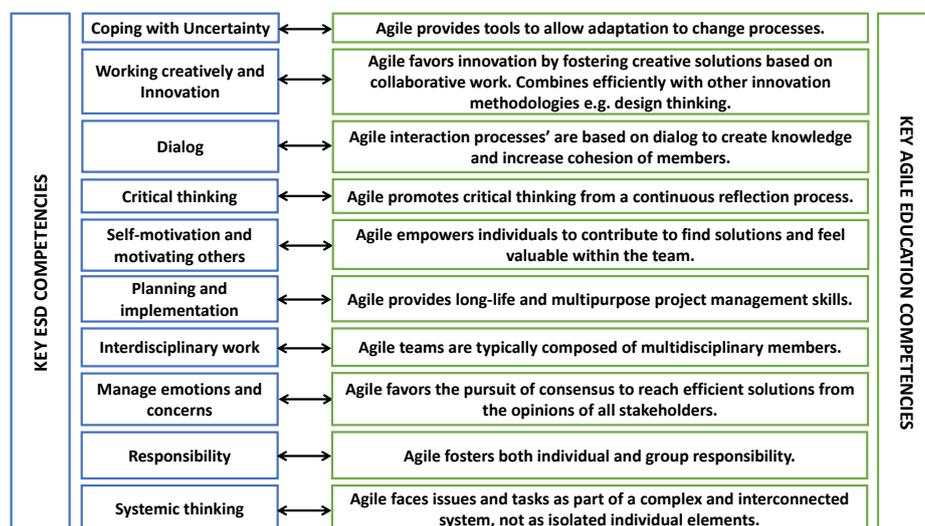

Figure 6. Link between key ESD competencies and key Agile Education competencies.

6.5. Limitations of the Systematic Review

Despite the growing popularity of Agile methodologies within recent years, its application in the field of education is still a novelty in an early phase, and existing published experiences are mainly motivated by educators interested in the topic without the formal backup of school management and institutions. Although the number of articles is considerable, a large majority of them have been conceived to be presented at conferences (see Figure 5). Consequently, many studies do not present a thorough and detailed experimental design, creating then a possible bias in the experiences and results. Our screening process has tried to eliminate those studies the conclusions of which were not supported by enough evidence and a statistically significant sample. On the other hand, the development and fostering of key ESD competencies has been manifested in most works in an unintended or collateral way. In spite of the evidenced link between competencies empowered by Agile Education and ESD competencies, authors do not explicitly mention improving sustainability as their main objective (although creating responsible and life-long learners is clearly stated as an objective). Moreover, a reduced number of articles (N = 5) having gone through the title and abstract screening, could not be retrieved due to restricted access from our institution to the publisher database and were, consequently, left out of the review. It is expected that, in the following years, exhaustive

works and projects using Agile as the core to create education experiences will be published, allowing an expansion of the current study by means of a meta-analysis.

7. Conclusions

By using Agile methodologies to design, structure and steer courses as a whole, or punctual activities and projects, instructors are offering a valuable framework and environment for students to develop valuable competencies that can serve to increase their performance in their work life and their development as responsible citizens living in a sustainable way. The study has revealed how the core competencies, in which Agile Education is deeply rooted, are shared with key competencies for ESD identified by researchers over the last decades.

The change in the education paradigm to evolve from "traditional education" to "Agile education" implies a large, although easy to adopt, revolution in the design, planning, teaching and evaluation processes of educational programs. This revolution entails the fostering of a more participative and collaborative education that empowers students in rights but also in responsibilities as the tasks and learning objectives are clearly stated by means of publicly specifying their ownership. Students become active learners and cannot remain passive in courses structured in this way. In addition to the transmission of ESD competencies, students learn a work methodology that is largely applied in the labor market, preparing them, then, in a better way to address challenges presented in modern work environments.

The present research sheds light, as well, on the opportunity and the current challenge of Agile methodologies as a strategy to favor models of economic sustainable development from the context of education. It is important to be aware of the impact and controversy that the implementation of agile methodologies in the work environment can generate. A misuse of these Agile methodologies oriented to the sheer obtaining of results and short term benefits, without considering the socio-environmental impact, can cause negative effects in the environment that comes from unsustainable actions (overproduction, resource wasting, disproportionate generation of waste, etc.). The mere application of agile methodologies in the context of education does not guarantee the promotion of pro-environmental behaviors. Special emphasis must be done during the process so that the underlaying ESD competencies enumerated along this work, and which are put in practice by means of Agile, are revealed and known by the students. When the synergies generated between ESD and Agile methodologies are known and explained, key competencies to teach responsible and sustainable citizens and future employees, as well as businessmen, are consolidated.

The studies analyzed in this review have shown how the application of a series of basic actions such as forcing periodic group meetings, gathering feedback, working in cycles, equitably distributing tasks and developing a closer relationship between faculty and students, allow the development of important competencies such as critical thinking, coping with uncertainty, adaptability, creativity, dialog, respect, self-confidence, emotional intelligence, responsibility and systemic thinking which conform the pillars of sustainability-oriented citizens.

The applications of Agile Education are multiple and varied. Different methods like Scrum, Kanban or XP can be curated to fit almost any course or learning experience and show great potential to adapt to the life-long learning required by our current fast-evolving society.

Author Contributions: Conceptualization, A.L.-A., A.O.-V. and F.P.-V.; methodology, A.O.-V. and A.L.-A.; validation, A.L.-A. and F.P.-V.; formal analysis, A.O.-V. and A.L.-A.; investigation, A.L.-A., A.O.-V. and F.P.-V.; data curation, A.O.-V. and A.L.-A.; writing—original draft preparation, A.O.-V. and A.L.-A.; writing—review and editing, A.O.-V.; supervision, F.P.-V.

Appendix A

Table A1. Summary of key aspects of the works included in the study.

Author & Reference	Edu. level	Agile Method	Objectives	Results	ESD Competencies
Fernández, I. [70]	Vocational Education.	Agile PDCA.	Improve employability of students.	Superiority of Agile Program to transmit initiative, self-confidence and communication competencies.	Motivation, enthusiasm, initiative, team work, empathy, conflict resolution, adaptability and change management, self-confidence and communication.
Cubric, M. [39]	Higher Education.	Agile L&T. (Adaptation of Scrum).	Organize teaching of the course and learning Agile Project Management by doing. Measure initial uncertainty, impact on learning, engagement, performance, type of learning satisfaction, teamwork and role of the teacher.	Students value prompt feedback, engagement of professor, practical applications of methodology. Learning was enhanced. Good perception on transmitted competencies.	Team work, time-management, negotiation, respecting classmates and growing self-confidence in face-to-face communication.
Razmov, V. & Anderson, R. [75]	Higher Education.	Adaptation of Scrum.	Developing a personalized approach to teaching. Implement short feedback cycles. Allow demand-based personalization of content. Measuring perceptions on students and instructors.	Instructors feel that Agile allows focusing attention on important topics, and there is less guesswork to do. Students value incremental delivery approach and learning experience.	Dealing with uncertainty.
Kastl, O. & Romeike, R. [76]	Secondary Education	AMoPCE: Agile Model for Projects in Computer Education	Gain insight into how Agile practices assist individual learning processes in heterogeneous courses, and how it helps teachers to design and organize projects to support students individually.	Frequent meetings reduces dominant-student attitudes. Better picture of strengths and weaknesses of students for teachers. Easier to provide individual guidance to students. Students look after each other. Quantity and quality of interactions increases. Efficient method to foster self-cooperative learning in heterogeneous classes.	Communication, self-organization, reflection, ability to work in teams, collaboration.
Damian, D. et al. [46]	Higher Education.	Scrum	Manage distributed software project course between a Canadian and a Finnish university. Expose students to cultural differences in a work environment. Develop competencies to work in globalized contexts.	Challenges due to cultural differences (in how ideas are conveyed) and differences of seniority in the topics treated. Students rate positively the experience of developing a real product using a methodology employed in real work environments. Communication skills are improved.	Teamwork, planning, effective communication in a globalized team.
Valentin, E. et al. [78]	Higher Education.	Scrum	Develop soft-skills required in international labor market.	Competencies were improved after finalization of the program. Students valued positively both outcome and Agile methodology employed. Modifications of Scrum to fit educational environments proposed.	Communication, story telling, responsibility and commitment, leadership, transparency, honesty, time management.

Table A1. *Cont.*

Author & Reference	Edu. level	Agile Method	Objectives	Results	ESD Competencies
Elgueta J.C. [79]	Higher Education.	Kanban	Carrying out practical learning projects to solve real problems for the community and develop skills and competencies to serve the local environment.	Remarkable improvement of key ESD competencies in the context of community work.	Communication, complex problem solving, empathy towards the community, teamwork, collaborative work, working under pressure, self-management, self-organization, listening to peers, responsibility, value differences, tolerance.
Battou, A. et al. [80]	Higher Education.	Agile Learning Design (custom design).	Designing a Virtual Learning Environment for a Project Management course using an Agile learner-centered approach based on three packages: learner, domain and adaptation, which are articulated using a design-and-prototype iterative loop.	The deployed method allows course designs to be modified according to the needs of learners emerging during development. Human contact with students is improved leading to higher motivation in the students.	Collaborative learning, participation, problem-solving.
Fernanda, S. et al. [38]	Higher Education.	Adaptation of Scrum.	Five objectives: (i) plan, develop and follow up academic activities in an agile way, (ii) creating self-managed students, (iii) active involvement of teachers and students, (iv) improve key competencies and (v) improve satisfaction and efficiency of team.	High satisfaction among students and high rates of completion of course objectives. Optimal organization of course, acquisition of competencies. Increase of motivation and interest.	Organizational capacity, teamwork, communication, leadership.
Krehbiel, T.C. [36]	Higher Education.	Adaptation of Scrum.	Analyzing how Agile can be used to articulate courses in different disciplines.	Students acknowledge Agile leads to a more effective learning experience and efficient use of time with better communication and teamwork while simulating real world conditions. Faculty noticed increased quality in work delivered by students.	Communication, team-based work, creativity, leadership.
Onieva, J.L. [33]	Higher Education.	Scrum	Managing a class project in the context of a course in the Primary Education Teaching degree. Improve competencies included in the curriculum of different degrees in the Education College. Identify key competencies both professors and students must possess.	High motivation of students. Increased quality of delivered works. Reduction of conflicts in work teams. Acquisition of competencies.	Professors: planning, developing critical thinking and communication skills, adapting to changes. Students: Problem resolution, reflection, autonomy, collaboration, respecting diversity and discrepancy.

References

1. Royle, K.; Nikolic, J. A modern mixture, Agency, Capability, Technology and 'Scrum': Agile Work. *J. Educ. Soc. Policy* **2016**, *3*, 37–47.
2. Gannod, G.C.; Troy, D.A.; Luczaj, J.E.; Rover, D.T. Agile way of educating. In Proceedings of the 2015 IEEE Frontiers in Education Conference (FIE), Washington, DC, USA, 21–24 October 2015; pp. 1–3. [CrossRef]
3. Branson, R.K.; Rayner, G.T.; Cox, J.L.; Furman, J.P.; King, F.J. Interservice Procedures for Instructional Systems Development. Phase 3. *Develop* **1975**, *5*, 396.
4. Glassey, R.; Wiggberg, M.; Haller, P. Agile and Adaptive Learning via the ECK-model in the Software Development Academy. In Proceedings of the EC-TEL 2018: 13th European Conference for Technology-Enhanced Learning, Leeds, UK, 3–6 September 2018.
5. Ryan, A. *Education for Sustainable Development and Holistic Curriculum Change: A Review and Guide*; The Higher Education Academy: York, UK, 2011.
6. Heidi Musser—Embracing the Agile Mindset & Agile's Core Principles—The Agile Alliance. Available online: https://www.agilealliance.org/embracing-the-agile-mindset-agiles-core-principles/ (accessed on 22 February 2019).
7. Agile 101, The Agile Alliance. Available online: https://www.agilealliance.org/agile101/ (accessed on 22 February 2019).
8. Larman, C.; Basili, V.R. Iterative and incremental developments. a brief history. *Computer* **2003**, *36*, 47–56. [CrossRef]
9. Jeff Sutherland, Real Time Process Improvement with SCRUM. Available online: http://jeffsutherland.org/2004_09_01_oldstuff.html (accessed on 22 February 2019).
10. The Standish Group—CHAOS Report. Available online: https://www.standishgroup.com/outline (accessed on 22 February 2019).
11. Owen, R.; Koskela, L.; Henrich, G.; Codinhoto, R. Is agile project management applicable to construction? In Proceedings of the 14th Annual Conference of the International Group for Lean Construction, Santiago, Chile, 25–27 July 2006; pp. 51–66.
12. Vázquez-Bustelo, D.; Avella, L. Agile manufacturing: Industrial case studies in Spain. *Technovation* **2006**, *26*, 1147–1161. [CrossRef]
13. Kitzmiller, R.; Hunt, E.; Sproat, S.B. Adopting best practices: "Agility" moves from software development to healthcare project management. *CIN Comput. Inform. Nurs.* **2006**, *24*, 75–82.
14. Room, G. *Complexity, Institutions and Public Policy: Agile dEcision-Making in a Turbulent World*; Edward Elgar Publishing: Cheltenham, UK, 2011.
15. Schwaber, K.; Sutherland, J. *The Scrum Guide 2017*. Available online: https://www.scrumguides.org/docs/scrumguide/v2017/2017-Scrum-Guide-US.pdf#zoom=100 (accessed on 21 May 2019).
16. Sutherland, J. Business Object Design and Implementation Workshop. *SIGPLAN OOPS Mess.* **1995**, *6*, 170–175. [CrossRef]
17. Van Ruler, B. Agile public relations planning: The reflective communication scrum. *Public Relat. Rev.* **2015**, *41*, 187–194. [CrossRef]
18. Streule, T.; Miserini, N.; Bartlomé, O.; Klippel, M.; De Soto, B.G. Implementation of scrum in the construction industry. *Procedia Eng.* **2016**, *164*, 269–276. [CrossRef]
19. Sutherland, J. Inventing and Reinventing SCRUM in five Companies. *Cutter IT Journal* **2001**, *14*, 5–11.
20. Greening, D.R. Enterprise scrum: Scaling scrum to the executive level. In Proceedings of the 2010 43rd Hawaii International Conference on System Sciences, Honolulu, HI, USA, 5–8 January 2010; pp. 1–10.
21. Jira—Agile Project Management Tool. Available online: https://www.atlassian.com/software/jira (accessed on 22 February 2019).
22. Version One—Agile Project Management Tool. Available online: https://www.collab.net/ (accessed on 22 February 2019).
23. Pivotal Tracker—Agile Project Management Tool. Available online: https://www.pivotaltracker.com/ (accessed on 22 February 2019).
24. Ismail Kaya—Differences between Kanban and Scrum. Available online: https://www.cmswire.com/information-management/agile-vs-scrum-vs-kanban-weighing-the-differences/ (accessed on 22 February 2019).
25. Trello—Virtual Kanban Board. Available online: https://www.trello.com (accessed on 22 February 2019).

26. Microsoft Azure—What Is Scrum. Available online: https://docs.microsoft.com/en-us/azure/devops/learn/agile/what-is-scrum/ (accessed on 22 February 2019).

27. Stewart, J.C.; DeCusatis, C.S.; Kidder, K.; Massi, J.R.; Anne, K.M. Evaluating Agile Principles in Active and Cooperative Learning. In *Proceedings of the Student-Faculty Research Day, CSIS*; Pace University: New York, NY, USA, 2009; pp. B3.1–B3.8.

28. Nuottila, J.; Aaltonen, K.; Kujala, J. Challenges of adopting agile methods in a public organization. *Int. J. Inf. Syst. Proj. Manag.* **2016**, *4*, 65–85. [CrossRef]

29. Ribeiro, A.; Domingues, L. Acceptance of an agile methodology in the public sector. *Procedia Comput. Sci.* **2018**, *138*, 621–629. [CrossRef]

30. Dewi, D.A.; Muniandy, M. The agility of agile methodology for teaching and learning activities. In Proceedings of the 2014 8th Malaysian Software Engineering Conference (MySEC), Langkawi, Malaysia, 23–24 September 2014; pp. 255–259. [CrossRef]

31. Wals, A.E. Mirroring, Gestaltswitching and transformative social learning: Stepping stones for developing sustainability competence. *Int. J. Sustain. High. Educ.* **2010**, *11*, 380–390. [CrossRef]

32. Kamat, V.; Sardessai, S. Agile Practices in Higher Education: A Case Study. In Proceedings of the Agile India, Bengaluru, India, 18–23 March 2012; pp. 48–55. [CrossRef]

33. Onieva, J. Scrum como Estrategia para el Aprendizaje Colaborativo a través de Proyectos. Propuesta Didáctica para su Implementación en el Aula Universitaria. *Revista de Currículum y Formación del Profesorado* **2018**, *22*, 509–527. [CrossRef]

34. Domenico Lembo, M.V. Project Based Learning + Agile Instructional Design = EXtreme Programming based Instructional Design Methodology for Collaborative Teaching. *Tech. Rep.* **2012**, *8*, 1–24.

35. Peha, S. Agile Schools: How Technology Saves Education (Just Not the Way We Thought it Would). 2001. Available online: https://www.infoq.com/articles/agile-schools-education (accessed on 22 February 2019).

36. Krehbiel, T.; Salzarulo, P.; Cosmah, M.; Forren, J.; Gannod, G.; Havelka, D.; Hulshult, A.; Merhout, J. Agile Manifesto for Teaching and Learning. *J. Eff. Teach.* **2017**, *17*, 90–111.

37. Linden, T. Scrum-Based Learning Environment: Fostering Self-Regulated Learning. *J. Inf. Syst. Educ.* **2018**, *29*, 65–74.

38. Fernanda, S.; Manuel, S.; Germania, R.; Samanta, C.; Danilo, J.; Patricio, A. Agile methodologies applied in teaching-learning process in engineering: A case of study. In Proceedings of the 2018 IEEE Global Engineering Education Conference (EDUCON), Tenerife, Spain, 17–20 April 2018; pp. 1201–1207. [CrossRef]

39. Cubric, M. An agile method for teaching agile in business schools. *Int. J. Manag. Educ.* **2013**, *11*, 119–131. [CrossRef]

40. Bada, S.O.; Olusegun, S. Constructivism learning theory: A paradigm for teaching and learning. *J. Res. Method Educ.* **2015**, *5*, 66–70.

41. McCourt, D.M. Practice theory and relationalism as the new constructivism. *Int. Stud. Q.* **2016**, *60*, 475–485. [CrossRef]

42. Amineh, R.J.; Asl, H.D. Review of constructivism and social constructivism. *J. Soc. Sci. Lit. Lang.* **2015**, *1*, 9–16.

43. Mattar, J. Constructivism and connectivism in education technology: Active, situated, authentic, experiential, and anchored learning. *Revista Iberoamericana de Educación a Distancia* **2018**, *21*, 201–217. [CrossRef]

44. Honebein, P. *Seven Goals for the Design of Constructivist Learning Environments. On Constructivist Learning Environments: Case Studies in Instructional Design*; Wilson, B.G., Ed.; Educational Technology Publications: Englewood Cliffs, NJ, USA, 1996; pp. 11–24.

45. Noguera, I.; Guerrero-Roldán, A.E.; Masó, R. Collaborative agile learning in online environments: Strategies for improving team regulation and project management. *Comput. Educ.* **2018**, *116*, 110–129. [CrossRef]

46. Damian, D.; Lassenius, C.; Paasivaara, M.; Borici, A.; Schröter, A. Teaching a globally distributed project course using Scrum practices. In Proceedings of the 2012 Second International Workshop on Collaborative Teaching of Globally Distributed Software Development (CTGDSD), Zurich, Switzerland, 9 June 2012; pp. 30–34. [CrossRef]

47. Chun, A.H.W. The Agile Teaching/Learning Methodology and Its e-Learning Platform. In *Advances in Web-Based Learning—ICWL 2004*; Liu, W., Shi, Y., Li, Q., Eds.; Springer: Berlin/Heidelberg, Germany, 2004; pp. 11–18.

48. Siemens, G. Moving beyond Selfdirected Learning: Network-Directed Learning. Available online: http://archive.is/tVRLa (accessed on 22 February 2019).
49. Siemens, G. Connectivism: A Theory for the Digital Age. Available online: http://www.elearnspace.org/Articles/connectivism.htm (accessed on 22 February 2019).
50. Tillema, H.; Kremer-Hayon, L. Practicing what we preach. Teacher educators' dilemas in promoting self-regulated learning: A cross case comparison. *Teach. Teach. Educ.* **2002**, *18*, 593–607. [CrossRef]
51. Zion, M.; Slezak, M. It takes two to tango: In dynamic inquiry, the self-directed student acts in association with the facilitating teacher. *Teach. Teach. Educ.* **2005**, *21*, 875–894. [CrossRef]
52. Panitz, T.; Panitz, P. Encouraging the Use of Collaborative Learning in Higher Education. In *Issues Facing International Education*; Forest, J.J., Ed.; Garland Publishing: New York, NY, USA, 1998.
53. Johnson, D.W.; Johnson, R.; Holubec, E. *Circles of Learning*, 4th ed.; Edina, M.N., Ed.; Interaction Book Company: Halifax, MN, USA, 1993.
54. Dillembourgh, P.; Baker, M. Negotiation spaces in Human-Computer Collaborative Learning. In Proceedings of the International Conference on Cooperative syetms (COOP'96), Juan-Les-Pins, France, 12–14 June 1996.
55. D'Souza, M.J.; Rodrigues, P. Extreme Pedagogy: An Agile Teaching-Learning Methodology for Engineering Education. *Indian J. Sci. Technol.* **2015**, *8*, 828–833. [CrossRef]
56. Collazos, C.; Guerrero, L.; Vergara, A. Aprendizaje Colaborativo: Un cambio en el rol del profesor. In Proceedings of the Memorias del III Congreso de Educación Superior en Comutación, Jornadas Chilenas de la Computación, Punta Arenas, Chile, 5–9 November 2001.
57. Barrows, H.S. *The Tutorial Process*; Springfield, I.L., Ed.; Southern Illinois University School of Medicine: Springfield, IL, USA, 1992.
58. Cathcart, A.; Greer, D.; Neale, L. Learner-focused evaluation cycles: Facilitating learning using feedforward, concurrent and feedback evaluation. *Assess. Eval. High. Educ.* **2014**, *39*, 790–802. [CrossRef]
59. Wiek, A.; Withycombe, L.; Redman, C.L. Key competencies in sustainability: A reference framework for academic program development. *Sustain. Sci.* **2011**, *6*, 203–218. [CrossRef]
60. Wiek, A. Operationalising competencies in higher education for sustainable development. In *Handbook of Higher Education for Sustainable Development*; Barth, M., Michelsen, G., Rieckmann, M., Tohomas, I., Eds.; Routledge: Abingdon-on-Thames, UK, 2016; pp. 241–260.
61. Leal Filho, W.; Manolas, E.; Pace, P. The future we want: Key issues on sustainable development in higher education after Rio and the UN decade of education for sustainable development. *Int. J. Sustain. High. Educ.* **2015**, *16*, 112–129. [CrossRef]
62. Melendro, M.; Murga, M.A.; Novo, M.; Bautista-Cerro, M.J. Estrategias formativas innovadoras en educación ambiental y para el desarrollo sostenible. *Revista Iberoamericana de Educación a Distancia* **2008**, *11*, 15–39.
63. Cebrián, G.; Junyent, M. Competencias profesionales en Educación para la Sostenibilidad: Un estudio exploratorio de la visión de futuros maestros. *Enseñanza de las Ciencias* **2014**, *32*, 29–49. [CrossRef]
64. Murga-Menoyo, M.A. Competencias para el desarrollo sostenible: Las capacidades, actitudes y valores meta de la educación en el marco de la Agenda global post-2015. *Foro De Educ.* **2015**, *13*, 55–83. [CrossRef]
65. Barth, M.; Godemann, J.; Rieckmann, M.; Stoltenberg, U. Developing key competencies for sustainable development in higher education. *Int. J. Sustain. High. Educ.* **2007**, *8*, 416–430. [CrossRef]
66. Roorda, N. Sailing on the Winds of Change. The Odyssey to Sustainability of the Universities of Applied Sciences in the Netherlands. Ph.D. Thesis, Maastricht University, Maastricht, The Netherlands, 2010.
67. Lambrechts, W.; Mulà, I.; Ceulemans, K.; Molderez, I.; Gaeremynck, V. The integration of competences for sustainable development in higher education: An analysis of bachelor programs in management. *J. Clean. Prod.* **2013**, *48*, 65–73. [CrossRef]
68. McDonald, A.; Welland, R. Agile Web Engineering (AWE) Process: Multidisciplinary Stakeholders and Team Communication. In *Web Engineering*; Springer: Berlin/Heidelberg, Germany, 2003; pp. 515–518.
69. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Available online: http://prisma-statement.org/ (accessed on 22 February 2019).
70. Fernández, I. Mejora de Competencias: Introducción de la Gestión de Calidaad en Nuevas Metodologías Educativas. *Profesorado Revista de Currículum y Formación del Profesorado* **2017**, *21*, 279–308.
71. Deming's PDCA—I6sigma. Available online: https://www.isixsigma.com/dictionary/deming-cycle-pdca/ (accessed on 22 February 2019).
72. Chickering, A.; Gamson, Z. Seven principles for good practice. *AAHE Bull.* **1987**, *39*, 3–7.

73. Dalton, S.S.; Tharp, R.G. Standards for Pedagogy: Research, Theory and Practice. In *Learning for Life in the 21st Century*; John Wiley and Sons, Ltd.: Hoboken, NJ, USA, 2008; Chapter 14, pp. 181–194. [CrossRef]

74. Kolb, D.A.; Boyatzis, R.E.; Mainemelis, C. *Experiential Learning Theory: Previous Research and New Directions in Perspectives on Thinking, Learning, and Cognitive Styles (Educational Psychology Series)*; Routledge: Abingdon-on-Thames, UK, 2001.

75. Razmov, V.; Anderson, R. Experiences With Agile Teaching In Project Based Courses. In Proceedings of the 2006 Annual Conference & Exposition, ASEE Conferences, Chicago, IL, USA, 17 June 2006.

76. Kastl, P.; Romeike, R. Agile projects to foster cooperative learning in heterogeneous classes. In Proceedings of the 2018 IEEE Global Engineering Education Conference (EDUCON), Tenerife, Spain, 17–20 April 2018; pp. 1182–1191. [CrossRef]

77. Agilefant, a Lean Transformation Tool That Empowers Your Organization To Execute Change Faster. Available online: https://www.agilefant.com/ (accessed on 22 February 2019).

78. Valentin, E.; Carvalho, J.R.H.; Barreto, R. Rapid improvement of students' soft-skills based on an agile-process approach. In Proceedings of the 2015 IEEE Frontiers in Education Conference (FIE), El Paso, TX, USA, 21–24 October 2015; pp. 1–9. [CrossRef]

79. Elgueta, J.C. Methods agile and methodology A+S in the teaching of software engineering. In Proceedings of the 2016 IEEE International Conference on Automatica (ICA-ACCA), Curico, Chile,19–21 October 2016; pp. 1–6. [CrossRef]

80. Battou, A.; Baz, O.; Mammass, D. Toward a virtual learning environment based on agile learner-centered design. In Proceedings of the 2017 Intelligent Systems and Computer Vision (ISCV), Fez, Morocco, 17–19 April 2017; pp. 1–4. [CrossRef]

81. Reed, P. An Agile Classroom Experience. In Proceedings of the Agile 2008 Conference, Girona, Spain, 5–8 May 2008; pp. 478–483. [CrossRef]

82. Wainer, M. Using agile management to share course projects among multiple classes. In Proceedings of the AGILE 2006 (AGILE'06), Minneapolis, MI, USA, 23–28 July 2006. [CrossRef]

83. Pinto, L.; Rosa, R.; Pacheco, C.; Xavier, C.; Barreto, R.; Lucena, V.; Caxias, M.; Maurçio, C. On the use of SCRUM for the management of practcal projects in graduate courses. In Proceedings of the 2009 39th IEEE Frontiers in Education Conference, San Antonio, TX, USA, 18–21 October 2009; pp. 1–6. [CrossRef]

84. Benton, M.C.; Radziwill, N.M. A Path for Exploring the Agile Organizing Framework in Technology Education. In Proceedings of the 2011 Agile Conference, Salt Lake City, UT, USA, 7–13 August 2011; pp. 131–134. [CrossRef]

85. Kamat, V. Agile Manifesto in Higher Education. In Proceedings of the 2012 IEEE Fourth International Conference on Technology for Education, Washington, DC, USA, 18–20 July 2012; pp. 231–232. [CrossRef]

86. Manamendra, M.A.S.C.; Manathunga, K.N.; Perera, K.H.D.; Kodagoda, N. Improvements for agile manifesto and make agile applicable for undergraduate research projects. In Proceedings of the 2013 8th International Conference on Computer Science Education, Colombo, Sri Lanka, 26–28 April 2013; pp. 539–544. [CrossRef]

87. Layman, L.; Cornwell, T.; Williams, L.; Williams, L. Personality Types, Learning Styles, and an Agile Approach to Software Engineering Education. *SIGCSE Bull.* **2006**, *38*, 428–432. [CrossRef]

88. Chaiwut, N. Improve the accomplishment of project in PBL learning by using an agile method. In Proceedings of the 2014 Twelfth International Conference on ICT and Knowledge Engineering, Bangkok, Thailand, 18–21 November 2014; pp. 94–97. [CrossRef]

89. Anagnostopoulos, K.; Vakaloudis, A. Towards successful technical internships: An Agile-oriented training methodology. In Proceedings of the 2015 10th International Conference on Computer Science Education (ICCSE), Cambridge, UK, 22–24 July 2015; pp. 337–341. [CrossRef]

90. Kudikyala, U.K.; Dulhare, U.N. Using Scrum and Wikis to manage student major projects. In Proceedings of the 2015 IEEE 3rd International Conference on MOOCs, Innovation and Technology in Education (MITE), Amritsar, India, 1–2 October 2015; pp. 15–20. [CrossRef]

91. Isong, B.; Ifeoma, O.; Gasela, N. On the Integration of Agile Practices into Teaching: An Approach to Overcoming Teaching and Learning Challenges of Programming. In Proceedings of the 2015 International Conference on Computational Science and Computational Intelligence (CSCI), Las Vegas, NV, USA, 7–9 December 2015; pp. 264–270. [CrossRef]

92. Missiroli, M.; Russo, D.; Ciancarini, P. Agile for Millennials: A Comparative Study. In Proceedings of the 2017 IEEE/ACM 1st International Workshop on Software Engineering Curricula for Millennials (SECM), Buenos Aires, Argentina, 27 May 2017; pp. 47–53. [CrossRef]

93. Arora, R.; Sondhi, S. An Agile Approach for Engaging Students in Research and Development. In *Proceedings of the XSEDE16 Conference on Diversity, Big Data, and Science at Scale*; ACM: New York, NY, USA, 2016; pp. 51:1–51:4. [CrossRef]

94. Musarurwa, T.J.C.S.S. Students teaching students: A long-term, team based project. In Proceedings of the 27th International Conference on Computer Applications in Industry and Engineering, Markham, ON, Canada, 6–8 November 2017.

95. Grimheden, M.E. Can agile methods enhance mechatronics design education? *Mechatronics* **2013**, *23*, 967–973. [CrossRef]

96. Hefley, W.E.; Thouin, M. Evaluation of Experiential Learning in Scrum and Agile Project Management. In Proceedings of the Twenty-second Americas Conference on Information Systems, San Diego, CA, USA, 11–14 August 2016.

97. Saltz, J.S.; Heckman, R.; Shamshurin, I. Exploring How Different Project Management Methodologies Impact Data Science Students. In Proceedings of the ECIS, Guimarães, Portugal, 5–10 June 2017.

98. Fronza, I.; Ioini, N.E.; Corral, L. Teaching Computational Thinking Using Agile Software Engineering Methods: A Framework for Middle Schools. *ACM Trans. Comput. Educ.* **2017**, *17*, 19:1–19:28. [CrossRef]

99. Arimoto, M.M.; Barroca, L.; Barbosa, E.F. AM-OER: An Agile Method for the Development of Open Educational Resources. *Inform. Educ.* **2016**, *15*, 205–233. [CrossRef]

100. McAvoy, J.; Sammon, D. Agile Methodology Adoption Decisions: An Innovative Approach to Teaching and Learning. *J. Inf. Syst. Educ.* **2005**, *16*, 409–420.

101. Magana, A.J.; Seah, Y.Y.; Thomas, P. Fostering Cooperative Learning with Scrum in a Semi-Capstone Systems Analysis and Design Course. *J. Inf. Syst. Educ.* **2018**, *29*, 75–92.

102. Monett, D. Agile Project-Based Teaching and Learning. In Proceedings of the International Conference on Software Engineering Research and Practice (SERP), Las Vegas, NV, USA, 22–25 July 2013.

103. Yin, X.; Zhu, G.; Feng, L. Agile Team Learning Model Based on Fast Task Mining. In *New Horizons in Web-Based Learning—ICWL 2010 Workshops*; Luo, X., Cao, Y., Yang, B., Liu, J., Ye, F., Eds.; Springer: Berlin/Heidelberg, Germany, 2011; pp. 328–335.

104. Čepić, R.; Tatalović Vorkapić, S.; Lončarić, D.; Anđić, D.; Skočić Mihić, S. Considering Transversal Competences, Personality and Reputation in the Context of the Teachers' Professional Development. *Int. Educ. Stud.* **2015**, *8*. [CrossRef]