Modelling blended solutions for higher education: teaching, learning and assessment in the network and mobile technology era

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Stefania Bocconi & Guglielmo Trentin

Institute for Educational Technology, National Research Council, Genoa, Italy

Abstract

The aim of the article is to highlight the role of network and mobile technologies in enhancing the particular characteristics of blended solutions with a view to (a) potentiating/enriching the teaching/learning processes, (b) exploiting the varied opportunities it offers for their observability, and hence for their monitoring and formative and summative assessment.

The article will emphasise how this potential can only be captured by solidly integrating the process of instructional design with that of monitoring and assessment.

The first part of the article will present a proposed conception of blended solutions, giving examples. This preamble is considered necessary because, although there is apparent general agreement on the definition of blended solutions, differences are often evident in the conception of its details and application.

The second part of the article discusses a possible breakdown of blended solutions into its various components (onsite, online, individual and above all collaborative learning), so as to understand how their respective characteristics can be used to enrich/potentiate both the teaching/learning and the assessment processes. The role of network and mobile technologies in supporting and fully exploiting the special features of blended solutions will be explored using concrete examples.

The third part of the article will address the question of how to combine and/or use singly the various components of blended solutions, adapting them to the specific goals of the instructional path and to the activities, which are functional to the achievement of these goals. In other words, there will be a discussion of instructional design and of the planning of the monitoring system to be used in the formative and/or summative assessment of the teaching/learning process.

To conclude, implications for the implementation of blended solutions will be discussed, pointing out the need for a richer understanding of their key aspects and modalities in order to adapt them to emerging contexts and evolutionary models such as Massive Online Open Courses (MOOCs), as well as to adapt them to university students' needs and current learning practices.

Keywords: blended learning; network and mobile technologies; assessment; collaborative learning; instructional design; university teaching.

Introduction

Blended learning environments have grown rapidly over the last decade, and have probably become the "new normal" in university course delivery (Dziuban, Moskal, Kramer & Thompson, 2013). Although discussion of the precise meaning of the term "blended learning" is still ongoing (Kaleta, Skibba & Joosten, 2007; Graham & Allen, 2009), there seems to be widespread agreement that blended learning involves a combination of face-to-face and online learning (e.g. Stacey & Gerbic, 2008; Graham & Dziuban, 2008).

Generally speaking, definitions emerging from the existing literature focus on three main scenarios (Graham, 2013): (1) blending online and face-to-face instruction; (2) blending instructional modalities; and (3) blending instructional methods. Some definitions of blended learning also imply a reduction in face-to-face contacts in favour of online activity (e.g. Picciano, 2009).

Several authors also focus on quality implications (e.g. Smythe, 2012), highlighting the transformational potential of blended learning. For example, Trentin and Wheeler's (2009) definition requires that integration of online with traditional face-to-face activities occurs within a planned strategy, thus concerned with improving overall pedagogical quality.

Prominent models of blended learning in higher education (Graham, Henrie & Gibbons, 2013) seem to vary along the following 5 dimensions: *supplemental* (e.g. online materials and activities provided); *replacement* (how much of a course is taught face-to-face versus technology-mediated); *emporium* (e.g. offering on-demand personal assistance); *buffet* (students' choice of learning options); and *fully online* learning.

Emerging practices and research (e.g. Graham & Allen, 2009) also show variations in the rationales for adopting a blended approach in higher education contexts; these mostly concentrate on: effectively responding to students' current needs (Cavanagh, 2012); offering opportunities for personalised learning paths (Oh & Park, 2009); innovating university teaching (Trentin & Wheeler, 2009); increasing access for students and flexibility in terms of students' on-campus time (Cavanagh, 2012); impacting on student and faculty satisfaction (e.g. Wu & Liu, 2013); addressing sustainability issues and achieving greater cost-effectiveness (e.g. Trentin & Wheeler, 2009).

With traditional learning environments increasing the use of network and mobile technologies, the landscape of blended learning in higher education is now rapidly being transformed. By offering unprecedented opportunities for communicating, sharing, meaning-making, content and context generation, network and mobile technologies provide affordances that stimulate students' ability to operate successfully in, and across, different contexts, utilising their everyday life-worlds as learning spaces (Cook, Pachler & Bachmair, 2013). Thus, critical distinctions between onsite and online learning also become less predominant. Cavanagh (2012) terms this as the '*post-modality era',* where students are increasingly unconcerned with the distinctions between face-to-face and online learning, instead choosing individual courses that meet their particular needs at any given time, regardless of modality. At the institution level, Cavanagh also points out how meeting students' needs with institutional ecosystems that adequately support them and enable them to succeed will become a crucial component of university strategic plans (ibid, p. 227). For this to happen, Repetto & Trentin (2013) moreover highlight the need to investigate how the uses of network and mobile technologies, which have been autonomously acquired by students and teachers outside the school context, could be channelled towards new educational paradigms.

The present article aims to explore the roles of network and mobile technologies in facilitating the emergence of new blended learning scenarios (i.e. blended solutions) in higher education. The paper begins by defining key components of blended solutions.

The proposed definition of blended solution suggests a conceptual alignment for the further understanding of (1) the multifaceted nature of blended solutions, and (2) the role of network and mobile technologies within each component of the proposed blended solution model. Hence, there is an exploration of network and mobile technologies potential in enriching the teaching and learning process, as well as in enabling multiple perspectives on its monitoring and assessment. Guidelines for using the proposed blended solution components in the instructional design process are also suggested.

The various facets of blended solutions

It clearly emerges from the specialised literature that there are various ways of seeing blended solutions (e.g. Garrison & Kanuka, 2004; Graham, Woodfield & Harrison, 2013). The reason for this likely lies in the very concept of "blended", i.e. the mixing of different teaching approaches in the most varied of combinations when proposing learning activities aimed at the achievement of one or more educational goals.

In university teaching, many teachers believe that blended solutions are the most sustainable, since they offer the combined typical advantages of the different approaches that form them. Trentin (2008 - 2010) highlighted some of the reasons often leading to the adoption of these approaches, including the following opportunities for:

- *Recuperating classroom time in favour of greater interaction with students*, whenever possible delegating to teaching materials the explanatory role the teacher has often played in a face-to-face lecture. In other words, in class the teacher limits his/her explanation of what the student can study independently (explicit knowledge vehicled through handbooks, publications, videos), reinvesting the time gained in direct interactions with the students, either for further explanations and clarifications, or for transmitting his/her own particular professional know-how (non-explicit knowledge or in any case knowledge which cannot be vehicled through handbooks and publications). Consistent with this, Means and colleagues (2009) found evidence that students' opportunity for increased face-to-face time with the instructor during instruction results to be one of the significant moderating variables for effective blended learning. The primary findings of their study claimed that "classes with online learning (whether taught completely online or blended) on average produced stronger

student learning outcomes than did classes with solely face-to-face instruction" (ibid, p. 18).

- *Fostering structured collaborative learning processes*, which would otherwise be impossible due to lack of sufficient classroom time and/or physical spaces; in addition, thanks to the asynchronous nature of online communication, each student is given the chance to actively participate in the group study, according to his/her own study and learning pace. Moreover, researchers have argued that improved outcomes may have more to do with increased learner time on task in the BL environment (Sitzmann, Kraiger, Stewart & Wisher, 2006).
- *Reducing the number of face-to-face lectures*, for example, in order to help working students or students living far from the university, or finding solutions, albeit bland ones, to the problem of classroom availability.

As can be seen, in the first and second cases the choice is more of a pedagogical type, i.e. aimed at optimising classroom time, without necessarily reducing the number of face-to-face lectures; additionally, in the second case the intention is primarily to find solutions to logistic/organisational problems. However, available evidence shows that it is the pedagogical possibilities (i.e. by combining both the richness of interactions in a face-to-face environment and the flexibility, convenience, and reduced opportunity costs associated with online learning) enabled by the modality that can lead to students' satisfaction with blended learning options. In fact, recent research looking at over a million course evaluations across different course formats (Dziuban & Moskal, 2011) showed that the overall educational experience is what is valued by learners, and "modality does not impact the dimensionality by which students evaluate their course experiences" (ibid, p. 240).

Although the aspect of blended solutions which is normally most emphasised is the alternation between face-to-face and distance learning activities, the concept of "blended solution" actually refers to the integration of methods and teaching tools rather than to the space/time dimension. In fact, as already discussed, the concept of blended solutions is used to cover a mixture of various instructional approaches, either exclusively face-to-face or distance teaching or a combination of the two.

In this article, instead of emphasising the alternation of face-to-face and distance learning, and in order to underline the role of technologies in enhancing the particular

characteristics of blended solutions, the "onsite/online" learning terms are used as follows:

- *onsite learning* refers to the learning process which takes place in a physical space (a classroom lecture, a collaborative laboratory activity, study in the library or at home);
- *online learning* refers to an individual or collaborative learning process which develops instead in virtual spaces according to the canons of online education.

Having specified this, Figure 1 depicts a diagram within which the following can be combined in various ways: (a) *learning processes* (individual, collaborative); (b) *learning spaces*, i.e. the spaces within which learning develop (onsite, online); and (c) *teaching methods* (more directive, e.g. lectures, tutorials, drill and practice, etc.; less directive, e.g. simulations, problem-solving, project development, etc.) chosen for the achievement of the specific educational goals.

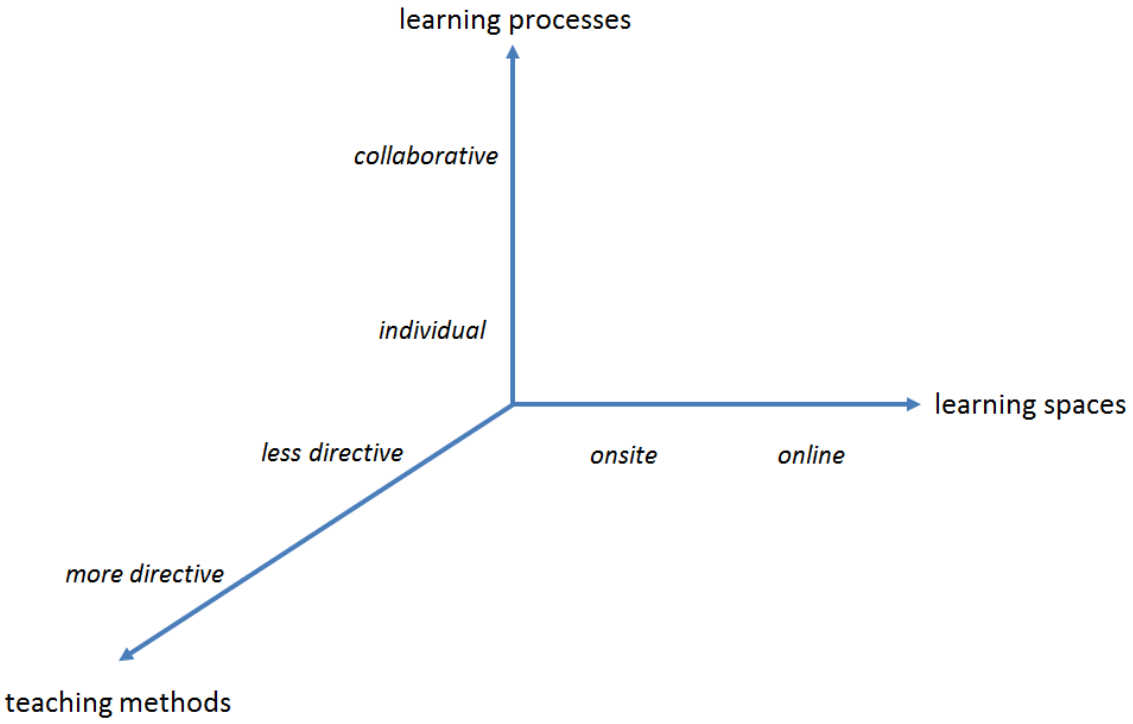


Figure 1. Three-dimensional space within which the blended solutions are developed

The plane, which most characterises onsite/online learning in this space, is the one defined by the *learning process* and *learning space* dimensions. Figure 2 attempts to give a visual representation of the different combinations which develop on this plane:

blended solutions derive from the intersection of the 4 circles related in fact to the learning spaces (*onsite/online*) and learning processes (*individual/collaborative*). It should be noticed that the blended solutions intersection (represented by the highlighted core area shown below) is time independent (i.e. implementing some individual and some collaborative learning elements, at different times).

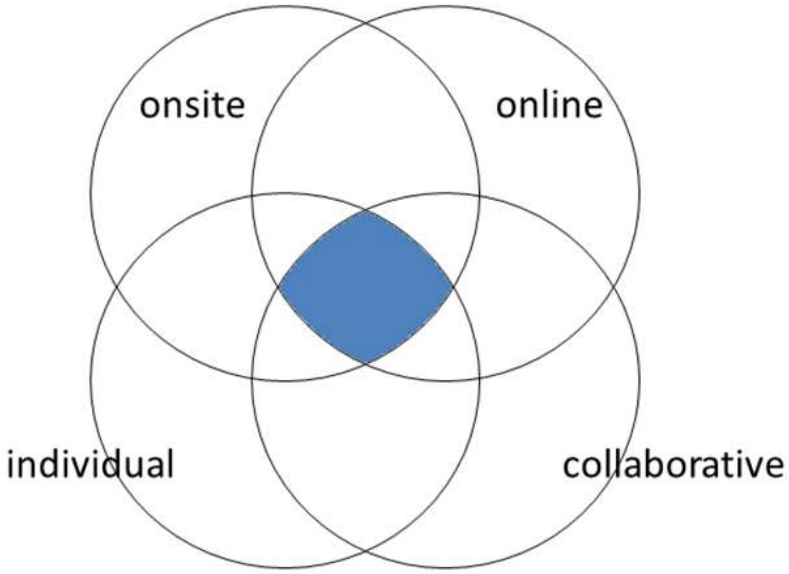


Figure 2. Blended solutions as the intersection of different combinations (at different times) of learning spaces and learning processes.

Actually, Figure 2 shows an idealised vision of blended solutions, but it is not always the case to deal with such a balanced combination of the different online/onsite components. There are in fact situations where online activities dominate and others where these are limited to rare moments in the educational path.

An example of the first case is the typical online course during which students go back to the classroom at particular moments of the course (e.g. introductory meetings; intermediate meetings; end-of-course meetings).

An example of the second case is the traditional face-to-face course sporadically integrated with online individual and/or collaborative study events, these sometimes being used to propose reflections on themes of the next face-to-face lecture, and sometimes, after the lecture, to stimulate thoughts about what has been presented in the classroom.

Still regarding the second case, it is useful to observe that online activity is not always limited to the time between one lecture and the next, but may extend over a

much wider timespan, being conducted in parallel to several classroom activities (Figure 3).

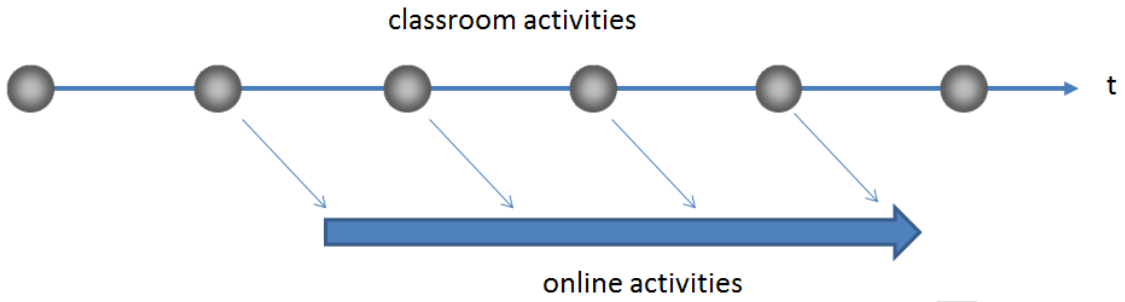


Figure 3. Integration between classroom activities and online activities in a blended solution.

This situation may occur when:

- students are assigned a complex task (e.g. collaborative development of an online document), whose completion requires an adequate length of time;
- a project-based educational strategy is adopted, in which classroom activities are aimed at providing the necessary knowledge for the development of an increasingly finely-tuned project, on a topic which runs through the whole or part of the course, and which gives students the chance to put such knowledge into practice.

Thus, the balance (in relation to the amount of activities) between online and onsite in blended solutions can vary considerably, strongly depending on the pedagogical setting. The creation of a blended solution must be based not only on an adequate integration of teaching methods and tools, but also on pedagogical consideration to complementary dose onsite and online components. For this, a good balance of onsite activities (face-to-face lectures, labs, discussion of online experiences etc.) and online activities (individual study, group activity, etc.) must be guaranteed in planning a course, in such a way that the former are functional to the latter and *viceversa*. For instance, firstly students can be invited to create an individual index for a mini-thesis (*onsite/individual activity*) and then guided to socialise the various indexes through group online cross-analysis and discussion in order to identify convergences and divergences (*online/collaborative activities*) (more examples are presented in the third part of the article).

In other words, onsite activities must help lay the foundations for a more effective development of the subsequent online activities, clarifying goals, assignments,

deadlines and expected results. In the same way, online activities must be organised so as to be functional (or even indispensable) to the next onsite meeting (Trentin, 2010).

After this foray into the various facets of blended solutions, the following sections of the paper will break down the Figure 4 diagram into its various components, in order to understand how their specific characteristics can be exploited for enriching/potentiating both the teaching/learning and the assessment processes, with the support of network and mobile technologies.

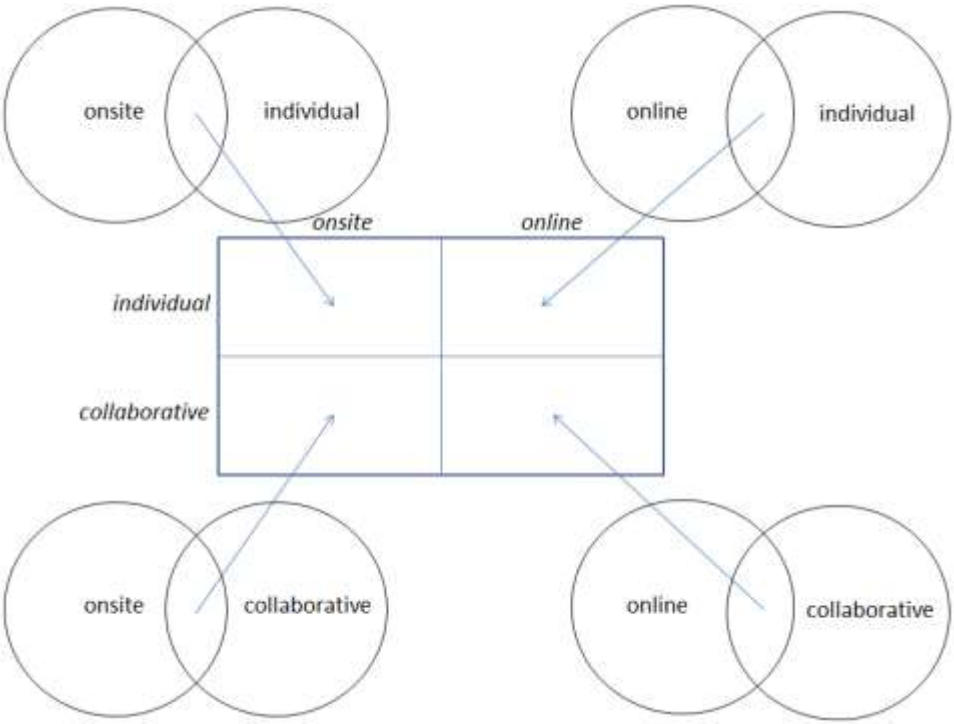


Figure 4. Matrix of the key components of blended solutions.

Implications of network and mobile technologies for teaching, learning and assessment processes in blended solutions

This section explores each component of the proposed blended solution model in order to reach a deeper understanding of their effective characteristics. To this end, each of the four quadrants depicted in Figure 4 is analysed in detail, looking at the implications of network and mobile technologies use for facilitating and enhancing teaching, learning and assessment processes in blended solutions in higher education.

The overall idea is that, in *onsite-individual* and *onsite-collaborative* components, mobile technology mainly serves as a generic "*information and communication space*" that amplifies knowledge sharing, while the learning process still takes place inside the physical space, at individual and/or at group level.

Accordingly, in *online-individual* and *online-collaborative* components, network and mobile technologies provide the "*learning space*" where the learning process actually takes place. Hence, the focus is on network and mobile technologies affordances that facilitate students' learning interactions with both the network of resource pools (i.e. online-individual) and the network of individuals (i.e. online-collaborative). Some practical examples taken from the university context are given below.

Blended Solution component 1: Onsite-Individual learning

This first component refers to the learning process that takes place at individual level in physical spaces (e.g. classroom, library, home). Both teachers and students use network and mobile technologies as means to amplify the information and communication process, thus improving and expanding opportunities for exchanging knowledge and contents.

From a teaching point of view, mobile technology can be used to collect on-the-spot feedback/insights on topics presented during traditional frontal lectures (e.g. through a specific Twitter 'hashtag') (Luckin et al., 2012). Thus all students are provided with equal opportunities to engage (i.e. inclusive teaching practice), according to their individual learning styles, and are enabled to assess their understanding of the concepts before leaving the classroom.

Additionally, as part of formative assessment, university teachers can use these data to track the on-going lectures and slightly refocus it so as to address certain questions posed by students (i.e. fill knowledge gaps); similarly, formative assessment might also take place among learners, as students may compare their (mis-) conceptions of the lecture. As ex-post evaluation, data can be used to detect students' misconceptions and propose more personalised learning plans.

Hence, use of network and mobile technologies allows teachers to increase the participation level of all students during traditional classes, as well as to optimise both range and time, gathering a wider set of data; in other words, network and mobile technologies (e.g. the Twitter-activity) help teachers to overcome the limitations of traditional onsite-individual learning settings (e.g. help to detect individual learning needs in large face-to-face classrooms), adding a collaborative or cooperative dimension to a typical individual learning setting.

More generally, from a learning point of view, network and mobile technologies can increase students' interaction and personalised contact time with teachers (Dziuban

et al., 2013), as well as offering them opportunities to access a greater variety of media-rich contents (Abrami, Bernard, Bures, Borokhovski, & Tamim, 2011), personally connecting to the topics discussed inside and outside formal learning spaces. A further example of this conception of onsite-individual learning is offered by flipped classroom models (e.g. Hill, 2012; Graham, Henrie & Gibbons, 2013), which empower students to learn at their own pace away from the teacher and to lead conceptual discussions when reconnected together in the classroom. The use of videos and other pre-recorded media allows lectures to be controlled by the students, who consume information in any place (i.e. onsite) and at any speed (watching, rewinding, and fast-forwarding as needed), thus also taking major responsibility for their own learning (i.e. self-learning) (Stacey & Gerbic, 2008).

Blended Solution component 2: Online-Individual learning

This second component deals with the learning process that takes place at individual level inside virtual spaces (e.g. immersive learning environments, remote labs, interactive simulations, etc.). Network and mobile technologies thus provide here the learning space where learning processes occur, also giving continuity to students' learning interactions activated in onsite contexts.

From the point of view of learning, network technology enables students to engage in real-time, hands-on experiments using instruments via remote online laboratories[1]. By means of an Internet browser and a user interface, students can observe the experimental conditions in real time and remotely control lab equipment (e.g. Gravier, Fayolle, Bayard, Ates, & Lardon, 2008). Conducting experiments motivates students and allows them to formulate hypotheses (i.e. inquiry-based learning), thus making learning more effective (Luckin et al., 2012). Hence, unlike conventional laboratories, remote labs enrich students' learning processes by vastly increasing the scope of experiments (see e.g. iLabs project at MIT which offers 24/7 access to extremely expensive tools[2]).

As regards teaching, network and mobile technologies allow university teachers to effectively support students' activity, for instance during remote lab sessions, by engaging them in dialogues to monitor their progress and understanding. As part of

[1] See for instance the PR2 remote lab on robotics http://pr2-remotelab.com,or the NASA Mars Curiosity simulator http://mars.jpl.nasa.gov/explore/freedrive/

[2] https://wikis.mit.edu/confluence/display/ILAB2/Home

summative assessment, teachers can evaluate students' progress by sharing their interface view or listening in on their audio recordings (Brindley, Walti & Blaschke, 2009). Hence, network technologies offer opportunities to track students' complex activities, by collecting a wide range of data about their decisions and action modes in remote learning environments.

Blended Solution component 3: Online-Collaborative learning

This third component concerns the learning process that takes place at community level in virtual social spaces (e.g. social media, CVE- collaborative virtual environments, CSCL systems, etc.). The focus is on network and mobile technologies uses facilitating online interactions and interrelations among individuals.

From a teaching point of view, network and mobile technologies can enable teachers to perform quality management and monitoring of on-going processes inside the learning community. As the collaborative learning takes place online (thus the process can be captured and made "transparent" by the use of network technologies), teachers can monitor groups' activities regularly and closely, providing timely and continuous feedback when necessary to prevent groups from getting stalled or going off topics. This type of formative evaluation helps students develop specific skills and deepens their learning process (Brindley et al., 2009).

From a learning point of view, network and mobile technologies can support and improve students' online collaboration aimed at the co-creation of common artifacts to meet certain learning objectives throughout the process (i.e. project-based collaborative learning) (Deal, 2009; Trentin, 2010). For instance, wiki technologies help promote students' discourse and a sense of group purpose in learning (Neumann, 2012), providing adequate means for facilitating co-construction processes such as collaborative writing, and giving students equal rights and responsibilities for developing page content, starting discussions about the content of a page, tracking any changes over time, and restoring previous versions if needed.

Network and mobile technologies can also increase students' self-help dynamics, by amplifying groups'/individuals' reciprocal interactions for supporting one another in the application of what they have learnt and for sharing solutions and strategies for the use of the new acquired knowledge.

As part of summative assessment, network technologies can improve university teachers' opportunities to monitor and assess three key aspects of collaborative learning: students' *collaboration process*; group *final product*; and individual students' *learning*

outcomes (e.g. Swan, Shen & Hiltz, 2006). Objective data automatically traced by network and mobile technologies (e.g. number of messages, network analysis views of social relationships) can be combined with subjective data (teachers' evaluation, peer evaluation conducted inside the learning community), thus allowing conclusions to be drawn about the collaborative process, regarding both the individual student's and the group's contribution to the community (Trentin, 2009).

Generally speaking, evaluation of the process also provides useful information about the pedagogical design of the course and its efficacy.

As for the assessment of students' final products, this includes the quality of both the contents and the overall structure (i.e. internal consistency and relevance of page interconnections, of concept maps). Thus, the choice of a specific network technology (e.g. wiki environments) can impact on the quality of a final product by increasing opportunities to create a richer network of meaningful connections among concepts that would not be possible with other tools.

Finally, regarding the assessment of learning outcomes, which mainly involves teachers' subjective evaluation of students' learning, network and mobile technologies can support teachers' analysis of certain elements (i.e. those emerging from the recording of students' conversations and debates), including the appropriateness of the terminology used and the quality of their argumentative discourse, thus assessing their ability to present well-grounded arguments (Bocconi, 2012).

Blended Solution component 4: Onsite-Collaborative learning

This fourth component refers to the learning process that takes place at group level in physical spaces (e.g. in- and outside-class, library, home). Both students and teachers use network and mobile technologies to support and amplify knowledge exchange at group level, thus moving communication and collaboration outcomes out of the physical-local context in which collaborative learning takes actually place.

From a teaching perspective, network and mobile technologies can facilitate the organisation and management of in-class interactions, by allowing teachers to automatically collect and organise data and to return immediate feedback to students' group discussions. For instance, network technology allows a real-time Delphi-like approach, facilitating teachers' real-time calculations and visualisation of students' replies. In the process of completing this group task, students are invited to reflect upon a proposed concept/problem and send their own definition/solution to the teacher. Teachers automatically process groups' data and in real time return an overview table

including all replies, inviting students to review other groups' definitions and to modify the initial one if they feel it is needed.

Network and mobile technologies allow adoption of similar approaches even in large classes, where they can also be used as warm-up activities to force students to think through the arguments being developed, increasing their engagement and active participation in peer instruction processes (Smith et al., 2009).

In summative assessment, network and mobile technologies can help teachers to collect evidence of the learning processes that occur during in-class (onsite) group discussions, also providing means to compare students' knowledge over time and to monitor their learning progress (i.e. the learning curve).

In conclusion, the common theme emerging from the analysis of each component of the blended solution model is the need to consider what pedagogical practices are made possible by network and mobile technologies use, in order to adequately conceive and design the bridge between *learning spaces* and *learning approaches* and thus move towards a structured and sustainable blended solution.

A guideline for planning the use of the various components of blended solutions

After having broken down the proposed blended solution model into its various components, and discussed how to exploit their respective particular characteristics with the support of network and mobile technologies, this section depicts the reverse procedure, i.e. different ways of recombining these components into a blended solution, adapting them each time to both the chosen teaching/learning and formative or summative assessment processes.

It should immediately be pointed out that these two processes (teaching/learning and assessment) must necessarily interact with each other. In other words, when planning the teaching activity there is the need to make sure that the path to be followed by the students is both "observable" and "traceable", so that useful information for the assessment process can be gathered from their individual and/or group actions.

The assessment process may concern: the *individual student* (e.g. levels of learning, of active contribution to group work etc.); the *products* developed during the proposed activities (artifacts, problem-solving, exercises etc.); the *teaching process* used by the teacher to achieve the declared goals.

By “observable” is meant any activity which can actually be observed by the teacher, such as a forum discussion, allowing conclusions to be drawn not so much (or not only) about each individual student’s level of active participation, but also about their way of using the subject-specific terminology, their way of arguing their opinions and/or their choices, etc. These are very important elements for helping the teacher understand what progress the students are making in the acquisition of subject-specific knowledge or transversal knowledge (group work, correct manner of expressing oneself, arguing one’s opinion etc.).

By “traceable” it is meant any activity that leave “digital traces” which can be analysed asynchronously by the teacher Take for example the outcomes of an online test, or the above-mentioned forum. Besides being observable, this is also traceable, in the sense that it leaves a written trace of the various interventions which can be read afterwards by the teacher and assessed according to the level of active contribution to the discussion. Figure 5 shows the learning path and the related traceable/observable activities analysed in different moments in time (axis *t*) for assessment purposes.

Other digital traces, which are useful for assessment purposes, are those recorded by the social media, for example the chronology of the modifications of a group-generated document (e.g. a wiki); this allows analysis of the series of modifications made by each student and their level of contribution to the co-construction of an artifact. Moreover, the traceable learning path might also be an opportunity for student’s individual formative assessment, enhancing metacognitive skills of the learner by ‘reviewing’ the steps of his/her own individual learning path.

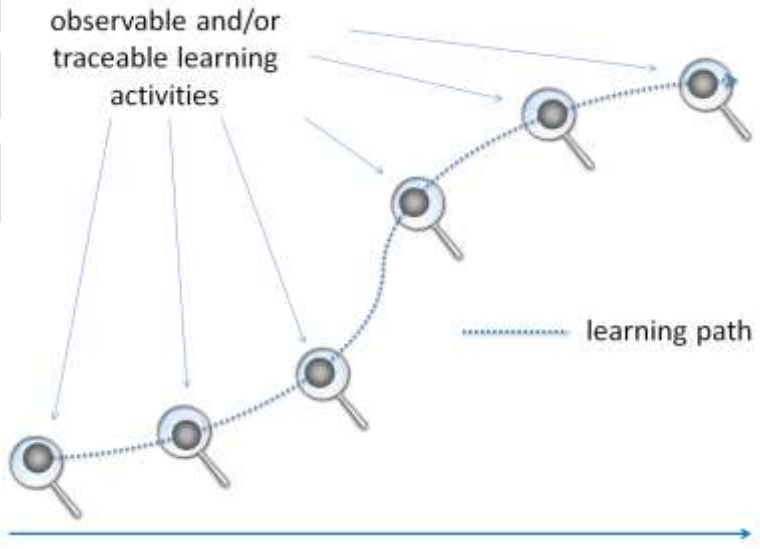


Figure 5. Observability and traceability of the learning path in different moments in time for assessment purposes.

At this point it is clear that the instructional design phase cannot be separated from that of the monitoring system (and more generally of the assessment process), in order to fully exploit the possibilities offered by the observability and traceability of the students' actions for the assessment of either the learning process or the blended solution itself.

So in planning a blended solution, it is good practice to choose the best combination of its components bearing in mind both the goal to be achieved and the method to be used for assessing its achievement.

In this sense, the design approach should indeed be reversed, i.e. first establish the monitoring system which is functional to the assessment, then construct the teaching activity in such a way as to favour the collection of the data and information which will feed said system.

This is the approach in fact followed in the "Polaris" (Trentin, 1999 - 2001 - 2010) instructional design methodology, developed within the project of that name for the online training of school teachers, and subsequently refined in web-enhanced learning projects in several Italian universities (Repetto & Trentin, 2011).

The key point of this methodology is a clear, unequivocal definition of the objectives; from this, the ways of assessing their achievement are first derived, then the teaching activities are structured so as to create the above-mentioned observable and traceable path. In the following, the planning phase according to the Polaris methodology is discussed in details.

As discussed above, the starting point of the whole methodology is meticulous definition of the learning objectives and their structuring. Learning objectives correspond to a detailed, structured list of expected learning outcomes. Therefore, each objective must be accompanied by an explicit statement of what the student must know or be able to do with respect to the corresponding learning topic.

Proper definition of objectives has a strong impact on subsequent steps in design, and especially on the mechanism used to evaluate both the course as a whole and learning in particular.

The way objectives are formulated should hint at the mode to be used for gauging their achievement.

It is useful to distinguish between general objectives applicable to, say, a course module, and the specific objectives of a *learning unit* or part thereof. Objectives can be

structured in a variety of ways, including arrangement in a taxonomy (Bloom, 1956) or in a hierarchy of main and subordinate objectives (Gagné, 1970).

The Polaris model features a combination of these two approaches, i.e. objectives arranged in a hierarchy and described using action terms derived from Bloom's taxonomy. This combination is illustrated below in Figure 6.

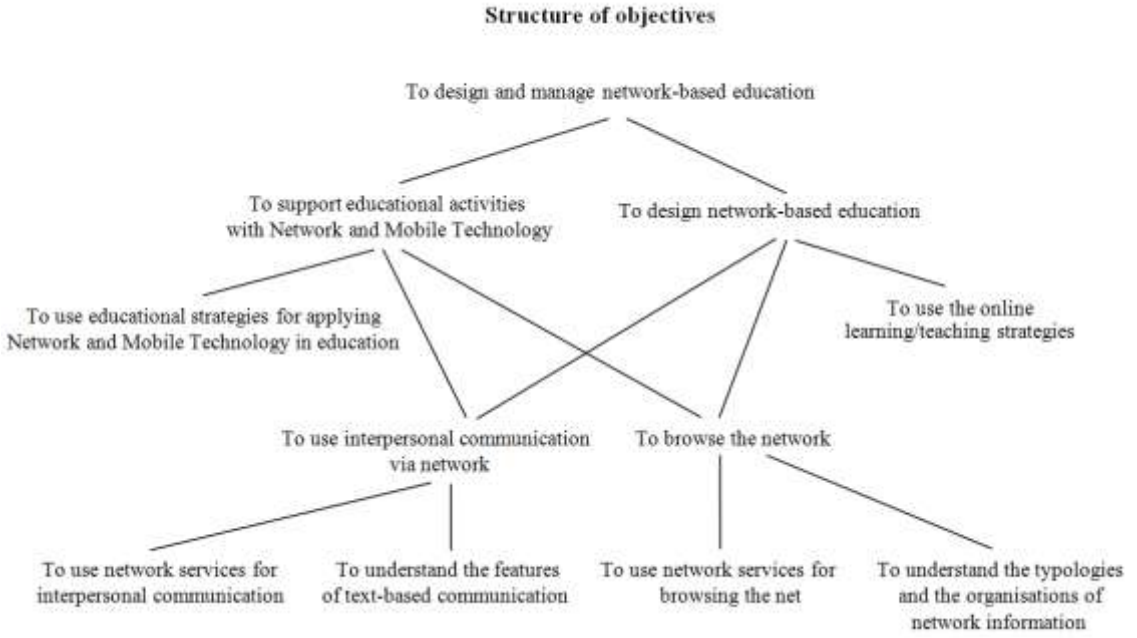


Figure 6. Structuring the objectives of a course on network-based education

One last observation on this phase is needed. Following the preliminary definition of objectives, it is advisable - before moving on to the subsequent steps in the design process - to stop and ask oneself how achievement of each single objective is to be evaluated (Trentin, 2001).

It is an extremely efficient test, which provides important feedback about the coherence of the structuring/definition of the objectives and about what assessment tasks to set for the objective and/or subjective measurement of their achievement. This is in line with the commonly-held belief that the key elements for defining assessment measures should emerge from the act of formulating the objectives themselves (Rowntree, 1981).

These points are a clear indication of just how important the formulation and structuring of objectives is within instructional design, and also of the impact that this crucial aspect can have on other elements. Indeed, definition of objectives can be seen as the starting-point in a circular design process that links assessment, content definition

and identification of learning methodologies for reaching expected learning outcomes (Figure 7).

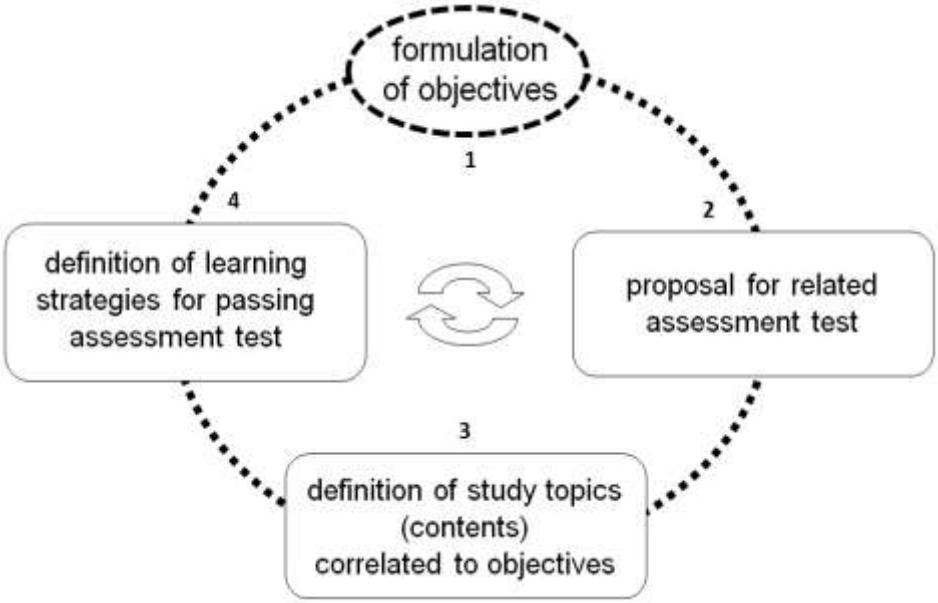


Figure 7. Formulation of objectives as a reference point in instructional design

As shown in Figure 7, the logical sequence should be as follows:

(1) formulate an objective using clear, unambiguous action terms (e.g. "know how to solve first-degree equations");
(2) identify an effective means for evaluating achievement of that objective (e.g. "set first-degree equations");
(3) define contents suitable for studying the topics related to the learning objective;
(4) define a learning strategy suitable both for the study of those contents and for passing the evaluation task outlined in point 2 (e.g. theoretical study and guided exercises for solving first-degree equations).

Although this sequence may appear obvious, it does not appear to be widely adopted in practice. At least this is the impression one gets from the all-too-frequent clashes between the way learning activities are proposed and the way they are evaluated.

Table 1 shows examples of some possible combinations of: (a) teaching objectives formulated according to Bloom; (b) annexed assessment modality, for gauging their achievement; (c) onsite and/or online activities to propose to the students. In the "Contents and Activities" column in particular, examples of the various components discussed in the previous section are shown.

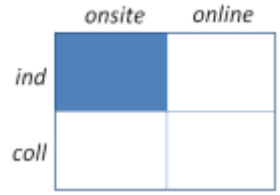
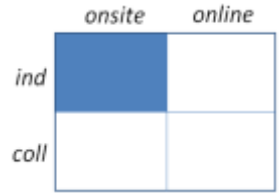
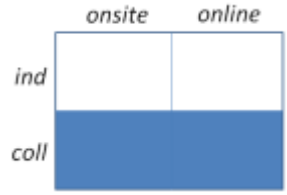
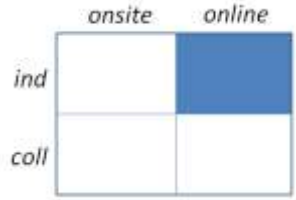
Table. 1 – Possible relations among objectives, assessment strategies, contents/activities in blended solution design.

1. Objective		**2. Assessment**	**3-4. Contents and Activities**
Knowledge	Ability to evoke knowledge	Objective-assessment tests	Individual onsite study with online support (teacher, self-help)
Comprehension	Ability to re-use acquired knowledge	Subjective-assessment test of re-use	Conceptualisation through maps (individual onsite or online)
Application	Ability to re-apply and re-use acquired knowledge to solve new problems	Problem solving	Application of knowledge to a practical case (individual onsite problem-solving, upload of an individual document)
Analysis	Ability to separate the elements, identifying the relations between them	Assessment of the elements considered and of the analysis conducted on the basis of these elements. Assessment of the arguments used in conducting the analysis	Creation of analysis grid and application of it to other group members' documents; formulating an individual opinion, also with reference to one's written document (e.g. online forum or wiki activities)
Synthesis	Ability to combine elements to form a new organised coherent structure	Assessment of: (a) final product using predefined criteria; (b) transversal skills (e.g. ability to work in a team, ability to communicate effectively, etc.); (c) active participation	Agreement on a single group product starting from individual analysis (group discussion and collaborative online production, e.g. of a wiki)
Evaluation	Ability to formulate critical judgments of value and method	Assessing the arguments on which the critical judgment is based	Online peer-review of the documents of the different groups (e.g. cross-revision of the wiki page using its "comments" function)

The table was found to be a useful reference tool in designing a blended solution for an online university course (Trentin, 2007a - 2007b). This was mainly conducted online but included some classroom sessions.

The aim of the adopted blended solution was the collaborative development of a synthetic document (i.e. final product) on the theme "Network Technology and Knowledge Flow", a kind of mini-thesis aimed at helping students prepare the final exam. In Table 2, the left column shows the various steps in the script of the activity proposed to the students; the right column shows the quadrants of the blended solution model described earlier, into which the various activities fall.

Table 2. – Scripts stages and related blended solution model components in "Network Technology and Knowledge Flow" course.

Script stages	***Quadrants of the blended solution model***
Classroom lectures and individual study of course contents (*knowledge).*	
Individual development of a conceptual map which highlights what students consider to be key topics, as well as connections between them; socialisation of the various maps and subsequent classroom discussion of them (*comprehension*).	
Individual creation of index for the mini-thesis based on the above representations (*application*).	
Socialisation of the various indexes, group online cross-analysis and discussion of indexes in order to identify convergences and divergences (*analysis*).	
Online discussion aimed at defining a single version of the index agreed on by each group; socialisation of the various indexes produced by the groups and teacher-moderated discussion (in the classroom) aimed at agreement on a single version of the index; final synthesis of the various indexes prepared by the various groups (*synthesis).*	
Development of wikis using a parallel type of collaborative strategy (division of labour), which involves each student developing a section of the overall document. During this activity each co-writer is asked to constantly check the development of the other sections of the wiki, both to avoid repetitions (pages with similar contents) and to identify connections between their own page and those of the co-writers.	
Once the different sections of the shared document have been written, the co-writers are asked to peer-review all the pages and suggest to their colleagues how to integrate and improve their respective texts *(evaluation).* In this case, the aim is to encourage interaction between the author (the co-writer who generated the page) and the users (all the other co-writers accessing it) on the chosen subject. This interaction is facilitated by the "comments" function associated with each wiki page, through which short dialogues can take place among the different co-authors/users of the hypertext.	

The choice of using a wiki to support the blended solution described above is justified by the various possibilities that the tool offers for observing and tracing students' activities (versioning of the pages, discussion in the "comments" box or associated forum, tagging, creation of a viable links network, etc.). These possibilities can be

effectively exploited to carry out activities of monitoring and assessment, not only of the final product, but also of the process which has led to its production, and of the level of participation and active contribution of the single members of the work group (Trentin, 2009). Limitations of the proposed technology for the described settings includes that wiki environments still require refinement, especially to automate parts of the quantitative analysis of the actions performed by members of the learning group, thus reducing the time and manpower demands of the surveys and processing (ibid, p. 50).

Conclusions and recommendations for implementing blended solutions using network and mobile technologies

This article has proposed a possible approach for the modelling of blended solutions centred on the use of network and mobile technologies and aimed at improving teaching, learning and assessment processes in higher education. The proposed high-level view model is composed of four key components: *onsite-individual* learning, *onsite-collaborative* learning, *online-collaborative* learning and *online-individual* learning.

Given the recent widespread diffusion of network and mobile technologies, there is a need to rethink and redefine traditional conceptualisations of blended solutions (originally seen as hybrid combinations of face-to-face and distance learning), and to devise a more flexible and organic learning continuum which takes full advantage of the network and mobile technologies support.

By bringing online dynamics into onsite settings, mobile technologies are changing how university students perceive and participate in learning, i.e. they tend to select learning opportunities that fulfil their needs at any given time, regardless of modality.

Thus it becomes urgent to gain a deeper understanding of the implications of network and mobile technologies uses for teaching, learning and assessment in onsite/online learning spaces, carried out at individual and community level. The focus is on network and mobile technologies as these technologies amplify the interpersonal communication and collaboration aspects, as well as offering functions, which facilitate observation and tracking of the teaching/learning processes; this can also be used both for assessment purposes and for managing the quality of the process itself.

Being fully embedded in current students' practices, network and mobile technologies become important for teaching, learning and assessment processes, as it has emerged from the discussion developed in the present contribution.

Two elements are held to be essential for the effective application of the proposed model:

1) *good design* of the blended solution, taking into account the particular features of each component and adapting them to the stated learning objectives;
2) teachers' awareness of their changing role in the *management of the blended learning process*.

Regarding the first point, skill in designing the blended solution, this implies finding the right mix among possible components, thus effectively combining a number of teaching approaches that can be formal and informal, directive and discovery-oriented, based on technology and social interaction, and on online and onsite collaboration. To this end, it is therefore beneficial to start out with a clear definition of the educational objectives and then identify the most effective teaching activities and strategies for achieving each of them in turn.

Accordingly, a fundamental recommendation is to adopt instructional design criteria oriented which are towards blended solution, and which at the same time integrate approaches for 'designing classroom activities' with those for 'designing network-based education', also taking into account the specificities, potentiality and criticality of the technological media intended to be used (Trentin & Repetto, 2013). For example, during course planning a good balance should be guaranteed between onsite activities (face-to-face lectures, laboratory, discussion regarding occurrences online, etc.) and online activities (individual study, group activity, etc.), in such a way that each one is functional to the others.

However, many studies indicate that teaching blended courses is disruptive and imposes challenges at many levels across higher education institutions, including teaching de design (e.g. Samarawickrema, 2009). Indeed, teachers are by nature primarily experts in their subject and their pedagogy is generally "spontaneous" and related to their direct experience, refining their own style of managing the learning/teaching process. Although this "spontaneity" may even be acceptable in classroom teaching, the adoption of blended approaches automatically entails teachers acquiring the fundamental notions of instructional design (Repetto&Trentin, 2011).

In this way they can plan the most effective blend of approaches to achieve the stated learning objective, using both technology mediation and face-to-face interaction. This does not imply that adopting a blended approach requires teachers to become professional instructional designers, because they will still be required to be experts and teachers in their field. Nevertheless, if teachers are prepared to undertake the design, development and running of blended-type teaching activities, there will be greater improvement in the quality standard of the corresponding learning/teaching processes.

This leads to the second essential element mentioned at the beginning of this section, that is raising teachers' awareness of their changing role (Trentin, 2013), from teaching to *b-teaching.* In order to integrate blended solutions into their teaching practices, teachers must change their attitude to teaching, shifting from a vertical model of knowledge transmission to a more horizontal one, based on collaborative processes as well as individual study. The teacher's role continues to be a central one, even if it is now rather as facilitator of the process than as mere dispenser of knowledge.

With this point of view, the nature of the teaching/learning process inevitably undergoes radical changes, as does the student/teacher relationship. The teacher becomes a less authoritarian figure, closer to the role of class intellectual resource, as well as facilitator of student activities. This situation tends to attenuate the authority dynamics, which have traditionally existed in the classroom, and constitutes an undoubted opportunity for enriching the teacher/student relationship.

Thus, blended solution requires both teachers and learners to take on different roles and responsibilities from those of a traditional teaching-learning approach. Teachers who intend to adopt blended solutions in their practice therefore need fully to understand the philosophy underlying the concept of blended solution and the paradigm shift it involves; above all, in fact that blended teaching concentrates on the relationship among learners, as well as on the relationship between learners and the knowledge to be acquired. Students are helped to be more autonomous, proactive and responsible towards their own learning processes.

In this regard, the term "blended teaching" is used here to indicate the function that teachers perform not only in the context strictly connected to the use of network and mobile technologies, but also in a more general sense, when they organise and manage learning paths where 2.0 resources take on differing roles according to the different educational approaches adopted, i.e. ranging from being essential to being more modestly a simple support which is useful but not necessarily indispensable.

Recent Massive Open Online Courses (MOOCs), which integrate onsite and online, individual and collaborative, are an example of the proposed blended solution model, and in fact reinforce perception of the need for the two key elements identified above (i.e. micro-design of the process and materials, and blended teaching). In MOOCs, students mainly learn by making connections among media-rich resource pools and by communicating and collaborating with others (e.g. Conole, 2013). All the blended solution components discussed in the present contribution are in place.

In the novel MOOC contexts, network and mobile technologies offer a twofold opportunity to improve university teaching and learning processes: on the one hand, the creation and development of media-rich contents, such as micro-videos that address multimodal communication strategies (e.g. creating presentations with the text in front and the video in background) and the integration of interactive sections to actively engage students. In creating these educational materials, teachers refine contents for accuracy and fluidity, thus improving the efficacy and cognisance of educational resources that support *onsite-individual* learning. On the other hand, given the large number of MOOC participants, teachers' strategies for monitoring and managing learning interactions also change towards more "distributed" and peer-instruction teaching (e.g. Smith et al., 2009), scaffolding students' participation.

From a learning perspective, network and mobile technologies in MOOC settings amplify two key aspects of collaborative learning practices: *students' peer-assessment abilities* and *self-help dynamics*. Due to the impossibility of teachers' evaluating and assessing complex, open-ended assignments for courses with tens or hundreds of thousands of students, peer grading strategies are adopted in MOOCs to provide students with on-time and adequate feedback; by reviewing peers' work (usually following review criteria and grids provided by teachers), university students not only learn to identify critical and positive elements, but also improve self-assessment abilities. Additionally, while in traditional (and closed-community) online courses, collaboration mainly focuses on collaborative production of project artifacts, in the MOOC online format collaboration is mainly encouraged through students' self-assistance practices (Hill, 2012).

To conclude, in line with the learning needs arising from the newest pedagogical settings like MOOCS, the proposed model brings blended solutions in line with students' real current network and mobile technologies uses, by mixing the different

components to form a continuum which shifts between individual and collaborative, online and onsite learning.

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