Technology & Education: adaptation of TPACK (Technological Pedagogical Content Knowledge) model in the LMS (Learning Management System) adopted by CIHEAM-IAMBa

Onofrio Lorusso, *Luigi Sisto*, *CIHEAM – Mediterranean Agronomic Institute of Bari, Italy*

ABSTRACT. The LMS seems the most favourable solution for the application of different but complementary types of knowledge useful for technology-based instruction. To test this assumption, the TPACK model (http://www.tpack.org) was applied to the LMS adopted by CIHEAM – Mediterranean Agronomic Institute of Bari (IAMB) after a ten-year experience of E-Learning focused on the "collaborative" approach. Based on the experience carried out by MAIB, it results that the selected LMS (Claroline) is compatible with the philosophy expressed in the TPACK model, as it is equipped with appropriate tools to meet the teacher's needs in the application of the pedagogical knowledge (PK), content knowledge (CK) and technological knowledge (TK). Moreover, in this article, the above knowledge is identified and localized in the selected platform to understand whether and how is the TPACK model suitable for this particular environment.

KEYWORDS: Collaborative approach, eLearning environment, Learning Management System, Technology-based instruction, TPACK model

Objectives

Some research studies on training techniques look at the diversity and blend of knowledge and skills as an advantage. This is the case of the studies conducted on the TPACK model. In this article the above model is applied through the Learning Management System to the IAMB E-learning system. The assumption is that this model can be adapted to the applied technological solution for its

configuration and structure, and that both may be compatible in collaborative learning environments.

Efforts shall be directed towards finding the relations between the functional characteristics of the technological tool and the actual problems to solve in relation to pedagogical, content and technological issues. Can an LMS platform work as a valuable tool to develop the above model for the delivery of e-learning courses? It will be interesting to observe whether and how, through the use of an LMS, in this environment you achieve the symmetry of the three components (TK-CK-PK) of the model considered (Figure 1). The above components, identified and adequately framed in different platform tools, could redesign theoretically a new symmetry of the TPACK model following the IAMB E-learning experience.[1] This Institute, which has worked for many years in Distance Learning, has chosen the (LMS) Claroline platform (www.claroline.net) as a response to methodological, multilinguistic and sustainability needs. This choice satisfies appropriately the proposed educational method and user-friendliness and favors the individual's motivation through a grounded cognitive approach.

The TPACK model

Following some researchers of the Michigan State University the model is based on the knowledge required for teaching. Teachers should effectively integrate the technological knowledge (TK) with content knowledge (CK) and pedagogical knowledge (PK). The focus is on the teacher's heterogeneous knowledge in a theoretical "TPACK" balance. This model is graphically represented as the intersection between the TK-CK-PK areas (Figure 1). Therefore, the interweaving of this knowledge generates different knowledge. For example considering and intersecting pedagogical knowledge (PK) with content knowledge (CK) we obtain an area (PCK) that explains how particular topics, problems or issues are organized, represented and adapted to the diverse interests and abilities of learners, and presented for instruction (Shulman, 1987, pp. 1 - 21).

1. www.iamb.it

Figura 1. TPACK Image
Source: http://tpack.org
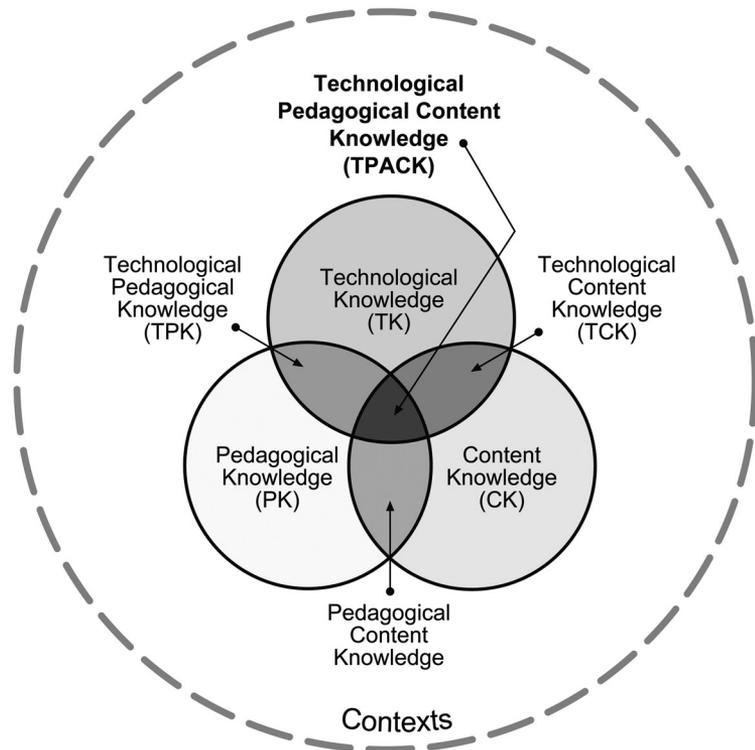
In the same way considering TK and CK we obtain new knowledge (TCK) between technological and content knowledge. Similarly, if we examine the intersection of TK and PK, i.e. technological and pedagogical knowledge (TPK), we highlight the various technological solutions oriented to learning.

TPACK describes the intersection of the three forms (technological, pedagogical and content) of knowledge, perfectly integrated in a new "composite knowledge". There is an ample literature dealing with the integration of different forms of knowledge in education. The TPACK model is not a new idea and is supported by scholars who are aware of the importance of interdisciplinary knowledge applied to training. The TPACK model has been detailed in *Technological Pedagogical Content Knowledge: A Framework for Teacher knowledge* by Punia Mishra and Matthew J. Koehler, result of previous articles of the same authors supported by others such as: Kathryn Hershey,

Lisa Peruski, Aman Yadav and Kurnia Yahya. Therefore the TPACK model is the result of shared efforts. For a good understanding of the model, we propose hereby a short description of the three primary forms of knowledge: content (CK), pedagogical (PK) and technology knowledge (TK).

Content Knowledge (CK)

Content knowledge (CK) is knowledge about the actual subject matter that is to be delivered, either learned or taught. This requires that the study material be structured and elaborated in relation to the degrees of difficulty (whether for high school or a graduate course), the context (geographical area, type of learners, language, etc.) and the subject matter (mathematics, physics, art history, agriculture, computer science, etc.). Clearly, teachers must know and understand the individuals who make up the class, and should be ready to apply effective theories and procedures for learning. Also, they should be able to organize contents through reasoning and appropriate structures to connect ideas (conceptual maps). Teachers should estimate the difficulty of the subject matter for learners and thus envisage education pathways of varying degrees of difficulty based on pre-established teaching objectives.

Pedagogical Knowledge (PK)

Pedagogical knowledge (PK) is deep knowledge about the practices or methods of teaching. This knowledge enables planning education programs based on the pre-established objectives (teaching). This is a form of knowledge that is involved in all issues related to student learning, classroom or virtual environment management, lesson plan development and implementation, and the methods and measures for student evaluation. The teacher evaluates and is constantly informed about the skills acquired by the single student and the whole class (monitoring). He knows the techniques or methods to be used in the classroom, the reference target and the strategies for student assessment (docimology). A teacher with a pedagogical approach should know how do students construct knowledge and acquire skills (cognitive style). Therefore, pedagogical knowledge is based on the awareness of how important cognitive and social aspects are for the implementation of successful strategies. A topical example is the use of effective strategies for on-line teaching via the Internet (E-learning 2.0).

Technology knowledge (TK)

Training does not make full use of the available technology, it often uses it only partially without contextualising it. The combination of technology and training necessitates much greater efforts from teachers who should calibrate the tools required for an effective and captivating enjoyment of teaching. Technology knowledge (TK) facilitates the use of all the communication technologies that can "abolish" both space and time. Current technologies, however, require good knowledge about the use of different tools such as computers, tablets, telematic networks, etc. The teacher is necessarily involved in specific computer skills which can be increasingly integrated in the training activity. Hence, it is essential to get familiar with the operating systems and the use of different software such as: office automation, database, browser and e-mail. TK also includes the ability to connect electronic devices or to install and remove software, create and archive documents, etc.

Overview of the LMS

A Learning Management System (LMS) or Learning Support System (LSS) is a web system (platform) designed to enable whoever is involved in a learning process, running as well as enjoying courses. Services generally include the access control, the communication (synchronous and asynchronous) tools and the platform administration. Moreover, tools include groups' management, evaluation systems and learning pathways. Most of these systems have different internal test generators (true/false, multiple choices or single answers, completion, by combination) that are valuable assessment and self-evaluation tools. This is all ensured by interchange SCORM standards.
This technology includes all the tools required to develop useful activities for different functional profiles: teacher, student, tutor, managers, and it gives the possibility to create or modify various user profiles according to the platform operating concessions.

Therefore by an LMS it is possible to:

- Host the instructional multimedia contents;
- Control access to resources (Monitoring);

- Offer pedagogical activities related to communication and socialization (for instance forum, chat, announcements, etc.);
- Enable tutoring activities;
- Facilitate teaching activities;
- Manage users' community;
- Implement documents associated with training (for example readings and documents for complementary and in-depth analyses).

Based on the above properties it is possible to implement:
- Features of archive and skill management;
- Administrative management of resources;
- Administration of pedagogical materials and quality management.

The implementation of an LMS achieves and supports the notion of "knowledge management". There are many platforms of the two kinds: "business" and "open source". You find hereby some of them with a short description:

- Chamilo (http://www.chamilo.org), GPL (General Public License). It is based on a multilingual architecture and supports over 40 languages. The software is written in PHP and employs MySQL database, used in Europe and in Latin America.

- Claroline (http://www.claroline.net), developed by French speakers, is a platform designed to favor users' communities (GPL license). It is used by many world institutions (universities, schools, associations, corporates, etc.) and is specially fit to create and manage e-learning courses and online collaboration spaces (e-community).

- Docebo (http://www.docebo.com) is an open source platform distributed under GPL license. The Docebo project originated in 2005 and in May 2010 it included over 13 500 logged in users. Contrary to other Open Source platforms, Docebo has been designed to be adapted to complex cases with a high number of participants.

- Dokeos (http://www.dokeos.com) is another GPL-licensed platform. Like Claroline, it is based on a good multilingual architecture. The software is written in PHP and utilizes MySQL.

- eFront (http://efrontlearning.net), created by EPIGNOSIS corporate, this platform is distributed in France. There is the commercial version in the Enterprise and Education applications and the Open Source version in the basic application. It is very intuitive, SCORM compatible.

- Ganesha (http://www.ganesha.fr) is an Open Source LMS produced by ANEMA corporate. Ganesha is tailored to individual paths. Contrary to other platforms, Ganesha organizes the activities and pedagogical resources around the student rather than around the course and its contents.

- ILIAS (http://www.ilias.de), Open Source, enables managing a wide range of contents and users in an integrated system. ILIAS makes available to users all e-learning "utilities", and complies with the main standards (LOM, SCORM, IMS-QTI, AICC, RSS format)

- Moodle (http://moodle.org) is the most popular Open Source platform. It has many features that are not always necessary for the management of an e-learning course. Moodle is also compliant with all the main interchange and compatibility standards.

Since the beginning of its e-learning activity (2002) IAMB has chosen Claroline as the most appropriate platform for the applied teaching method (collaborative-constructivist).
Moreover, this platform satisfies the following preference criteria:
It enables the creation of virtual working communities (groups or classes) where the group identity discourages the typical dropping out of online courses. A functioning community strengthens its links through the exchange of resources. It proposes the individual (the learner) as the leading protagonist in his/her capacity to interpret the study and synthesis contents (wiki and assignments) suitable for adult training. It is flexible towards the

updates that favor lifelong learning. It is characterized by a low "digital divide" impact that enables identifying and implementing more favorable solutions in terms of user-friendliness, benefit-cost ratio, language opening, and does not set technology as a cognitive barrier.

Description of the applied methodology for the identification and localization of the 3 types of knowledge TK, CK and PK in Claroline

The method applied by IAMB is based on the "collaborative-constructivist" approach and is built around the interaction and communication between the various actors of the learning process. The collaborative-constructivist activity is mostly carried out in the "forum" of the platform where students tackle subject-matters by asking questions or comments and by answering the questions and comments raised by other colleagues. Basically, the discussion among students is encouraged in order to create team spirit and improve their "problem solving" capacity. In this area the tutor has only the task to foster and start up the discussion and then monitor it. The teacher follows the discussion intervening, where necessary, to clear unsolved questions and comment the outcomes of on-going activities. Lastly, the system involves the monitoring and evaluation of the activities conducted in the same working area.
But let's see now if and where it is possible to develop the three forms of "knowledge" of the TPACK model in the LMS adopted by IAMB.

Claroline & Pedagogical Knowledge (PK)

"Claroline has been developed following teachers' pedagogical experience and needs. It supports course managers in their projects and stimulates them to set up efficient resources promoting the acquisition of knowledge and skills. Claroline is based on strong pedagogical principles coming from literature on the added value of the technologies for training. It uses technology as a support for pedagogy. Information is transformed into knowledge by the student's activities. This process is sustained by motivation and interaction factors. By the systemic loop, this new knowledge

feeds the following learning process. The platform is based on the teacher's needs which can be summed up as follows: publishing documents and announcements, giving students tools to develop activities and to demonstrate their skills, allowing interactions between students with teachers" (Consortium Claroline, 2006).

Figure 2. Dynamic representation of our learning model. "E-learning with Claroline" (Lebrun, 2006)
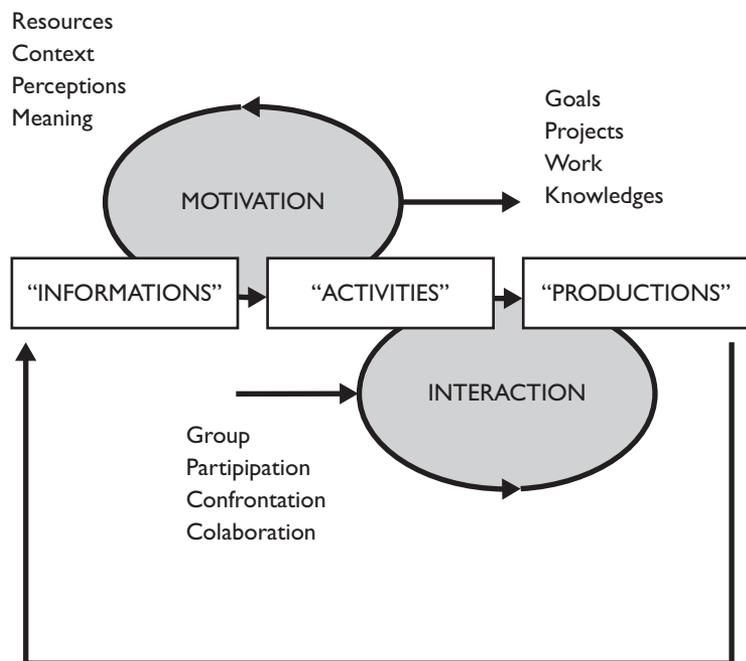
Claroline & Technology Knowledge (TK)

In our case the technology supplies the appropriate tools to develop a teaching method. Claroline is particularly suitable for the application of highly interactive methods like the "collaborative" one that is applied by IAMB. Actually, it makes use of different user-friendly tools (see Figure 3) that can effectively meet all teaching needs. The platform does not require special technological skills from "users", be teachers or learners, except the basic knowledge to participate in an e-learning course (uploading and downloading). In any case if the user has advanced computer

skills, the system tools make possible other specific applications, such as the monitoring, editing and publishing.
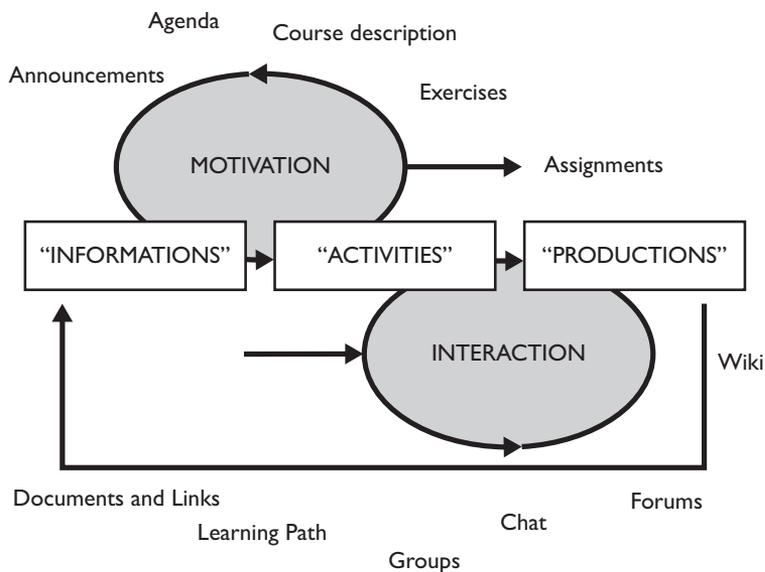
Agenda   Course description

Announcements

Exercises

MOTIVATION   Assignments

"INFORMATIONS" → "ACTIVITIES" → "PRODUCTIONS"

INTERACTION   Wiki

Documents and Links   Forums

Learning Path   Chat

Groups

Claroline & Content Knowledge (CK)

In the platform under consideration the learning objects are mostly implemented in the "Learning path" area, subject to processing by the selected "authoring software". The same area includes the self-evaluation tests that are useful to students for understanding autonomously the degree of achieved learning. In the "Documents" space there are complementary and more detailed explanatory contents. The development of contents of an effective e-learning teaching module needs an accurate definition of instructional objectives. Once these objectives are defined, the teacher provides various kinds of didactic materials that will be then transformed into appropriate digital contents for an e-learning platform. In addition to the "Learning path", Claroline offers other tools where to include further contents such as "Bibliography", "Linkography" and "Glossary".

## Application of the TPACK model to IAMB system and Conclusions

Based on the description presented in the previous chapter you may deduce that Claroline offers the possibility to develop all types of knowledge of the TPACK model exhaustively and on equal bases. We focus now on what happens when observing the application of the TPACK model in the specific case of the e-learning courses delivered by IAMB on LMS Claroline platform. The analysis is based on the average data on the usage of different platform tools detected by monitoring 15 "online and "blended" delivery courses (Figure 4). We can observe that during the period of course delivery, the most largely used platform tools are the "Forum" (60%), followed by the "Learning path" (25%) and the "Documents" (7%).

Figure 4. Snapshot of use (%)

Forum 60%

Users 3%

Course Description 1%

Learning Path 25%

Announcement 4%

Chat 1%

Document 7%
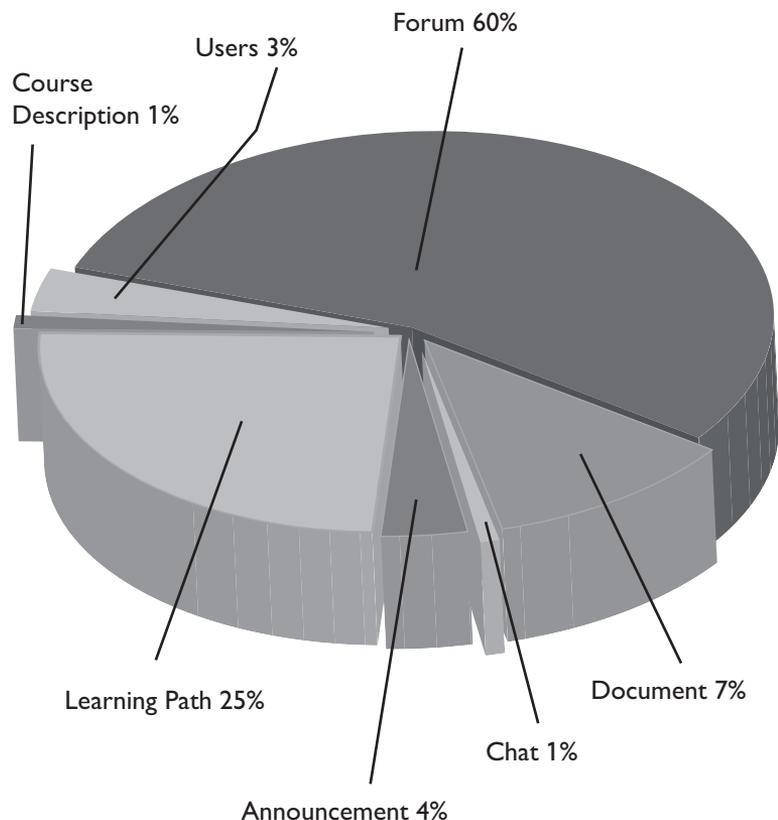
These results are certainly related to the proposed "collaborative-constructivist" learning method that requires a greater interaction among all the actors of the training process. In accordance with the methodological choice based on W. Glasser principles stating that learning skills increase significantly when a subject matter is "discussed" within the group, a minimum participation of both students (4 posts) and teachers (3 posts) is required in forums. The posts actually useful for learning are those related to the subject under study (development) supported by "social" posts. Obviously, it is essential to study the contents in the "learning path", where it is also possible to carry out self-evaluation tests. We can conclude that the TPACK model, applied to the above LMS platform in the IAMB experience, aligns itself but does not coincide with the graphical representation available in the literature (Figure.1) because, although keeping the same components, it shows a different symmetry. Figure 5 shows the graphical representation of the new symmetry of the above model adjusted to the IAMB method on Claroline LMS. It is to be pointed out Pedagogical Knowledge (PK) is the predominant component. This is because the method proposed by IAMB necessitates more activities basically targeted to improve the psychological and social aspects associated with distance learning. The awareness of belonging to a "Learning Community" attenuates the feelings of loneliness that are generally perceived in "self-learning".

Figure 5. TPACK model in IAMB contest
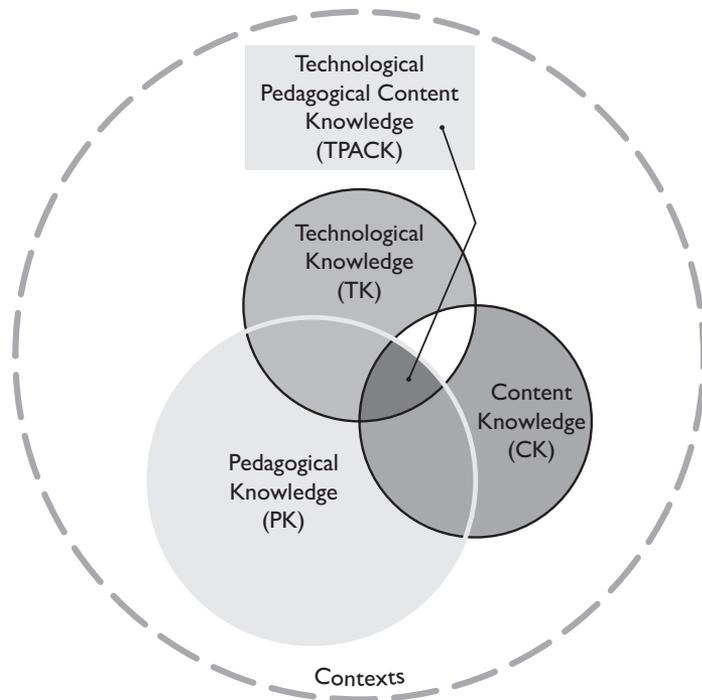
The invitation to join the forum discussions, both for "leaders" and "followers", is the ideal solution, not only to increase the learning skills but above all to create an environment where the socialization enables improving the "problem solving" capacity and "building" new knowledge. With this in mind, IAMB has aimed at favoring the pedagogical component (PK) of the TPACK model on the applied LMS platform envisaging its further development through new E-Learning 2.0 solutions. Consequently, the new learning methods will be increasingly directed to abolishing space and time constraints for Lifelong and Lifewide Learning. The teacher consistent with the TPACK model is inclined to use the sustainable (open source and low digital divide impact) technology that would best fit the new learning methods in relation to the different delivery systems, contexts and training needs. Also, based on this study and with an eye to new training activities, IAMB could apply the strategies aimed at improving the combinations of the three components of the TPACK model that might be further investigated and studied.

References

Galliani Luciano (2005), *Metodologie integrate (in aula, in rete, sul campo) per la formazione continua degli insegnanti,*
http://www.indire.it/ted/materiali/galliani.pdf

Koehler Matthew J., Mishra Punya, Yahya Kurnia (2007), *Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy, and technology*, "Computers and Education", n. 49
Lebrun Marcel (2006), *eLearning with Claroline*
http://docsse.com/view.php?id=960073

Koehler Matthew J., Mishra Punya, Hershey Kathryn, Peruski Lisa (2004), *With a little help from your students: A new model for faculty development and online course design,* "Journal of Technology and Teacher Education", V. 12, n. 1, pp. 25–55

Koehler Matthew J., Mishra Punya, Yahya Kurnia (2004), *Content, pedagogy, and technology: Testing a model of technology integration*. Proceedings of the the Annual Meeting of the American Educational Research Association, April 2004, San Diego, CA, USA

Koehler Matthew J., Mishra Punya, Yahya Kurnia, Yadav Aman (2004), *Successful teaching with technology: The complex interplay of content, pedagogy and technology*. Proceedings from the Annual Meeting of the Society for Information Technology & Teacher Education, Atlanta, GA, Charlottesville, VA, USA, Association for the Advancement of Computing in Education

Lodrini Tarcisio (2002), *La mente al lavoro. Introduzione alla didattica costruttivista,* in Lodrini Tarcisio (Ed.), *Didattica costruttivista e ipermedia,* Milano, Franco Angeli, pp. 13-50

Mishra Punya, Koehler Matthew J. (2006), *Technological Pedagogical Content Knowledge: a framework for teacher knowledge,* "Teachers college record", V. 108, n. 6, pp. 1017-1054.

Pepe Dunia, Terzaroli Paola (2010), *Lifelong learning e Lifewide learning,* in Castello Valentina, Pepe Dunia (Eds.), *Apprendimento e nuove tecnologie. Modelli e strumenti*, Milano, Franco Angeli, pp. 293-319

Sarti Luigi (2003), *Costruttivismo sociale, e-Learning, comunità di apprendimento in rete,* in Stagi Luisa, Vercelli Gianni (eds.), E-*Learning e formazione continua. Risorgeco: il trasferimento di buone pratiche attraverso la Fad,* Milano, Franco Angeli, pp. 73-78

Shulman Lee S. (1987), *Knowledge and Teaching: Foundations of the New Reform, "*Harvard Educational Review", V. 57, n. 1, pp.1-21
http://people.ucsc.edu/~ktellez/shulman.pdf

Sisto Luigi, Lorusso Onofrio, Slimani Mohamed (2006), *Distance Learning Experience within the "Training Course Addressed to Operator of Sustainable Agriculture Development in Mediterranean Climate Countries": Analysis of Results, "*Cahiers Options Méditerranéennes", V. 65
http://www1.iamb.it/download/options/cahier_options_65.pdf

Sintesi

Nel contributo si illustrano i vantaggi dell'impiego della piattaforma Claroline – un LMS specificamente progettato per agevolare la collaborazione online delle comunità di apprendimento – come ideale strumento di applicazione del modello TPACK (Technological Pedagogical Content Knowledge) al sistema e-learning dell'Istituto Agronomico Mediterraneo di Bari (IAMB-CIHEAM).
Infatti, dagli studi e dalle verifiche sperimentali effettuate presso l'Istituto – che vanta una decennale esperienza nel campo dell'e-learning ispirato ad un approccio costruttivistico e collaborativo – risulta che tale ambiente di apprendimento soddisfa appieno tutte le principali esigenze metodologiche, multilinguistiche e di sostenibilità; e consente non soltanto di salvaguardare le caratteristiche del modello TPACK, ma pure di sfruttare al meglio l'intera gamma delle sue potenzialità.
La cornice teorica di riferimento TPACK, valorizzando l'eterogeneità e la miscela di saperi, competenze e abilità, è contraddistinta dalla simmetria fra le sue tre maggiori componenti, che s'intersecano scambievolmente in un equilibrio dinamico, frutto di

continue negoziazioni e della ridefinizione incessante delle relazioni reciproche: l'area delle conoscenze relative ai contenuti (CK), l'area delle conoscenze pedagogiche (PK) e quella delle conoscenze tecnologiche (TK).

Per conoscenze relative ai contenuti s'intende la conoscenza dello specifico argomento, che deve essere trasmessa con la mediazione didattica, vale a dire insegnata e appresa.

Le conoscenze pedagogiche indicano invece la profonda conoscenza delle pratiche e dei metodi d'insegnamento, che permette di pianificare programmi basati su obiettivi prefissati (il vero e proprio insegnamento).

Le conoscenze tecnologiche rendono inoltre possibile l'utilizzo efficace di tutte le tecnologie comunicative, le quali, eliminando i vincoli spaziali e temporali, garantiscono la perfetta armonizzazione fra la dimensione tecnologica e quella dell'istruzione/formazione.

Grazie alla felice combinazione fra l'impianto metodologico prescelto (TPACK) e il LMS impiegato (Claroline), gli insegnanti riescono così ad integrare con successo, nella concreta pratica educativa, tutte e tre le aree di conoscenza individuate: CK, PK, TK. In questa prospettiva, è proprio l'intrecciarsi delle conoscenze a generare ulteriori, differenti conoscenze.

La piattaforma Claroline ha dimostrato – attraverso i test cui è stata sottoposta allo IAMB – di sostenere validamente la creazione di comunità di lavoro virtuali (gruppi o corsi), pur mantenendo il singolo discente al centro del progetto educativo, come protagonista attivo ed indiscusso della costruzione del suo personale apprendimento. Nella sua flessibilità, è in grado di facilitare e promuovere il lifelong learning e consente di identificare e implementare le soluzioni più favorevoli per quel che riguarda la facilità d'uso, il rapporto costi-benefici e l'apertura alle lingue e ai linguaggi. È infine caratterizzata da un basso "digital divide", in modo da scongiurare il rischio che la tecnologia, anziché costituire un fattore abilitante, si trasformi in un'insuperabile barriera cognitiva.