Chapter 19

TEAL (Technology Enhanced Active Learning) for STEAM, humanities and CLIL

Letizia Cinganotto

INTRODUCTION: ORIGINS OF TEAL

TEAL was born in the USA, related to Physics teaching, and first developed by North Caroline State University. Soon after, it was adopted and implemented by the Massachusetts Institute of Technology (MIT), in particular by prof. Peter Dourmashkin and his colleagues. This model was created with the aim of overcoming some of the weaknesses identified in the Physics curriculum, improving student academic achievement, and attracting the girls to the STEAM. In fact, the students attending Physics courses were mainly male.

The innovation managed to combine and integrate traditional pedagogy with active learning at MIT, facilitating the co-construction of knowledge and the development of active learning. Learning test results from recent years have shown that students learn and perform better in Physics thanks to the TEAL methodology (Dori & Belcher, 2005; Dori et al., 2007). The drop-out rate decreased from 20% to 5%. The effectiveness of the TEAL methodology was reported by the students with reference to the following dimensions: collaborative learning, peer and teacher support, organizational renewal, innovative learning environment, use of the "clicker" technology.

Teaching has become more interactive and focused on helping students learn concepts rather than on the delivery of content; teachers and students have acquired a higher level of awareness in the use of classroom technologies such as "clickers" and the associated methodology of peer instruction (Cinganotto et al. 2016).

EXPLANATION OF THE TOOL

TEAL methodology combines lectures, simulations and workshops with digital tools and different devices for an active learning experience, based on both individual and collaborative tasks. The methodology calls for ICT and physical

spaces to be closely interlinked: in fact, it requires basic technological equipment to be used in spaces with specific characteristics and equipped with flexible, versatile, easily arranged furniture. The furniture layout includes a teacher's desk usually located in the middle of the classroom, round tables as work-islands, IWBs, and as many projection points (or whiteboards) as the number of work-islands. Students are divided into groups usually consisting of 3 or 5 students: the odd number is important to avoid situations where decisions are difficult to make, and the members are required to vote.

The picture below shows the TEAL room at MIT.

Figure 1 - The TEAL room at MIT

The teacher introduces the topic to be studied through a "concept question", which is a problem or situation to be solved or discussed with the aim of finding possible solutions in groups.

The TEAL cycle starts with a poll or quiz launched by the teacher through the so-called "clicker" technology, a webapp such as Mentimeter, Kahoot, Quizlet, Socrative or similar, allowing students to respond immediately, just by following their intuition. The results of the poll will be shown on the IWB and will be displayed until the end of the cycle.

Each group will then work on the theme given in a collaborative and active way with the help of devices to select and gather information and data, and also carrying out experiments and tests, if needed. Finally, the results from the work assigned will be shown by each group to the rest of the class in order to

get peer feedback from classmates and the teacher's feedback. The final product, to be presented together with the storytelling of the process and the dynamics of the group during the work, can take the shape of an artifact (paper or digital), a ppt presentation or even more advanced technological solutions, such as a blog, a website, etc.

The main pillars of TEAL can be summarized as follows:

- Problem posing/solving to develop critical thinking skills,
- Cooperative learning and discovery learning in small groups or in pairs,
- Peer tutoring and Peer learning,
- Learning by hands-on experiments to develop active involvement in the learning process,
- Inductive methods: from the observation and the practice to the conceptual frame,
- Concept questions with individual reflection, peer discussion, corrective feedback from the teacher,
- Challenge-based learning: launching challenges to the students through a gamification process,
- Project-based learning: working with the aim to produce a project through artifacts (video, tutorial etc.),
- Experimentations, visualizations, simulations,
- Task-based learning: activities assigned according to specific tasks,
- Interactive presentations and OER (Open Educational Resources).

The TEAL cycle is made up of four steps:

1. *Activation*: this step consists of providing students with a theme, an issue that captures their curiosity, directs their interest, and motivates them to undertake an activity (this means activating student engagement). This is the "problem-posing" phase.
2. *Production*: the activity carried out in class, which allows students to respond to the challenge and teachers to implement active teaching according to the different subject areas: presenting and analyzing a case, carrying out a project, conducting an investigation, solving a problem. These activities prompt students to activate their thinking processes. In this phase, the teacher will take the role of a coach or tutor, observing the students in action, taking notes, using grids, and supporting each student according to their specific needs.
3. *Elaboration*: the phase of elaboration, or rather, re-elaboration, is a collective process of reflection and comparison of what has been learned. The

objective is to clarify, make explicit, and consolidate learning. In this phase, evaluation seems to be less important, but on the contrary, it is a transversal dimension as a continuous and formative practice. Therefore, assessment will involve observation and annotation of the students' activities in context, focusing on individual and group evaluation, self, and peer evaluation, as well as more traditional assessment learning tools.

4. *Closure:* an important phase of the lesson where the teacher will collect feedback, comment on it, and provide a brief explanation which will build a bridge to the next TEAL lesson.

   During this step, the teacher will go back to the initial poll and ask the students to compare their answers with the ones they would provide at the end of the cycle, after investigating, discussing, and acquiring new skills and knowledge. This step is crucial to activate reflection and meta-cognition, and to reach deeper learning.

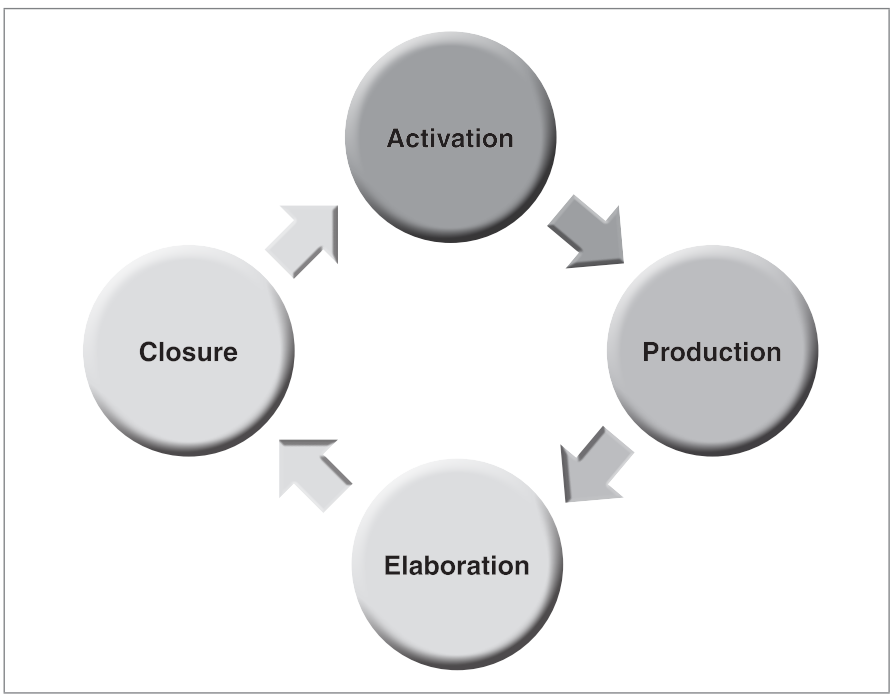

Figure 2 - The TEAL cycle

As already mentioned, the TEAL methodology employs a wide variety of organizational and instructional techniques and solutions, including interactive group work, the setting of work- islands with round tables and tablets for each group member, and the use of projection points for each work-island, etc. A

fundamental pillar of the TEAL methodology is the use of two-or-three-dimensional visualizations and simulations in digital and virtual environments, with the aim of facilitating the understanding of complex concepts, diagrams and graphs, and the study of phenomena, reactions, and events in real time and in a natural dimension. Therefore, in a TEAL STEAM class, the use of websites such as Phet Simulations or Labster is particularly effective, as the students are guided to work in a virtual laboratory, where they can interact, change chemical elements and observe what happens, comment and report on experiments, reactions, etc. This is particularly powerful in terms of deeper learning, as students are led to look at the world from the eyes of a scientist.

Group learning and individual learning are intertwined in the TEAL model based on the principles of peer tutoring, peer instruction, and reciprocal teaching. In particular, with regard to tutoring and peer learning, some elements are crucial, such as positive interdependence (Deutsch, 1968) (in cooperation) and negative interdependence (in competition); cognitive conflict (Piaget, 1926), allowing to re-organize one's own knowledge and view, and taking on someone else's perspective; the zone of proximal development and scaffolding (Vygotsky, 1978), which allows students to be individually helped and supported by the teacher, if necessary.

ASSESSMENT

As already mentioned, assessment is a transversal dimension in TEAL, especially formative assessment, and self-assessment, based on the use of learning journals, diaries, observation grids. These tools are important both for students and teachers, aiming at continuous and progressive improvement and at developing meta-cognition and meta-reflection.

An important dimension of TEAL is feedback, which, according to Hattie (2012), must be clear, connected to students' pre-knowledge, linked to meta-cognitive aspects, in relation to intentional learning and academic success criteria; it should also be just in time and should provide clear and useful indications to the students in order to elicit self-correction and continuous improvement, activating their self-regulation strategies. It is also important to pay attention to motivational and inclusive dynamics, considering socio-emotional learning (SEL).

A common protocol used to elicit peer feedback is the "ladder of feedback" (Fig. 3), from Project Zero, Harvard Graduate School of Education, which helps the teacher to guide a fruitful discussion among the students, leading them to actively listen to the presentation of the different groups. A speaker appointed from each group will generally present the product and at the same time the process, the dynamics, and the learning pathway. The classmates will have to note down possible clarifying questions, possible strengths and weaknesses and

will provide suggestions for alternative solutions or improvement. Each step will take a certain time, as also time awareness needs to be taken into account.

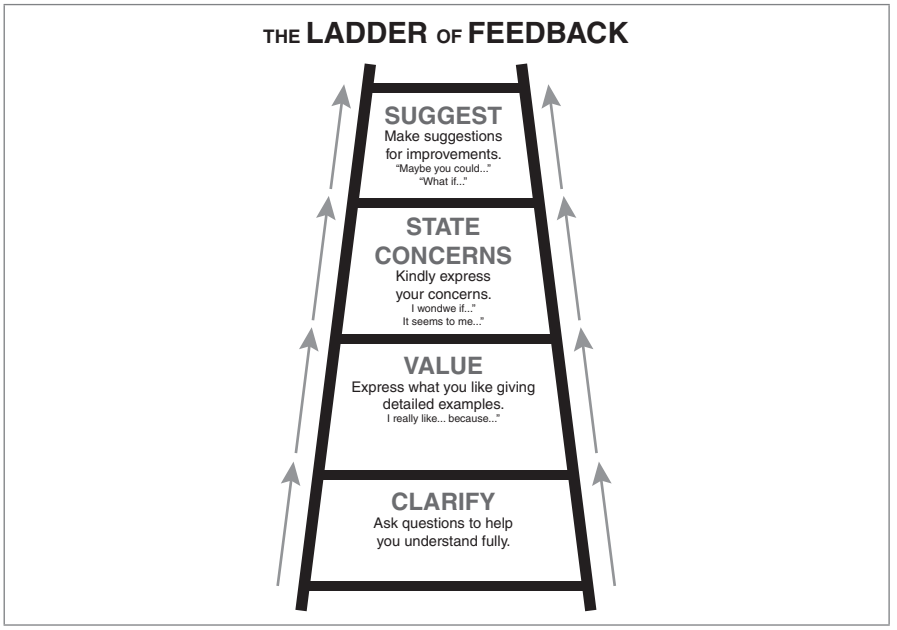

Figure 3 - The ladder of feedback

THE STUDENTS' ROLES IN TEAL

One of the important aspects of TEAL is the distribution of the roles among the different students.

The graph below includes possible roles in a TEAL cycle:

- *Technician*, dealing with the use of the tablet or other devices for finding information, resources, and data to be included in the presentation,
- *Presenter*, who will present the product to the classmates and to the teacher, also highlighting the process and the results,
- *Documenter,* who will take notes about the learning experience through a blog or a learning diary,
- *Critical friend*, who will pose questions and doubts and will call for the teacher if needed,
- *Secretary,* assigning roles, checking that everybody is active and important for the group and for the achievement of the results.

The above-mentioned roles are only some examples, but the teacher's creativity can make the difference and invent other possible roles. The students

themselves may think of other roles and any student can be responsible for a task which is in line with his/her own preferences and learning style.

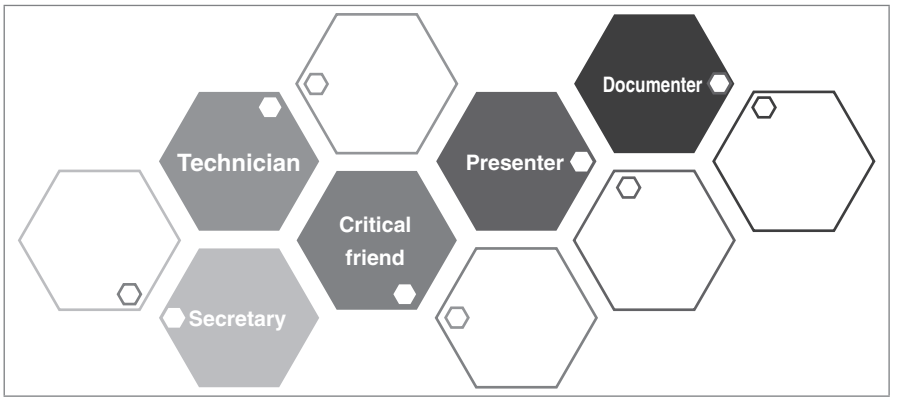

Figure 4 - Possible roles in TEAL

BLENDED TEAL

In recent years, even before the COVID-19 pandemic, the TEAL model has embraced more and more blended forms of teaching and learning, in order to make the model increasingly flexible and granular. In particular, a new way of designing activities was emerging, based on learning sequences, specifically:

- pre-learning sequence;
- video-lecture;
- post-learning sequence.

A key role is represented by the "lightboard video-lecture", a particular type of video-lecture realized through a specific technique, called "lightboard studio"[1]: the teacher, while illustrating the concepts or contents of a lesson, accompanies the explanation with drawings, graphs or maps made on a transparent blackboard, and in doing so s/he makes the training episode captivating and engaging (Figure 5). The lightboard studio uses a very innovative software, with a glass board to write on with colored markers without the mirror effect of the webcam: the result is a multimedia product with a strong cognitive and emotional impact, which is very close to the videos made by the famous Khan Academy[2] platform. The goal of Dourmashkin, who has already made many of his video lectures available for free on the MIT platform, is to create a vast digital library of

1. https://lightboard.info
2. https://en.khanacademy.org/

videos and other study materials, such as problems, concept questions, simulations. These materials can be useful from a flipped learning perspective, assigning the videos to the students in the pre-class phase, or in other cases as a follow-up activity, with the aim of making in-class activities more effective and productive.

Blended TEAL can be implemented in any educational scenarios, face-to-face, hybrid, blended, especially considering the unprecedented times of the COVID-19 pandemic, from which educators learned the need to provide "hyflex" models of instruction.

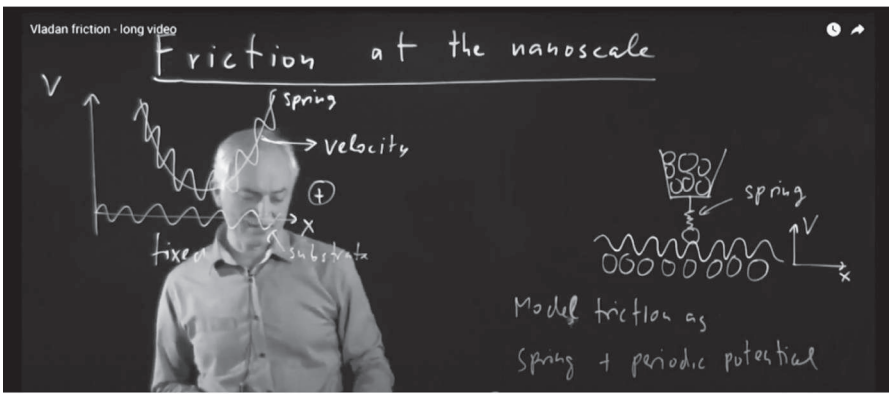

Figure 5 - The lightboard studio[3]

TEAL IN ITALY

TEAL[4] is one of the innovative ideas of the Gallery of the "Educational Avant-Gard[5]", a movement founded by INDIRE (Italian Institute for Documentation, Innovation, Educational Research) in 2014, which at the present collects more than 1300 schools all over Italy. The movement aims at circulating innovation among Italian schools, considering the different dimensions of the school model: organization, methodologies, learning environments, setting, schedule. It is a holistic perspective, aiming at rethinking and reshaping the traditional old-fashioned top-down lecture-based model.

3. "Lightboard videos in Physics": Dourmashkin's lecture available at the following link: https://www.youtube.com/watch?v=s_ipgnRQUiE
4. https://pheegaro.indire.it/uploads/attachments/2462.pdf
5. https://innovazione.indire.it/avanguardieeducative/teal

TEAL has been widely adopted by Italian schools both for STEAM and humanities, learning from Peter Doumarshkin, who has visited different Italian schools and ran seminars, lectures, interviews[6].

Italian teachers particularly appreciated the wide and differentiated use of technologies (mobile devices, projectors for group work, etc.). Flexibility is the key word they particularly liked from Dourmashkin's presentations, as it allows for the adjustment of setting, material, equipment and learning environment according to the specific needs and goals of each school. Among the teaching and learning strategies adopted in a TEAL class, the emphasis on the implementation of challenging and motivating tasks, involving the use of technology with the constant monitoring by the teacher observing and documenting the learning process, has turned out to be particularly powerful and effective.

In Italy, some schools have adopted TEAL as an integral part of the curriculum, with particular reference to STEM disciplines, but recently also in the humanities (especially history and philosophy), as well as in English, in CLIL (Content and Language Integrated Learning) mode. This has been a remarkable effort, as the adoption of the TEAL model in Italy represents a switch from the academic context, where the model was created at MIT, to the school context: upper secondary school first and lower secondary school in recent years.

TEAL FOR CLIL

TEAL is particularly effective when applied in a foreign language in CLIL mode (Cinganotto, 2016; 2018; 2021), a dynamic and interactive approach that makes use of a wide range of teaching techniques and strategies aimed at placing the student at the center of the learning journey, especially through manipulative and laboratory activities, such as those provided by the TEAL model. In TEAL CLIL, students, generally divided into groups, are asked to collaborate in the search for a solution to a problem posed by the teacher. In this phase they can interact in the foreign language, search for information, data, and authoritative sources on the Internet, through a tablet, or other mobile devices. Then, they can discuss and share the hypothesized solutions within the group and with the teacher through the single point of projection of the group and later with the entire class. Final in-class negotiation and discussion will lead to the presentation of the best solutions validated by the teacher. Oral interaction, simulations, experimentations, and group discussions in a foreign language within a TEAL environment can contribute to the implementation of a high quality CLIL path for both humanities and STEM and many Italian schools are already experimenting this way with success. The great flexibility of the TEAL model,

6. An interview to Peter Dourmashkin by the author of this chapter is available here: https://www.youtube.com/watch?v=Cga6n00K38o

the role of the teacher as a coach, the extensive use of technologies, the innovative arrangement of the learning environment, and the furniture, make TEAL a very powerful solution with a great impact on learning outcomes, regardless of the discipline to be conveyed through CLIL.

Collaborative processes, brainstorming, research, peer teaching, and group learning are among the pillars of CLIL methodology, which fosters active learning intertwining subject content and language competence. That is why TEAL can effectively enhance CLIL, especially when using immersive and virtual environments, where students will be asked to use the foreign language for authentic and meaningful tasks.

A recent development of CLIL is represented by the PTDL model[7] (Pluriliteracies Teaching for Deeper Learning) (Coyle, Meyer, 2021; Cinganotto, Cuccurullo, 2019), promoted by the European Centre of Modern Languages in Graz (ECML)[8], which is based on the importance to promote the vast range of literacies (or "pluriliteracies") needed by the 21st century students, among which the subject-specific literacies, and taking into account genre, style, register of a specific subject. Among the aims of the model, there is the importance of guiding the students to examine and investigate the world through the eyes of a scientist, a historian, a mathematician, etc. This is exactly in line with TEAL goals and methods.

TEAL CLIL is often implemented in the Italian classes not only for STEAM or humanities, but also for civics, dealing with SDGs related issue, Constitutions, or digital citizenship, which are the three pillars of civics, recently introduced in the Italian school curricula as a transversal and cross-curricular topic.

CONCLUSION

TEAL methodology could be easily introduced into Indian school curricula, especially at upper secondary school level, adopting the typical TEAL cycle (Activation, Production, Elaboration, Closure) in any subject, both STEAM and humanities. Individual learning, peer teaching, and group learning can activate socialization among the students, and foster critical thinking skills and creativity in the elaboration and presentation of the work and the artifact produced. The use of learning technologies will be an added value to any subject teaching, even if it is not necessary to have a highly advanced and fully equipped TEAL room. A possible adjustment can be made to the furniture and to the infrastructure, according to the specific context ("Easy TEAL").

Active and interactive methodologies which represent the core of the TEAL model will help Indian teachers rethink and reshape their teaching strategies and

7. The author is a member of the consultancy team of the PTDL project.

8. https://pluriliteracies.ecml.at/

style, by encouraging the students' active participation and responsibility in the choice of resources, information, media, and type of artifact to be presented to the classmates and to the teacher. Each student's positive interdependence within the group will help promote personalization and individualization of the learning pathways, without leaving any students out.

Considering the flexibility of the TEAL model, it can really represent an added value to Indian educational scenarios of the future.

REFERENCES

Cinganotto L. (2016). CLIL in Italy: A general overview. In Latin American Journal of Content and Language Integrated Learning, 9 [2], pp. 374-400.

Cinganotto L. (2018). Apprendimento CLIL e interazione in classe, Aracne.

Cinganotto L. (2021). CLIL & Innovazione, Pearson.

Cinganotto L. Cuccurullo D. (2019). Rethinking literacy in the 21st century: A pluriliteracies approach to CLIL. In Lublin Studies in Modern Languages and Literature, [S.l.], v. 43, n. 3, pp. 3-11, nov. 2019.

Cinganotto, L., Panzavolta, S., Garista, P., Guasti, L., & Dourmashkin, P. (2016). TEAL as an innovative teaching model Insights from "Educational Avant-Garde" Movement in Italy. In Journal of E-Learning and Knowledge Society, 12(2).

Coyle D., Meyer O. (2021). PTDL – Pluriliteracies Teaching for Deeper Learning, Cambridge University Press.

Deutsch M. (1968). Field theory in social psychology. In Lindzey G., Aronson E. (Eds.), The handbook of social psychology (Vol. 1, 2nd ed., pp. 412–487), Reading, MA: Addison-Wesley.

Dori Y.J., Belcher J. (2005). How does Technology-Enabled Active Learning Affect Undergraduate Students' understanding of electromagnetism concepts? In The Journal of the Learning Sciences, 14 (2), pp. 243-279, 2005.

Dori Y.J., Hult, E., Breslow, L., Belcher J.W. (2007). How Much Have They Retained? Making Unseen Concepts Seen in a Freshman Electromagnetism Course at MIT, Journal of Science Education and Technology, Vol. 16, No. 4, August 2007.

Hattie J. (2012). Visible learning for teachers: maximizing impact on learning, Routledge.

Piaget J. (1926). The Language and Thought of the Child, Routledge & Kegan.

Vygotsky L.S. (1978). Mind in society: The development of higher psychological processes, Harvard University Press.