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Design and Applications of the Techno-Pedagogical Innovation Model (TPI)

ABSTRACT

This article reflects on the concept of techno-pedagogical innovation (TPI) and the development of a model to guide interventions whose ambition is to foster this innovation in a sustainable and lasting manner. The TPI model is intended for all actors of education: researchers, technopedagogues, trainers, educational advisors and teachers. It is intended to be versatile and transposable to multiple fields. To illustrate and guide its use, the TPI model is applied to three different contexts: in-service teacher training, an online community of practice and e-learning design.

Keywords: technopedagogical, innovation, in-service teacher, community of practice, e-learning

Context

For several years now, action plans have been implemented at national (Fédération Wallonie-Bruxelles, 2019) and international (European Commission, n.d.) level to encourage the implementation of new and innovative practices, particularly through the integration of digital tools. These plans aim to encourage and contribute to the digital transition of the education system. This increase in interest requires a certain level of digital competence on the part of teachers and pushes them, willingly or not, to move towards more ambitious uses of digital tools (Boéchat-Heer & Gonzalez-Martinez, 2021).

Pragmatically, innovations can result from the initiative of teachers (bottom-up) or decision-makers (top-down). Although, in the first case, teachers are in favour of renewing their teaching practices, in the second case, the literature highlights a particular point of attention: when the innovation is imposed by decision-makers, it may be "difficult for teachers, who do not always see the meaning of the innovation" (Boéchat-Heer & Gonzalez-Martinez, 2021, p. 3). Other authors also agree on the importance of the meaning given by practitioners to innovation for the implementation of truly innovative and sustainable pedagogical practices (Fullan, 1985; Gather Thurler, 2004; Lison et al., 2014; Lemaître, 2015). The driving force of innovation therefore lies not so much in the introduction of the technological artefact but in the action of the individual. In this sense, this article adopts a socio-centric view of innovation.

In order to accompany this innovation, the Pedagogical Engineering and Educational Digital Service of the Faculty of Psychological Sciences and Education of the University of Mons (Belgium) is carrying out various support and training actions, particularly in distance learning, for teachers and trainers. These actions concern in particular the integration of digital tools in educational practices, the development of digital skills and the renewal of pedagogical practices. Their aim is therefore to guide the digital transition and encourage techno-pedagogical innovation.

In order to guide the different interventions in these varied educational contexts, it seems appropriate to investigate the scientific literature on theoretical models that can support the articulation between the different phases that we propose during training, support and exchange actions with the aim of promoting techno-pedagogical innovation. This literature review highlights two shortcomings: the first is that there is no consensus on a definition of "techno-pedagogical innovation", and the second is that, to our knowledge, there is no standard model to guide interventions directly in the field. Based on these observations, the ambition of this article is to (1) define techno-pedagogical innovation from a socio-centric viewpoint; (2) propose a model to guide its intervention in an educational context in order to help all the different actors involved in the dynamics of change to make their techno-pedagogical innovation projects sustainable and durable; (3) apply this model to three case studies.

Towards a definition of techno-pedagogical innovation: a process based on the action of the individual

In 2005, Bérubé & Poellhuber (quoted by De Villers, 2016, p. 136), put in place for the first time, a reference framework mentioning "the technopedagogical competencies that teachers must acquire and demonstrate in the classroom". In 2012, the Centre d'étude et de développement pour l'innovation technopédagogique (Study and Development Centre for Technopedagogical Innovation) presents technopedagogy as the articulation between technology and pedagogy, it also induces a reflection on the articulation between these two aspects. Technology must, in this case, be placed at the service of learning (Bérubé & Poellhuber, 2005 quoted by De Villers, 2016). There are two aspects to this concept. The first concerns pedagogical aspects such as "teaching and learning methods, motivation, skills to be developed in students, etc.; the second develops technological aspects such as the use of computers, the web, interactive whiteboards, etc." (De Villers, 2016, p. 137). Furthermore, innovation is often associated with the desire of social actors to make a voluntary change (Cros, 1997) to improve a situation that is deemed important (Anderson, 2004). These definitions highlight the importance of the individual's action in the process of techno-pedagogical innovation. Indeed, according to Betton and Pondaven (2019), digital integration is not necessarily synonymous with innovation and some digital inclusions may even reinforce traditional teaching. This process of innovation is not only based on the use of technological tools to assist teaching and learning, but also on the individual's reflection aimed at reorganising his or her teaching practices. Tricot (2017) confirms this by considering that an innovation in a teaching/learning context must enable a change in practices so that they are effective and efficient.

This "socio-centric" vision of innovation thus leads to a primordial place for social actors in the innovation process (Depover et al., 2007). Moreover, the definition of the concept of individual-oriented social innovation (Cloutier, 2003) is very similar to the concept of techno-pedagogical innovation: individual-oriented social innovation refers to innovation as "a support system designed to bring about lasting changes in the individual, to develop him or her so that he or she can regain power over the course of his or her own life" (Cloutier, 2003, p.10). According to the steering committee of the Forum on Social Innovations[1], any

[1] The Social Innovation Forum is an initiative of the Association nationale des assistantes de service social (ANAS).

social innovation is conditioned by 5 criteria: (1) an innovative, experimental character in a given context; (2) a state of mind and risk-taking on the part of the project's actors; (3) an impact on social policies at national or local level; (4) the quality of the partnership between the usual actors and the new ones; and (5) the participation of beneficiaries, volunteers and inhabitants of the territory concerned in the project. This vision of social innovation is perceived as a new way of doing things with the ambition of meeting social needs (Taylor, 1970) or solving a problem (Fontan, 1998; Lallemand 2001). The presence of innovativeness is therefore a *sine qua non* for this innovation (Gray & Braddy, 1988; Fontan, 1998).

At this stage of the writing, our postulate could be the following: techno-pedagogical innovation is a social innovation oriented on the individual in a specific environment: it is carried out in an educational context and the technology allows to solve a problem or to bring an educational added value. Finally, the aim of this innovation is to modify and improve practices.

In other words, innovation is a complex, dynamic and long-term process characterised by its innovative nature and its positive social and pedagogical consequences (Lallemand, 2001; Parravano & Bretesche, 2001 cited by Cloutier, 2003). Thus, the process of techno-pedagogical innovation would be associated with a learning/teaching process during which the practitioner could update his or her teaching practices thanks to the added value provided by digital tools.

Towards a conception of the TechnoPedagogical Innovation model (TPI)

Definition of the research theme and eligibility criteria

In order to guide our literature search, we conducted a systematic review of the literature on our research topic: innovation models. To improve the completeness of the search, this search was conducted on the Google Scholar engine (Zaugg et al., 2014). The keywords used were "innovation", "model" or "evaluation". In order to refine our identification of a theoretical model on innovation, we coupled the following adjectives to these concepts: "pedagogical", "technological" or "social" (e.g. social innovation). Indeed, our objective was to modify the technocentric approach that is regularly associated with innovation (Poumay, 2014; Lemaître, 2018). Once the theme and keywords were defined, the eligibility criteria were specified in order to select the studies to be included in

our corpus. To this end, only models of innovation centred on the action of the individual were selected. After the analysis of this basic corpus, some additional models were retained by consulting the references cited in the basic corpus. The selection of models was carried out by three researchers independently, "with a conciliation mechanism for the resolution of disagreements" (Zaugg et al., 2014, pp. 658–659).

Evolution from a social innovation model to a techno-pedagogical innovation model

Based on our definition of techno-pedagogical innovation, this article draws on a concept of social innovation (Figure 1) proposed by Le Réseau Québécois en Innovation sociale defined as:

> a new idea, approach or intervention, a new service, a new product or a new law, a new type of organisation that responds more adequately and sustainably than existing solutions to a well-defined social need, a solution that has found a taker within an institution, an organisation or a community and that produces a measurable benefit for the community and not just for certain individuals. The scope of a social innovation is transformative and systemic. It constitutes, in its inherent creativity, a break with the existing. (Le Réseau Québécois en Innovation Sociale, 2011, p. 3)

This search for more appropriate solutions and needs is also felt in the specific context of teaching. Indeed, the majority of teachers feel that they have little knowledge of the pedagogical uses of digital technology and are in constant demand for training adapted to their needs, but also to the equipment available (Delacharlerie et al., 2018).

As a result, the elements constituting the definition as well as the model of social innovation are, at first sight, present in most innovation projects where the concepts of "inadequate solutions", "needs" or even "transformation" are present in the existing context. It is in their implementation that the specificities appear. Therefore, we propose to outline the different steps foreseen by the Quebec network and then to explain the four adaptive phases we have imagined in order to establish the TPI model.

The social innovation model (Le Réseau…, 2011) is divided into three main operational phases: (1) emergence (2) experimentation and (3) appropriation (Figure 1). The emergence of the project takes up the conditions for the emer-

gence of an innovation project. The identification of the problem (the lack, dissatisfaction or imbalance of existing solutions) is the first step in this process. This identification of the problem will enable the development of a project that responds more adequately to the issues raised. This project must have a transformative scope and take into account the issues of the various stakeholders. This idea of co-construction is transversal to the social innovation process. Indeed, it is not simply in the development of the project that it is implemented, but in all its components. It allows the collective development, in the light of the knowledge and know-how of all the actors involved, of innovative responses adopted and appropriate to the various elements making up the project (management methods, financing, etc.). Then, in the experimentation phase, the innovation mechanism is tested in a real context. Experimentation is part of a quality process. This means that this phase provides for an evaluation of the system with a view to adjusting it. The last step consists of two levels of appropriation: one is local and the other is widespread. The interest of this phase is to disseminate the innovative system and ensure its sustainability. The authors speak of the project's influence to evaluate the resulting spin-offs. The project is therefore recognised as innovative when it is adapted or used. This phase therefore defines whether the actors have appropriated the innovation or not.

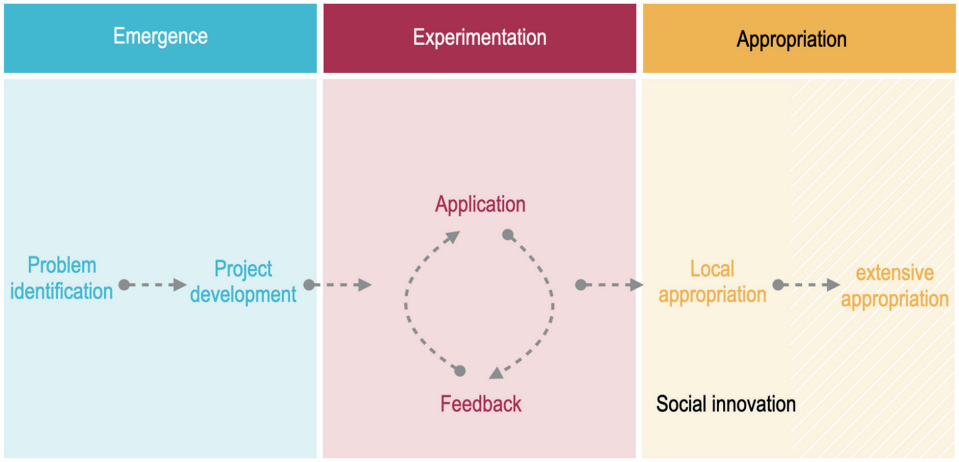

Figure 1. Social innovation model

Source: Le Réseau Québécois en Innovation Sociale, 2011.

The use of this model in an educational context seems relevant, but requires adaptation to take account of the implementation of technological supports.

The rest of this paper will lead to the adjustment of the model to include techno-pedagogical aspects, as well as aspects related to the training and support of teachers and, of course, trainers in a more general way.

Phase 1: a two-level model

The first phase of this modification gives rise to the identification of the actors in the model. Indeed, this model highlights two levels (Figure 2). The first level concerns the designer of the innovation. This designer can be a researcher, a teacher, a technopedagogue, a pedagogical advisor, etc. This is the investigator of the techno-pedagogical innovation. This level can involve several actors simultaneously if the innovation is the subject of a collaborative approach between researchers and practitioners in the world of education (Boilevin, 2013). This collaboration can be implemented between actors from the same sector of activity (intra-team collaboration) or from different sectors (inter-team collaboration). Taylor (1970) already emphasised in the 20th century the importance of multidisciplinary teams in the innovation process.

The second level concerns the beneficiaries of this innovation. Indeed, the ambition of an innovation concerns the change which, with the aim of improving a situation, may relate to a practice, a method, a way of teaching certain disciplinary contents, a procedure, etc. It may concern a product or a process. It may also allow new objectives to be achieved that could not have been addressed without a change in the situation (Peraya et al., 2004). The changes affect the beneficiaries of the innovation. Thus, in some cases, the

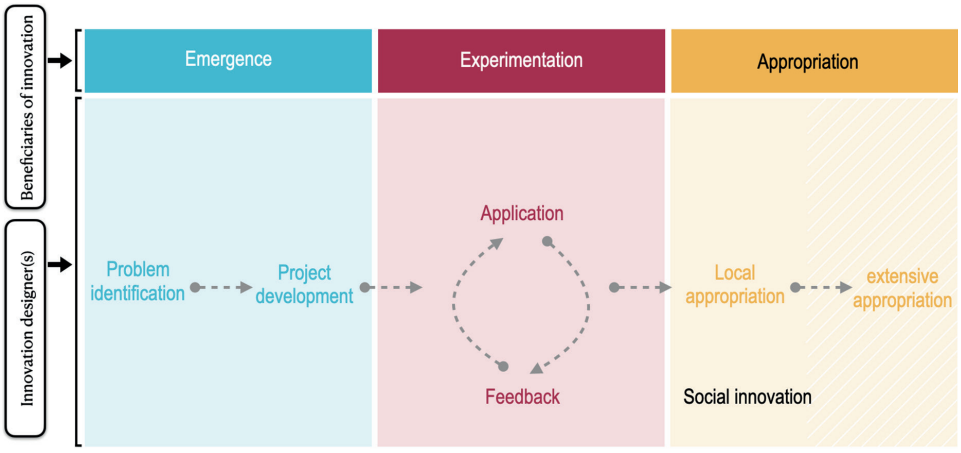

Figure 2. Phase 1 – a two-level model

Source: Authors' own elaboration.

designer(s) and the beneficiaries are different actors. This is notably the case in training courses that aim to renew teachers' practices (i.e. Delalande et al., 2019). In other research, the actors of the innovation and the target audience can be identical, which is the case of collaborative research (Boilevin, 2019). Indeed, the research by Kumps et al. (2019), shows that teachers are both the designers – they design the device in collaboration with the researcher – and the beneficiaries of the innovation – they reap the benefits of the innovation by modifying their teaching practices.

Phase 2: evolution of the behaviour of the beneficiaries of the innovation

The model of the Réseau Québécois en Innovation Sociale (2011), known as RQIS, proposes a 3-step model: emergence, experimentation, appropriation. As a reminder, these three steps refer to the evolution of social innovation. In the design of the model integrating digital technology, the ambition is to identify the 3 phases defining the development of the behaviour of the beneficiaries of techno-pedagogical innovation. Thus, with reference to Ameisen (2018), innovation is characterised in the behaviour of beneficiaries by:

1. Emergence: the behaviour appears in an individual;
2. Propagation: the behaviour spreads. It is adopted by more and more individuals.
3. Modification: the behaviour is accepted and reproduced by the majority of individuals.

With reference to our research area, although the term emergence seems appropriate, the other two can be discussed. For the second step, the term "diffusion" seems more appropriate (Rogers, 1995). Indeed, the sociologist Rogers uses the term diffusion of technologies to develop his theoretical model. Indeed, the author is interested in the way in which the individual will engage with and take ownership of the innovation. According to him, diffusion is "the process by which the innovation will be progressively communicated, through certain channels, over time, to the members of the social system" (Rogers, 1962 cited by Chapuis & Bovis-Vlahvic, 2016). Thus, the new practices spread gradually through the community of practitioners. Finally, the third step is manifested by the "adoption" of the innovation. The introduction of a new technology or new practices induces a process of change leading to a modification of organisational arrangements, skills, roles, etc. (Bobillier-Chaumon & Dubois, 2009). This adoption decision can be more or less forced, as is the case when the project's beneficiaries are enrolled at their own expense, or free, if they voluntarily join an innovation process (Baujard, 2004). This globalised adoption of behaviour

can be observed in education. Indeed, it is not uncommon for a teacher to rely on the expertise of a more experienced colleague to update his or her teaching practices (Delacharlerie et al., 2018). Therefore, it appears that the emergence and dissemination of new practices within a group leads to the adoption of practices beyond the group. These new practices can be instilled in colleagues who are not initially part of the group of beneficiaries of the innovation (Housni et al., 2020). The model we propose therefore consists of three steps: emergence, diffusion and adoption (Figure 3).

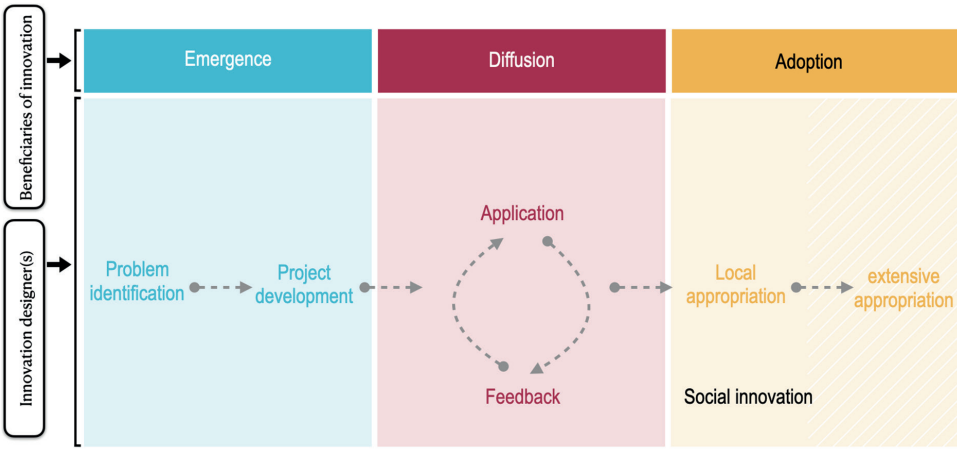

Figure 3. Phase 2 – evolution of the behaviour of the beneficiaries of the innovation
Source: Authors' own elaboration.

Phase 3: redefining the tasks of the innovation designer(s)

With reference to the modification proposed in phase 1, the second level refers to the tasks performed by the innovation designer(s). These steps are created on the basis of cross-referencing between several research approaches. According to Frechtling et al. (2002) cited by Randolph (2008), an evaluation method in research involves several steps: developing a conceptual model of the programme and identifying key evaluation issues; developing evaluation questions and defining measurable outcomes; developing an evaluation design; collecting data; analysing data; and sharing research results with interested audiences. For Vial (2015, p. 24), it is about "systematically producing, describing, evaluating and valuing the concepts, artefacts and experiences generated during a design and creation process". Within these steps, Temperman (2013) identifies regulation as an important step in order to adjust the learning environment based on the

analysed results. This addition corroborates with Deming's (1982) model according to which a quality process goes through 4 steps: "Plan", "Do", "Check" and "Act". In fact, the desire to be part of a fundamental approach, that of evaluation and regulation, which takes account of the results of the evaluation. We therefore propose a redefinition of the tasks in five steps (Figure 4): apprehend, design, implementation, evaluate and regulate.

Step 1: apprehend

Apprehension appears to be more "global" than the "problem identification" proposed in the social innovation model (Le Réseau…, 2011). This idea of "apprehending the problem" refers to a reflection or data collection with the beneficiaries beforehand in order to multiply the angles of view on the problem. This step may include understanding the inadequate situation, identifying needs, profiling beneficiaries or finding solutions. It is the anchor point of the process as it contributes to building new knowledge on which the designer relies to design the project.

Step 2: design

This step of the project gives rise to the design of a digital or physical environment. This design is conditioned on the one hand by the data collected during the apprehension step, and on the other hand, with reference to the TPACK model, by the judicious articulation between content, pedagogy and technology (Koehler et al., 2013). As mentioned before, the design of the device can be carried out by one or more designers. It can be foreseen in this second phase that the designed project will be subject to constant evaluation in order to respond as adequately as possible to the objectives to be achieved.

Step 3: implementation

Step 3 refers to the experimental treatment of the project, the intervention with the target audience in the context investigated. This may lead to a more formal treatment in the context of empirical research or to a more "informal" application in the context of an innovation implemented by a teacher. The principle of this step is to collect real data from observation, experimentation, interactions, etc. in a learning environment (Schneider & Class, 2020).

The last two phases of the model leave room for two relatively important steps in the continuous improvement of a teaching device: evaluation and regulation.

Step 4: evaluate

This step refers to the work of Temperman (2013). It gives rise to the evaluation of the environment a posteriori. Thus, according to the author, this evaluation can investigate perceptions, processes or performances. Perceptions are related to the learner's experience and can be of the order of motivation, usefulness, usability, etc.). Processes relate to how specific activities and events in the learning environment occur (usage, connection times, resource uses, etc.); and performance is determined by learning outcomes (level of mastery, progression, sustainability, transfer). Evaluation can be done through qualitative or quantitative analyses. It is also possible to carry out cross-analyses by combining this quantitative and qualitative information. "This questioning corresponds to a quality approach whose objective is the continuous improvement of the educational scenario (...). The answers obtained then provide the opportunity to regulate the environment developed, if necessary" (Temperman, 2013, p. 151).

Step 5: regulate

Following the evaluation of the system, it is possible to regulate the whole process if it does not achieve the objectives. This regulation consists of modifying the learning environment accordingly by making adjustments to the teaching scenario. "In reference to Van Der Maeren's typology (1997), our approach clearly has a pragmatic focus with the search for functional solutions for learning" (Temperman, 2013, p. 151).

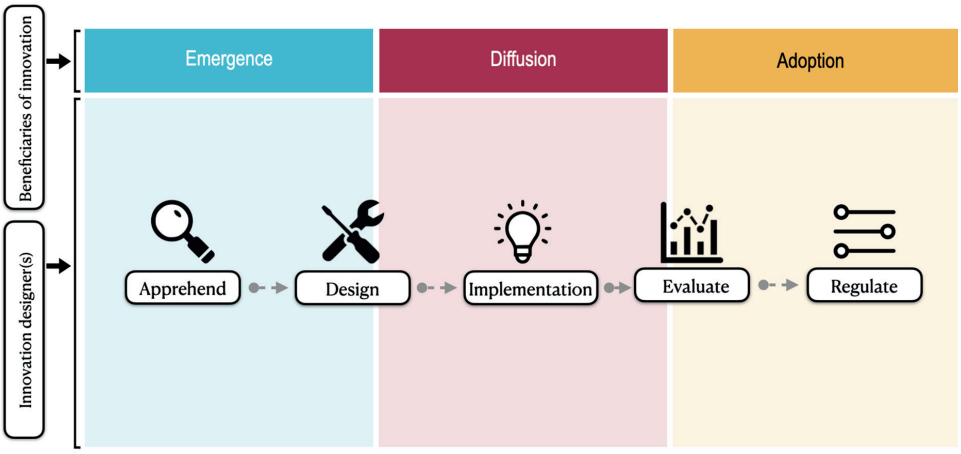

Figure 4. Phase 3 – redefining the tasks of the innovation actor(s)

Source: Authors' own elaboration.

Phase 4: the innovation process, an iterative approach with a view to quality

Finally, the last phase gives rise to the modification of the very structure of the model (Figure 5). Indeed, the research activity requires multiple loops in order to refine the system (Schneider & Class, 2020). This passage through multiple loops shows the importance of the iterative aspect of the model in a logic of continuous improvement of the learning environment (Deming, 1982; Amiel & Reeves, 2008). Such thinking is based on the principle that an innovation must continue to develop in order to survive. Therefore, once the last step is completed, the new state is considered standard, and the innovation continues from a new emergence.

With reference to Deming's model (1982), a multidisciplinary model of the quality approach, the *raison d'être* of the TPI model is therefore to be part of a continuous quality process. Indeed, "Plan" corresponds to our "Apprehend" step. "Do" is divided for the purpose of designing a techno-pedagogical model into two steps "Design" and "Implementation". "Check" is the equivalent of our

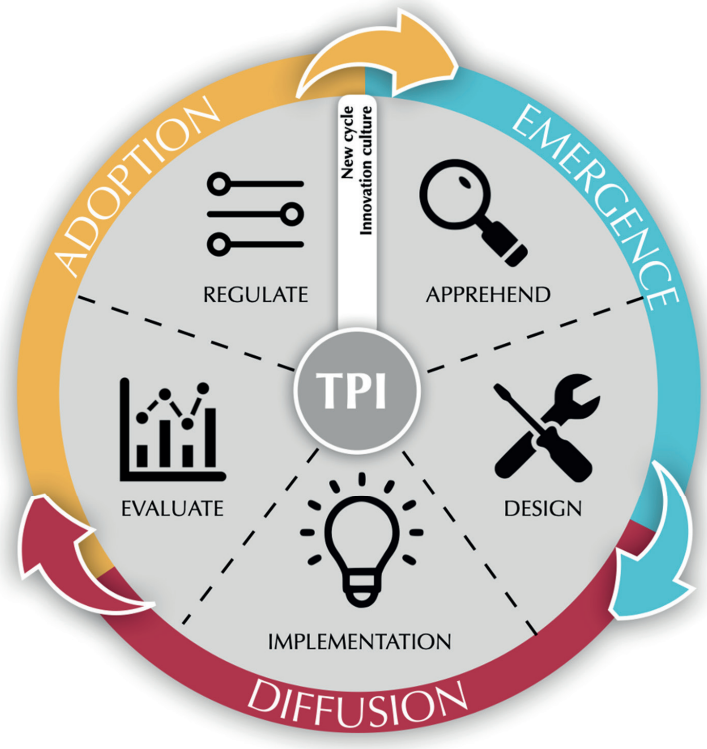

Figure 5. Techno-pedagogical Innovation model (TPI)

Source: Authors' own elaboration.

"Evaluate" phase, during which it is essential to identify the quality criteria to be favoured according to the context. In the context of a techno-pedagogical model, these will be criteria specific to technologies and those relevant to teaching and learning (Charnet, 2019). Finally, "Act" is similar to "Regulate". The interest of this last step is to chase away what proves to be of lower quality to improve the innovation process (El Gaied, 2019). According to Khelif and Chaoui (2009), the implementation of a quality process ensures reliability and validity. This system in a cyclical form gives the possibility to remedy any shortcomings found during the evaluate step. Finally, with reference to Gaudreault (2012), the implementation of a new cycle gives rise to a continuous search for innovation and, by extension, to a culture of innovation.

Applications of the model to 3 case studies in the context of training and coaching of trainers

In a deductive approach, this TPI model is applied in different contexts and adapted to the needs of various educational actors. To support the possibility of using this model in multiple contexts, we exemplify our approach in terms of three types of innovation designers: (1) a researcher, (2) a collaboration between practitioners and (3) a collaboration between researchers and higher education teachers.

Application by a researcher in a techno-pedagogical teacher training design context (Kumps, n.d.)

- Designer of the innovation: Researcher
- Beneficiaries: In-service teachers

Context of the techno-pedagogical engineering intervention:

With the Internet, information has become more accessible in a few clicks and seconds. Since 1995, the network has grown exponentially (Kemp, 2020). As a result, searching for information online is now part of the habits of the majority of the European population (European Commission, 2017). It is therefore not surprising that students choose this modality first and foremost to meet their academic and everyday information needs (Smahel et al., 2020). Educating them to be able to search and be critical on the web has therefore become one of the important goals of education (Hämäläinen et al., 2020) and this, from the early years of their schooling (Leu et al., 2015). However, this competence is not

much worked on for its own sake in school. The learning activities proposed by teachers remain very limited in this respect (Kumps et al., n.d.). Currently, the educational system of French-speaking Belgium, wanting to fill this gap, suggests in its new reference materials (Fédération Wallonie-Bruxelles, 2022) that pupils should be able to acquire transversal competences in this field. Thus, being able to search effectively for information on the Internet will be one of the skills that pupils will necessarily have to develop from the age of 8. However, teachers do not seem to be ready to provide this teaching (low sense of self-efficacy, lack of ideas for implementation activities, negative perception of usefulness and usability, etc.). This is why our intervention sets up an in-service training, totally at a distance, for a public of teachers.

To do this, we first (Apprehend Step) proposed a questionnaire adapted from the technology acceptance model in order to define the teacher-profiles regarding the acceptance of teaching online information retrieval. This first step highlights a major problem in the implementation of this teaching. The responses to our questionnaire show that teachers are facing difficulties in implementing online information retrieval teaching. The results show that there is a need for pedagogical and technical support.

To meet the needs identified by the teachers, we are designing a fully distance learning course. In order to build the content of the course (Design step), we opted for the analysis of the students' strategies and errors thanks to eye-tracking techniques. The actual practices of the pupils enabled us to formulate recommendations directly for the teachers in the field.

We then set up this training (Implementation step). It includes technical, techno-pedagogical and reflective aspects of the educational use of the Internet to search for information. The training is based on the connectivist pedagogical model and provides for the learner to be active and constructive throughout the training. It is through exchanges, consultation of resources, creation of links, etc. that the participant in the training will be able to find the answers to his or her own needs. This training course lasts ten weeks and ends with the collaborative design and implementation of a teaching sequence highlighting the search for information online.

In order to assess the training system put in place (Evaluate step), we analysed the evolution of teacher profiles before and after the training. Data was also collected one year after the training in order to measure the impact of our long-term training on teachers' acceptance of teaching online information retrieval. Teachers' perceptions of satisfaction, usefulness and usability of the training were also investigated.

These different steps and data collection finally allow us to make adjustments and recommendations (Regulate step) in order to train teachers to integrate a digital competence in the school context.

TPI model adjusted to the context:

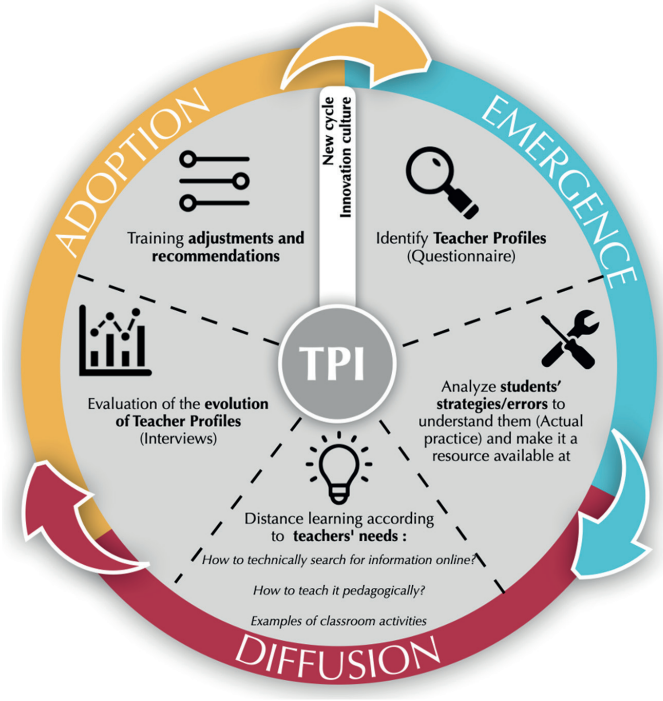

Figure 6. TPI model structuring teacher training

Source: Authors' own elaboration.

Application in a Community of Practice (CoP) context

- Innovation developer: CoP members – practitioner team[2]
- Beneficiaries: learners[3]
- Context of the Community of Practice

The project "Digital Transition for Teaching" (2019), known as Teach transition, is based on the following observations:

[2] Higher education teachers, secondary teachers, primary teachers, pre-school teachers, trainers, researchers, etc.

[3] Pupils, students or trainees depending on the learning context.

> The omnipresence of technology has profoundly changed all aspects of daily life, the way we think and act. It is important to train citizens, especially children and young adults, to use these digital technologies creatively, productively and critically (...) at the same time [there is] a strong interest in enabling teachers and trainers to exploit the potential of these new technologies efficiently. However, there is little structuring training for this public in relation to the demand from the field in the project's working area. Moreover, the training courses offered are not all valued and recognised on either side of the Franco-Belgian border. (Digital Transition..., 2019, p. 2)

The ambition of Teach Transition is therefore to create a framework and a continuous training course for teachers and trainers wishing to respond to the digital transition of their profession and to develop their skills in technopedagogy. Among the activities planned by the project, a community of practice (CoP) is to be set up around the project, led by the project's actors (technopedagogues) and whose members are represented by trainers and teachers at all levels (from pre-school to higher education). The ambition of this community is to identify and solve challenges around issues inherent to teaching practices.

For each CoP cycle, the members (Apprehend step) identify problematic situations for themselves or for their learners, i.e. situations that lead to difficulties either in the exercise of their profession or in the learning of their learners. To respond to these problematic situations, the members of the CoP invite experts to testify and discuss the issue. They can then create activities or suggest solutions in workshops (Design step). They can then apply these activities or solutions directly in their professional environment (Implementation Step). In order to assess the quality of the implemented ideas (Evaluate Step), the members evaluate them on the basis of previously identified criteria. They can discuss it together in an exchange workshop with the aim of making adjustments and improvements on an ongoing basis (Regulate Step). TPI model adjusted to the context is presented in Figure 7 (below).

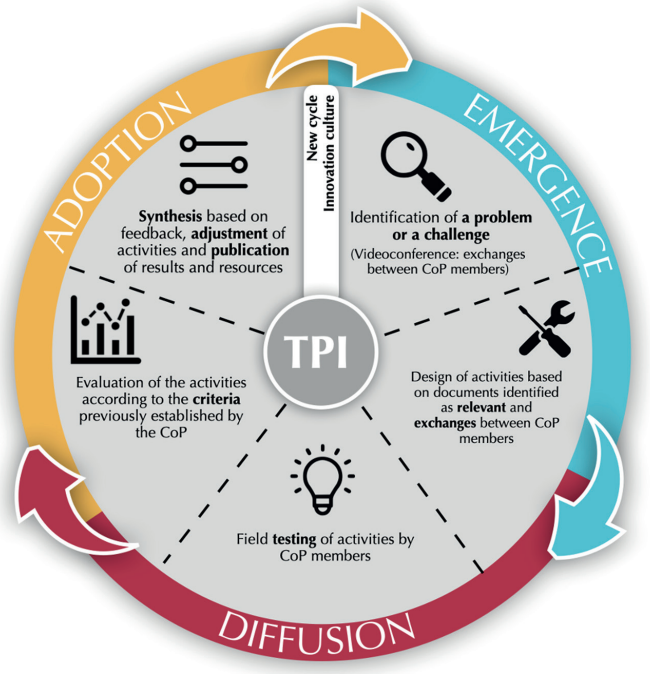

Figure 7. TPI model structuring a community of practice
Source: Authors' own elaboration.

Application by a researcher in an e-learning design context

- Designer of the innovation: Researcher and Higher Education Teachers
- Beneficiaries: Higher education teachers and their students

Context of the Community of Practice:

This third application of the TPI model is taking place within the framework of the Erasmus+ CoNeCTE project (Collaborative Network for Career-building, Training, and E-learning) in partnership with Lebanese higher education institutions. Among the objectives of this project, we find the support of teachers and students in their digital transition, particularly through distance learning. Indeed, the ambition is to set up a Virtual Learning Environment "which allows the production and sharing of digital educational content [...]. The virtual collaborative platform will contribute to an effective transition to graduate employment." (Chamber of Commerce, Industry and Agriculture of Beirut and Mount-Lebanon, 2021). Thus, to feed this virtual learning environment, four design teams have been set up to produce online training courses on various

topics such as economic and financial culture or bioinformatics. The development of these online courses constitutes a techno-pedagogical innovation in the sense that distance and hybrid courses are still difficult to recognise legally in Lebanon (Cressens, 2017).

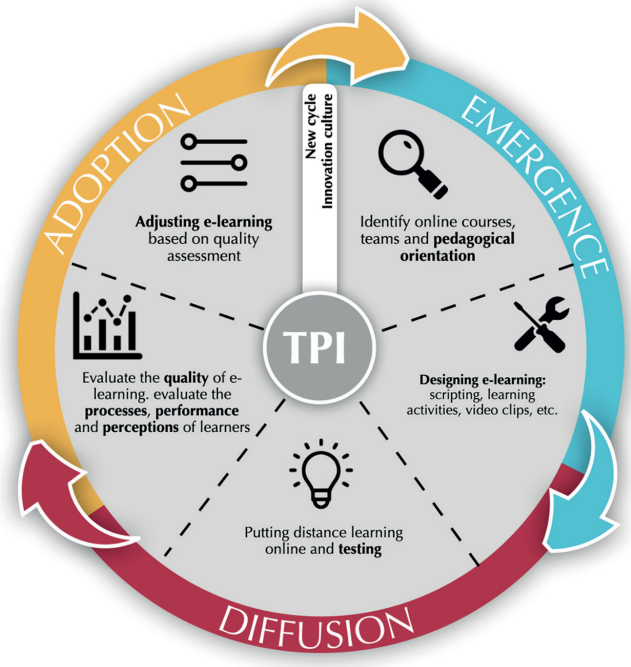

Figure 8. TPI model structuring the design of e-learning courses and the feeding of a virtual learning environment

Source: Authors' own elaboration.

Our role, as an institution belonging to the European Union, is to accompany and guide the teams to carry out this design work. Thus, we wished to apply this model of Techno-pedagogical Engineering to best accompany the Lebanese partners (Figure 8). The designers of this innovation are the researcher and the Lebanese higher education teachers participating in this Erasmus+ project. The beneficiaries are both the Lebanese teachers who can use the training modules and the students who can follow them. The project started with an analysis phase (Apprehend step). It was a question of identifying the online training courses to be carried out, of setting up the teams and of reflecting on the pedagogical orientation (Which target public? What prerequisites? What training objectives? What content? What learning strategies? etc.). Then, the design phase of the

distance learning courses consisted of scripting, designing and producing the activities, teaching aids and videos (Design step). This step was split into two: the design of the e-learning course (division into modules, scripting of activities, identification of pedagogical objectives for each activity, etc.) and development, i.e. the development of the e-learning tools. This choice was made because the Lebanese partners, the designers of the techno-pedagogical innovation, were used to working with the ADDIE model, which includes these two steps. At the time of writing, this step is still in progress. Next, the distance learning courses will be put online and tested with learners (Implementation step). Then the quality of the e-learning prototypes will be evaluated (Evaluate Step). This evaluation will be carried out according to the three dimensions put forward by Temperman (2013) to evaluate human learning environments: learners' perception, performance and products. Finally, the project will conclude by adjusting the e-learning courses according to this quality assessment (Regulate Step). TPI model adjusted to the context is presented in Figure 8 (above).

Conclusion

Based on our research activities in various fields, we have developed a model of techno-pedagogical innovation that can be applied in various contexts, such as training, coaching, collaborative research or the support of communities of practice. Our objective is to guide interventions related to the design of an innovative practice combining education and digital technology by adopting a sociocentric approach. Indeed, the literature has revealed that there is no clearly established definition of techno-pedagogical innovation nor a pragmatic model to which the designers of the innovation could refer.

According to our convictions, we want to put the beneficiary at the centre of techno-pedagogical innovation and thus propose a model that gives a sociocentric vision of innovation. In the literature review, the RQIS model (Le Réseau…, 2011) is identified as being applicable to any situation involving innovation. Therefore, we decided to adjust it so that it can be adapted to the educational environment. To achieve this, this model is fed by different theories relating to technopedagogy (Koehler et al., 2013), social innovation (Gaudreault, 2012) or the quality approach (Deming, 1982). It seemed essential to us to give a graphic form to this model. Indeed, a diagram makes it easier to visualise the relationships between the elements and the overall structure (Jamet, 2008) and therefore to go further than a linear text.

Once developed and in order to verify its transposition to various contexts, the TPI model is applied to three case studies: the design of a techno-pedagogical training course on online research for in-service teachers (Kumps et al., n.d.); the collaboration of practitioners through a community of practice; and an Erasmus+ CoNeCTE project that aims to develop e-learning in Lebanese institutions.

The TPI model considers that the guiding approach is an integral part of the innovation process and is the driving force behind it insofar as it makes possible the conditions for the emergence of this innovation. Indeed, by proposing moments of diagnosis, evaluation or regulation, the innovation makes sense for the educational actors. Our ambition is to develop a multi-purpose model that allows everyone to design an innovation and evaluate their practice in a continuous process. Moreover, we believe that this approach can also be implemented in multiple contexts, whether or not they include the use of digital tools. We therefore propose that practitioners, teachers, educational advisors and technopedagogues use this model to design technopedagogical innovation interventions in which the key factor is the action of the individual.

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