EVALUATING INNOVATION INJECTION INTO EDUCATIONAL CONTEXTS

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One of the big challenges faced by research in the Technology Enhanced Learning (TEL) field has to do with the injection of innovation into real educational contexts. Very often, innovative technologies fail to be taken up by practitioners because of difficulties in absorbing both methodological and technological innovation of the target contexts. This may be caused by resistance of the target users associated with conservatism of the contexts, but also by inadequate approaches to innovation promotion or even lack of evidence of the return of investment of the innovation itself. Thus, a crucial need of the TEL field consists in the ability to evaluate both the efficacy of a new technology in the specific context to permeate, and the effectiveness and adequacy of the intervention designed to inject this innovation into the intended situation. This paper contributes to fill in this gap by proposing an approach that joins aspects of Guskey's model to evaluate the effectiveness of teacher training events together with

indicators of the well-known Technology Acceptance Model, generally used to predict acceptance of a new technology. The approach proposed, called T&EAM (Technology & Event Acceptance Model), is illustrated. The discussion concerns its strengths and weaknesses and provides inputs for future applications and research.

1 Introduction

In the Technology Enhanced Learning research field, many projects aim to develop and inject methodological and technological innovation into a 'virgin' educational context. This process of exogenous (i.e. externally-driven) educational innovation usually leverages on teachers and is typically triggered by training events aiming to familiarize them with the technology, and consolidated by some kind of follow up, where they are scaffolded and guided through their first steps in the use of the new technology in real life contexts. In these situations, policy makers and/or researchers need to evaluate the results of both actions, thus assessing the adequacy and effectiveness of the training event as well as its effects in terms of longer term adoption of technology.

In this paper, we propose a 'joint approach', called T&EAM (Technology & Event Acceptance Model), built upon the conjunction of two existing and consolidated models, which have been merged to form a single framework for the evaluation of a training event and the associated technology-based educational innovation. The need for such an integrated approach derives from the awareness that the evaluation of a project's outcomes cannot be limited to the mere sum of the evaluation of the training event and of its practice-based follow-up. Rather, when the two actions are carried out in a synergic way, their evaluation too must be able to capture their joint effects, in order to fully appreciate the project outcomes.

We therefore intend to set the basis for the development of a framework that can be adopted in many other TEL projects, provided that they share the need of evaluating the effects of an innovation being injected into a new context in conjunction with a training initiative.

2 Theoretical background

The issue we intend to address here is the definition of an approach to evaluate the combined effects of the introduction of a new technology in a given context (and its methodological underpinnings) and of a training event addressing the perspective users. Our literature review therefore focuses on both aspects of the problem: the evaluation of the impact of a new technology in a given context and the evaluation of training events/programmes, and specifically those that aim to improve a teaching and learning process.

Both of these areas are very rich: there is plenty of models and frameworks

addressing these issues, some of which are very well-known and consolidated. In the following sections we firstly concentrate on some of the most popular models to evaluate the impact of technological innovation, and secondly on the evaluation of training programmes.

2.1 Models for technology impact evaluation

A number of models have been proposed in the last decades to analyse and predict user acceptance of new technological tools (Davis, 1989; Rogers, 2010; Thompson *et al.*, 1991; Venkatesh & Davis, 2000).

Among these, some of the most well-known aim to predict users' intentions towards technology, and actual usage of it, as dependent variables, on the basis of various determinants (i.e. independent variables) that include: attitudes, perception of usefulness, perception of ease of use, motivation (both extrinsic and intrinsic), and other social factors. One of the most popular, the Technology Acceptance Model (TAM) (Chuttur, 2009; Davis, 1989), focuses on two determinants, *Perceived Usefulness* and *Perceived Ease of Use*, and has given rise to several derivatives and evolutions, often used in educational contexts (Cheung & Vogel, 2013; Liu *et al.*, 2010; Persico *et al.*, 2014; Tarhini *et al.*, 2013). For example, TAM2 (Venkatesh & Davis, 2000), considers some additional determinants concerning social influence, including for example *Subjective Norm*, defined as "the person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein & Ajzen, 1975, p. 302). As described in the following, TAM and TAM2 provide the foundations for the development of our evaluation approach, although the three variables (*Perceived Usefulness*, *Perceived Ease of Use* and *Subjective Norm*) are not used as determinants, to predict behaviour, but as indicators of acceptance, after usage of the technology.

2.2 Models for training initiatives evaluation

As mentioned above, there is a multiplicity of models and studies dedicated to the evaluation of training programmes and training initiatives of different kind. With no intention to be exhaustive, we examine here those that have inspired our approach.

The Kirkpatrick's 4 levels model is probably one of the most well-known and widely applied. It considers 4 levels of training evaluation: reaction (a measure of satisfaction of the people involved in the training initiative), learning (a measure of knowledge and skills increase), behaviour (a measure of change in behaviour) and results (a measure of the effects on the institutions) (Kirkpatrick, 1994).

Guskey's 5-level model is also an extension of Kirkpatrick's, with the peculiarity of having been adapted to a teacher training context, thus paying special attention to effects on school contexts and students. It encompasses the following levels: participant reaction, participant learning, organizational support and learning, participant use of new knowledge and skills, student learning outcomes (Guskey, 2000).

3 The T&EAM approach

This section describes the T&EAM approach, the associated indicators, as well as the tools to be used for data collection.

3.1 Evaluating the technology acceptance with the T&EAM approach

As already mentioned, the TAM and its subsequent evolutions were chosen as the backbone approach to evaluate the technology in the T&EAM approach, even if it is acknowledged that this model was originally devised as a predictive tool. However, Persico *et al.* (2014) have already shown how the TAM indicators "perceived ease of use" and "perceived usefulness" can be used for ex-post assessment of the impact of a technology, by collecting information concerning users' opinions about these two indicators and complementing them with data gathered from other sources, such as observation and data tracked by the system itself. Furthermore, the subjective norm indicator introduced by TAM2 is also used.

The reasons for the choice of TAM and TAM2 indicators (Venkatesh & Davis, 2000) as main indicators of the T&EAM approach are two-fold: first, the number of experiences and studies where they have been applied witness their capacity to adapt to several contexts, including teachers' acceptance of technology (Huntington & Worrell, 2013; Persico *et al.*, 2014). Especially in those studies concerning the barriers to technology uptake by teachers (Delfino *et al.*, 2004; Lambert *et al.*, 2008; Lloyd & Albion, 2009), the TAM indicators have proved to be key determinants. Thus, training initiatives that can improve some of these factors are more likely to increase the chances that the proposed technology is adopted in the long run.

A second reason for this choice is that these models are applicable to any technology, if their indicators and the evaluation means are tailored to the system structure, functions and user types. This process of adaptation/tailoring is essential, especially when dealing with formative evaluation, as the accuracy of the problems' diagnosis improves with it.

Thus, in our approach the "perceived ease of use" and "perceived usefulness" indicators are used to build data collection tools aiming to understand the

users' opinions after use of the technology during ad hoc training event(s). In our model, these subjective data are complemented with more objective data about actual usage of the system. This latter information is typically obtained thanks to tracking mechanisms built in the technology, usually with learning analytics techniques (Persico *et al.*, 2014). These data provide, among other things, a measure of trustworthiness of the users' opinions. If, for example, a user says that a given functionality was easy to use, but tracked data show he/she never used it, his/her opinion is less trustworthy than that of a user who claims the functionality was difficult to use after having engaged with it for a significant amount of time.

3.2 Evaluating the workshops with the T&EAM approach

In the proposed approach, the evaluation of the training initiative(s) used to introduce the technology in one context is carried out according to Guskey's model (2002). This model is derived from Kirkpatrick's work (1994); evidence is collected and analysed at five critical levels:

1. workshop participants' reactions (i.e. perceptions on the training event);
2. workshop participants' learning (i.e. knowledge and skills gained);
3. organization support and change (i.e. impact on the organization where the participants work and organisation's support to the implementation of the innovation);
4. participants' use of new knowledge and skills (i.e. application of the acquired competence in the teaching profession);
5. student learning outcomes (i.e. impact on the students who are the ultimate beneficiaries of the innovation proposed).

While most evaluation models focus on levels 1 and 2, Guskey's model also takes into consideration factors that can facilitate or hinder innovation within an organization (level 3) and long term effects of the training events on participants (level 4), as well as on their students (level 5). This is the main benefit of this model in respect to the others.

According to the T&EAM, while level 1 to 3 are typically gauged at the end of the training event(s), level 4 and 5 data collection takes place after the follow up (medium term). The data collected from training participants are also complemented with data concerning the actual training sessions. These data are typically collected during the events by an observer, taking notes on the basis of a rubric.
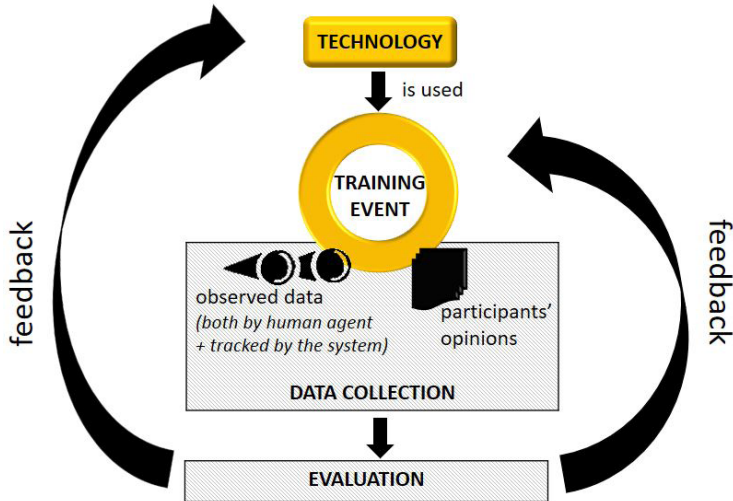
3.3 Data collection process

Fig. 1 - The T&EAM evaluation approach

Overall, in the T&EAM approach we have merged the TAM and the Guskey's models, customized their original indicators, and created joint evaluation means, thus forming a unique evaluation framework for data collection and data analysis.

The resulting T&EAM approach (see Fig. 1) allows to strike a balance between the need to carry out a deep analysis and evaluation of different aspects of the technology and the training events, on one hand, and the requirement to keep the effort of the users relatively low, so to make the approach more sustainable.

Fig. 1 represents the cyclic process of data collection and evaluation providing feedback on both the technology and the teacher training events. The data collected concern:

- Participants' opinions, gathered at the end of the training event(s), in a very easy and relatively unobtrusive way through questionnaires and interviews;
- Actual participants' behaviour during the events, annotated by human observers and/or automatic tracking.

The complete list of indicators is reported in Table S1 of the Supplementary file 1.
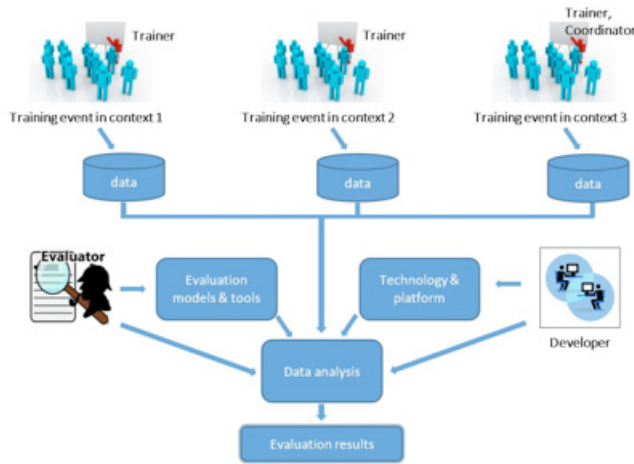
3.4 Managing evaluation within projects

Fig. 2 - Collaborative evaluation of training events according to the T&EAM approach

Boosting innovations into real contexts, in the context of complex (European) projects, is often done through several parallel events held in different locations and require data to be collected in a homogenous and comprehensive way (Pozzi *et al.*, 2015). The actors usually involved in projects of this kind, typically comprise (see Fig. 2):

- • a number of institutions/agents that carry out the pilot of the training events in one or more contexts (indicated as the trainers, in the following);
- • one institution leading the evaluation (identified as the evaluator in the following);
- • one actor in charge of the development and tuning of the technology (the developer).

The coordinating institution (the coordinator) could be any of the above actors, except the evaluator, to avoid conflicts of interest. The evaluator usually devises or instantiates the evaluation model, designs and produces the evaluation tools, coordinates data collection (which is carried out on site by the trainers) and carries out the data analysis (see Fig. 2).

In case the evaluation involves institutions in different countries, language problems need to be handled with the support of local partners; so, for example, the questionnaires should be developed in one common language (typically

English), and translated into the local languages. A first phase of analysis of any narrative (answers to open questions or interviews) should be carried out by the trainers, based on common guidelines provided by the evaluators, to produce raw data in English that can easily be interpreted by the evaluators.

4 Discussion

The T&EAM approach has been developed and experimented for the first time in METIS[1], a LLP Project aiming to foster methodological and technological innovations in learning design. In this project, the authors of this paper where in charge of the evaluation workpackage (Pozzi *et al.*, 2013; 2015a; 2015b). Within METIS, the target of the innovation were three different educational contexts (namely Higher Education, Vocational Training and Adult Education), thus the evaluation approach was applied to these three situations. Indeed, the T&EAM approach proved flexible enough to fit in with the three different contexts, and appears to be potentially exportable to several other educational contexts (Pozzi *et al.*, 2015).

The evaluation means were questionnaires and interviews based on rubrics produced in English by the evaluator and translated in Spanish and Greek by the local partners. A first round of the qualitative analysis was carried out locally, to produce English narratives corresponding to the open answers to questionnaires and interview transcripts.

Within the METIS project the application of the T&EAM evaluation approach yielded a wealth of information about ease-of-use, usefulness and actual use of the innovative technological system proposed to teachers (Asensio-Pérez *et al.*, 2017). These information referred specifically to the various functionalities of the technological system introduced by METIS, so the project partners were able to use them to improve and tune both the proposed technology and the training format, thus increasing the possibility that the technology is taken up by other actors in the same (or similar) contexts.

The approach allowed us to collect the data in a very unobtrusive way, with data collection carried out by the project partners in charge of the training in each context according to the guidelines provided by the evaluators.

This organization allowed for the T&EAM approach to be easily and consistently adopted and managed even by the partners who were not directly involved in its conceptualization. In particular, the online questionnaire proved to be very easy to be managed, once translated in the local languages; the interviews, carried out by the local partners and based on a common rubric provided in English, were slightly more complicated, because they required a certain amount of time and an effort to produce a synthesis in English of the

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[1] http://www.metis-project.org/

interviewee answers. Data collection through interviews was possible as long as the number of interviewees is relatively small; in case of big numbers, probably they should be replaced by questionnaires or even group data collection techniques, such as focus groups.

As far as the indicators are concerned, the ones deriving from the TAM model and devoted to evaluating technology acceptance provided information about ease of use and usefulness of each individual function of the software. Given that in METIS the number of functions implemented in the technology was very high, in order to make it easier for respondents to recall the functions referred to by the individual questions in the questionnaire, these were enriched with pictures of the platform, so to highlight the interface controls associated to the various program functions. This proved to be an effective strategy that allowed the users to straightforwardly understand the questions.

The indicators focusing on the training coming from Guskey's model were also very useful: not only did they yield information about the adequacy of the workshops in the different contexts, but they also informed us about the possibility that the technology would really be taken up in the various situations. Some problems emerged when collecting data about the Student Outcomes indicators, as it often happens in TEL research, because evidence about students learning appears very difficult to assess, as innovative methods and technologies cannot be easily compared with traditional ones. Probably, structured data collection protocols would have helped teachers to systematically collect more significant data about students learning ad this is something that should be fixed for future adoption.

Another challenge posed by the T&EAM approach regarded the juxtaposition of the data tracked by the system and those coming from the questionnaires and interviews. One of the reasons for these difficulties is the difference of granularity between the data typically tracked by the platform and those collected through the questionnaires and interviews. While the former are usually low level data, concerning individual actions of the users, the latter are higher-level data referring to the technology functions. Their comparison might require some effort to elaborate and aggregate the tracked data, so that they can be used to put in the right light the users' opinions on the technology functions.

As a last consideration, we should note that, usually the life span of a project is rather short and does not allow to wait for long term evidence that the innovation really permeates the target system. As a consequence, what can realistically be evaluated is the acceptance of the technology, the impact of the training event, as well as the short/medium term changes compared to the original conditions of the target context(s).

Conclusions

The T&EAM evaluation approach presented above aims to assess the acceptance of an innovative technology, when this is introduced for the first time into an educational context through some kind of training programme.

The novelty of the model lies not so much in the indicators and tools used, which mainly derive from other existing and well-known evaluation models, but rather in the way they are used and integrated into one coherent evaluation framework thus producing an overarching model. The proposed evaluation means jointly assess the technology and the training events and consider all the variables that may affect the uptake of the innovation, in order to produce a comprehensive picture of the forces that may foster or hinder the integration of the innovation into real conditions.

Even if the T&EAM has been conceived in the framework of one specific project, we believe the problem addressed is frequent in the TEL field, where many of the projects funded by the EC or other funding agencies aim to introduce methodological and technological innovation into established educational systems. For this reason, further research directions should aim to investigate transferability to projects with similar intents.

As to the authors, further research efforts will be devoted to the identification of the invariant factors of the model and of the degrees of freedom left to the evaluators when applying the model.

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