Participatory bottom-up self-evaluation of schools' smartness: an Italian case study.

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Abstract. This work presents the adaptation of the participatory approach used in the past to evaluate campuses' smartness to the case of K12 and High schools. The adaptation has been implemented taking into consideration both the *universalities* represented by the principles that have inspired the approach (i.e. satisfaction of needs described by the Maslow's pyramid and achievement of the "flow" state) and the *localities* represented by the evaluation framework put in place by the Italian Ministry of University, Research & Education (MIUR) through the INVALSI (National Institute for the Evaluation of Educational Systems). A pilot study is underway in several High and K12 schools. Preliminary results are reported and discussed.

Keywords: Smart Learning Ecosystems, Smartness Detection, Schools' smartness, Smart Schools, PCA, Flow state

1 Introduction

Schools, being the pillars of the educational systems (public or private), are the knots of one of the most widely spread network of ecosystems, that covers the whole national territory. Because of this, as discussed recently, schools are natural candidate to became drivers of social innovation and regional development.

Such propelling action, however, can be carried on effectively only if: a) the expectations of all groups of stakeholders involved in the educational processes - school staff, students, parents, territorial stakeholders - are known and b) if a detailed analysis of the educational processes is performed with the aim to find opportunities to stimulate synergies and co-participation and, finally, to improve the processes themselves and meet the needs of the community of reference. In other words you have to resort to a systemic approach and develop a dedicated design process. The first step is, unavoidably, the realization of a survey that can be shaped as a self-evaluation procedure. It has to allow for the collection of relevant information on the ecosystem and, as well, to establish benchmarks that could be used in the future to monitor and evaluate progresses of the learning ecosystem toward the achievement of an higher level of smartness. The main goals of the survey should be, thus, a) the involvement of all stakeholders in a participatory effort to gather their perceptions on

the ecosystem and their expectations; b) the identification of ecosystem improvement areas.

In the past we have developed a bottom-up participatory approach to support self-evaluation of ecosystems and applied it either to territorial ecosystems (e.g. smart cities [1]) and educational ecosystems (e.g. universities [2]) with the aim to detect the perceived level of their smartness and, as well, to make emerge the expectations of the stakeholders: citizens in the former case, students in the latter.

Two the assumptions that has been used in developing the approach:
a) the smartness of an ecosystem is related to its capacity to make achieve the state of flow [3] to the individuals that are part of the ecosystem and animate it;
b) the state of flow can be achieved only when all basic needs, described by the lower levels of the Maslow pyramid [4], are adequately met.

Accordingly we have developed a set of questionnaires aimed at obtaining information on the various aspects of the ecosystems, after having mapped these latter onto the levels of the Maslow's pyramid. The questionnaires have been designed to: i) obtain both quantitative and qualitative information on the different level of needs; ii) favor the "bottom-up" emergence of problems and expectations.

Compared with the case studies mentioned above - smart cities and universities - the application of the same bottom-up approach to schools requires additional efforts because it must be embedded into evaluation processes that may have been imposed to schools by the corresponding national educational system.

Specifically, in the case study considered here - that of the Italian schools system - any action has to take into account the complex evaluation system recently introduced by INVALSI (National Institute for the Evaluation of the Educational System) on behalf of MIUR (Italian Ministry of Education and Research) that imposes to all schools to produce the so called RAV (Self-Evaluation Report) [5].
The approach introduced by INVALSI, has been inspired by previous international experiences, and aims at evaluating schools as entities that provide a service to clients, i.e. families, who rely on schools to achieve the transformation of the raw material - their children - in a semi-finished element ready to access higher levels of education or, alternatively, enter into a productive context. Coherently to this vision the evaluation process introduced by INVALSI focuses on four aspects: 1) the *external context* to gather information on the boundary conditions; 2) the *internal context* to get information on available resources; 3) the educational *process*, with the intention to determine its efficiency and to identify the areas for potential improvements; 4) the *effectiveness of the process* thanks to the collection of numerical indicators (e.g. the achievement of appropriate level of numeracy and literacy).

Since the overall vision of the INVALSI framework tend to focus on service delivery and customer care it does not appear as the most suited tool to support the recovery and enhancement of constructive interactions among educational agencies - schools, families and territory - and the development of a participated action to foster and sustain the growth of the student. Despite of this the evaluation framework

introduced by INVALSI offers extensive possibilities for the integration of additional tools and the definition of additional indicators aimed at operating a more complete and, thus, better evaluation of the schools. A degree of freedom that when properly exploited, as we will see in the next paragraphs, allows to integrate into the INVALSI system a participatory and multidimensional approach with the goals to evaluate also the quality of the processes and to make emerge problems and stakeholders' expectations. Starting from the latter, then, you can co-design action plans aimed at improving the smartness of the school and, at the same time, to support social innovation and territorial development.

The goal of this paper is, therefore, to describe: a) the adaptation of our bottom-up participatory approach to the self-evaluation of learning ecosystems to get it integrated at best within the INVALSI framework; b) the first outcomes that emerged from a preliminary analysis of the data that have been collected to validate the approach.

2 Adaptation of the self-evaluation approach to monitor the schools' smartness

As anticipated above the questionnaires used for the participatory evaluation of the schools has been derived from a previous one used to evaluate the smartness of university campuses [6-10]. This latter originated an evaluation space composed by 10 indicators, or dimensions: *infrastructure, food services, environment, information & admin services, mobility, safety, support to social interactions, satisfaction, challenges and self-fulfillment*. The subsequent validation of the model conducted over two years, involving seven European campuses and the participation of about 1500 students, showed that the space of representation could be reduced by 4 dimensions - *environment, mobility, safety, satisfaction* - due to the strong correlation among indicators, and thus to the redundancy of some of them.

In the case of schools, as written in the introduction, we had to operate a redefinition of the questionnaire. This latter although continued to be inspired by the same vision had to incorporate also questions related to the main areas assessed by the RAV - *external context, internal context, process* and *process outcomes*.
The first step, thus, was to operate a mapping between the RAV and our bottom-up participatory approach with the aim to identify: a) aspects that can not be evaluated bottom-up because are closely linked to the collection of process or product quantitative indicators; b) aspects and/or indicators that are not included in the RAV but that can be integrated to improve the self-evaluation. Getting into the details:

• the *external context* in RAV is evaluated in terms of economic resources made available by the context to the school and in terms of socio-economic quantitative indicators;

in our bottom up approach the external context has been put in relation with the ability of the actors operating within the ecosystems - schools, family and territorial stakeholder - to create meaningful and constructive relationships i.e. social capital;

• the *internal context* in RAV is evaluated in terms of available funds, infrastructures and human resources;

in our bottom up approach the internal context is related to the quality of the elements that contribute to satisfy the needs represented by the lower levels of the Maslow pyramid: *resources* (to include infrastructures, equipments/artifacts that populate the educational place, human resources), *food services*, *quality of the environment*, *mobility* and *level of safety*;

• according to the prescriptions of the RAV - although often no suggestions on indicators to be adopted are provided - the *process* should be evaluated on many aspects: frameworks of reference used to design the process, instructional design to include didactic methodologies and evaluation approaches, scheduled actions, quality of the organization and organizational well-being, ability to involve all potential stakeholders, ability to mitigate problems, quality of socio-relational relationships, ability to manage and monitor the process;

in our bottom-up approach the process used to be related to the ability to generate social capital (see also external context), to offer challenges adequate to the competences of the actor (flow state) and to the overall satisfaction. In order to create a better integration with the RAV we have introduced a complex index, *process,* that includes the evaluation of both design choices and specific actions. Moreover we have transformed the *support to socialization* in a complex index to include the evaluation of the school climate, of the interaction among players and of the actions put in place to support inclusion, integration etc.

• *process outcomes* are evaluated by the RAV taking in consideration the outcomes of a quantitative test on literacy and numeracy competences, final students' marks, drop-out level, number of students' transfers, level of civic competences and, as well, by student carrier monitoring;

in our framework the goal is represented by: a) the achievement of the individual and community state of flow; b) thus by the increase of the level of all significant competences; b) by the increase in the smartness of the learning ecosystems.

Table 1 summarizes the aspects that are monitored by our bottom-up approach and shows the mapping on the RAV sections. Five different on-line questionnaires, containing both quantitative closed answers and qualitative open answers, have been made available on-line by means of LIFE environment [7] to collect opinions from students, teachers, technicians and administrative personnel, parents, and territorial stakeholders.

Table 1. List of the aspects evaluated by our bottom-up approach by means of the questionnaires. To each aspect has been associated an indicator or an index composed by several indicators. Last column shows the mapping of indices and indictors on the RAV sections.

Index	Quantitative Indicators	RAV section
Resources	Infrastructures Equipments Professional competences also open questions? yes	1.2.c; 1.3 (Economic and material resources) 1.4 (Professional resources)
Environment	Environment also open questions? yes	not included
Mobility	Acess & mobility also open questions? yes *(no students)*	partially in 1.3
Food services	Internal services External services also open questions? yes	not included
Safety	Internal safety External safety also open questions? yes Job security *(no students)*	not included
Support to socialization	Social climate Interaction among players Actions (integration. inclusion, diversity valorization, social&civic competences, support to social interaction) also open questions? yes	2.3 (Social&civic competences) 3.2.d & 3.2.e (Learning environment: relational dimension) 3.3.a (Inclusion)
Social capital	Interaction school-parents Parents involvement Interaction with territorial stakeholders also open questions? yes	3.7 (Integration with territorial stakeholders and schools-parents interaction).
Challenge	Challenges/opportunities also open questions? yes	partially included in 3.7.a-d

Index	Quantitative Indicators	RAV section
Process satisfaction	Design (agreement, clarity&sharing, tasks and resources allocation, organization) Actions (level of collaboration, inclusive actions, personalization, educational continuity, support to special needs, career guidance, support to self-evaluation) Wellbeing at work (valorization of competences, appreciation) *(no students)* also open questions? yes	3.1 & 3.2.c (Instructional Design and Evaluation) 3.5 (School management: strategic direction and organization) 3.3 (Inclusion and Personalization) 3.4 (Educational continuity and Career guidance) 3.6 (Valorization of human resources)
Process: Info-admin services	External communication Administrative simplification Interaction with the manager also open questions? yes *(no students)*	partially in 3.5
Self-fulfillment (and Flow)	Training opportunities and professional development (satisfaction, quality, impact) Dual education & Life Skills also open questions? yes	2.3 (Key competences) 3.6 (Development of human resources) partially in 3.7 (Dual education)

3 Preliminary results

Recently, the participatory approach described in the previous paragraph has been adopted by more than ten schools (K12 and high schools), located in the south-east area of the Rome city. Our approach has been adopted also because it has been considered a good starting point to design action plans capable to support the schools in getting "smarter ". In one K12 school the approach is already in use since two years.

Although a detailed discussion of the outcomes that emerged from the collected data is well beyond the goal of this paper nevertheless, in the following, we would like to present some preliminary considerations. The first one concerns the capability of the schools to involve the players of the learning process in the proposed participatory procedures. Participation of students was in general quite high in High schools and ranged from around 20% (worst situations) to more than 75% in the case of the largest participation. Participation of teachers was around 20-25% with some

exceptions where a participation level of 50-60% has been observed. Much lower has been the involvement of parents, usually around 4% with the exception of one school where the participation achieved the peak value of 15%. Participation of the technical staff was quite good, apart few exceptions, and ranged between 25% and 70%. No at all meaningful the participation of the territorial stakeholder. Overall these outcomes tell us that at present the schools - at the least those that took part in this study - look like as close systems with a limited interaction with the territory. More in general, they also indicate and confirm that interactions among educative agencies (schools, families, territory) are critically weak. The greatest part of the parents seem to consider schools as service providers rather than the engine of a co-participated educative project.

Despite of such general feeling we got also some positive signals that let hope for a better future: about one third of the parents that answered the questionnaire is available to collaborate with the school on many respects. Parents are also available to support economically the improvement of schools' infrastructures and didactic programs, especially if related to the acquisition of additional digital and horizontal competences. Concerning these latter we observed a discrepancy between teachers and parents. The former would prefer actions that can help students to acquire competences strongly related to the group dynamics (i.e. collaborative attitude, ability to establish interpersonal relationships, management of emotions and reactions, effective communication, etc.) while parents tend to privilege more individual competences that they think could be more relevant for the life, like: autonomy, critical thinking, and the self-motivation skill.

Another interesting aspect emerging from the first data screening is that all categories of players of the learning processes are largely favorable to support the development of the *excellence*: on average more than 70% of the parents, more than 80% of the students, more than 90% of the teachers. This means that after decades where the attention has been focused on students with special needs, nowadays schools and technologies are expected to support personalization of the didactics for all, also in the case of students whose potentialities would be repressed by a downscaling of the learning goals induced by the hope to make achieve to everybody a "lowest common denominator".

Finally we would like to shed a light on the detected differences among the perceptions that the main groups of players may have about the same school. Such differences have been carefully investigated for the case of the K12 school that have already adopted our method since two years. Table 2 and Figure 1 show the mean values of the 8 numerical indices - common to the main groups of players: - that have been extracted from the answers given to the quantitative questions by students, teachers and parents for both 2015 and 2016 cohorts.
Usually set of indicators like those considered in Table 2 tend to be affected by relevant correlations that, of course, should be investigated to identify the space of representation most adequate to show the differences among the schools taken in

Table 2. Mean values of the indicators extracted by the answers given to the close quantitative questions. The scale ranges between 1 and 10.

Indicator/University	Teachers 15	Parents 15	Students 15	Teachers 16	Parents 16	Students 16
Resources	5,66	5,68	6,74	5,98	5,97	6,43
Environment	5,88	5,29	6,86	5,92	5,69	7,01
Food services	5,86	5,45	3,80	6,22	6,32	4,69
Safety	6,15	6,79	7,39	6,32	6,79	7,66
Support to socialization	7,52	7,11	7,70	7,64	7,32	7,82
Social capital	6,57	6,09	6,25	7,31	6,46	6,12
Challenges	6,48	5,86	7,86	7,22	6,01	6,50
Process satisfaction	6,55	6,73	6,57	6,75	6,43	6,30
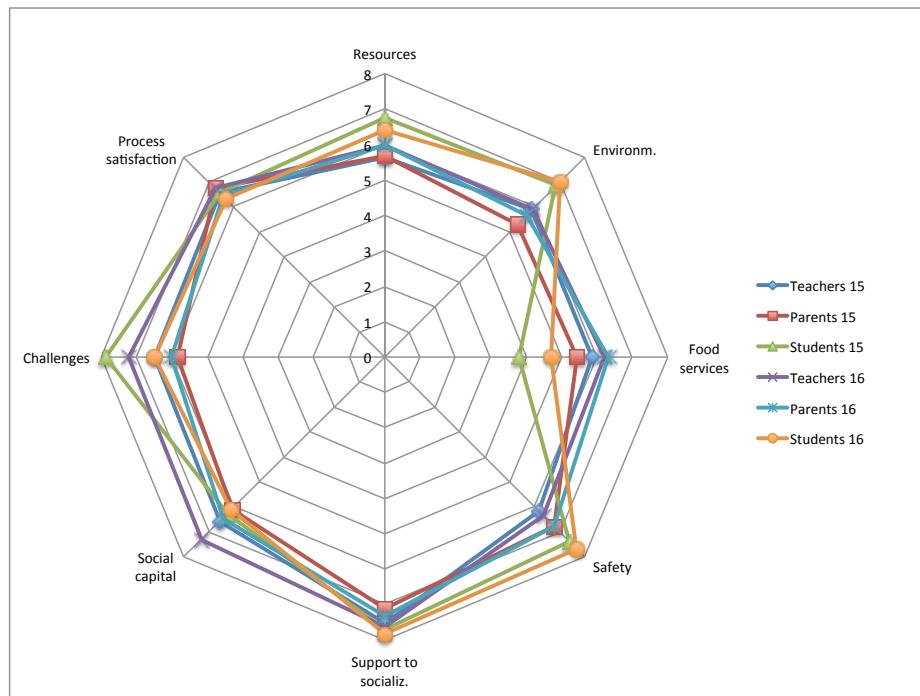
Fig. 1. Radar representation of mean values of the indicators reported in Table 2

consideration [6, 10]. In this specific case, however, we are dealing with what we may call "internal correlations", i.e. correlations among opinions expressed by different players involved with different roles in the same learning process. Our aim, thus, is to put in evidence possible differences among the perceptions that different groups of players may have and find the two-dimensional space of representation capable to show at best such differences. The inspection of the correlation matrix showed that the indices *Support to socialization* and *Process Satisfaction* are not helpful to distinguish among the groups of stakeholders. After their removal we were left with a six-dimensional space.
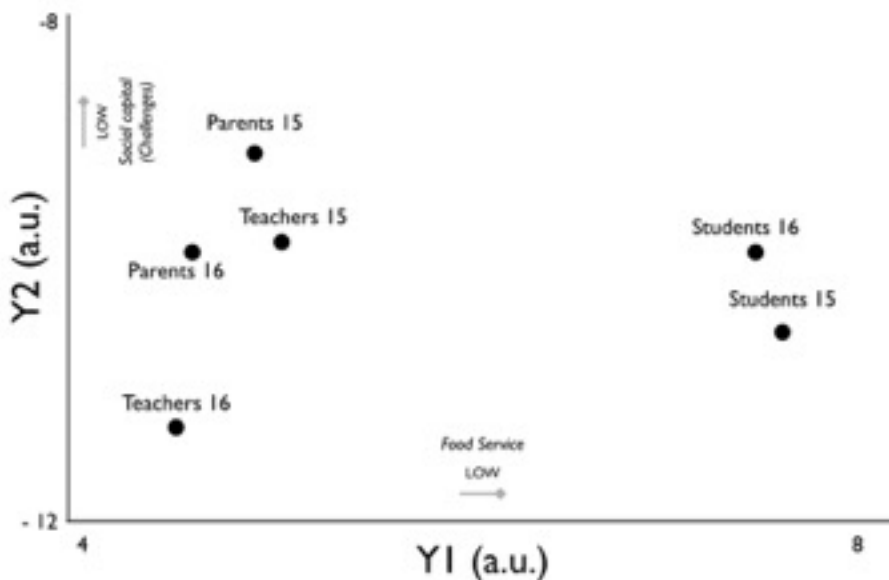
Fig. 2. Positioning of the categories of actors on the plane identified by the two principal components, Y1 and Y2, derived from a PCA applied to the reduced set of the indices: *Resources, Environment, Food services, Safety, Social capital and Challenge*

Other indices - *Resources, Environment* and *Safety* - show very strong correlation and all strongly anti-correlate with the indicators *Food services*. Using the Principal Component Analysis [8,9] we have checked that the removal of some of them do not affect significantly the loading on the first two components that remains always above 90%. The only observable effect of keeping all six remaining indices would be a proportional increase in the reciprocal distances among groups of player in the final two-dimensional space of representation, see Fig. 2. Since in this case our aim is to put in evidence differences we opted, despite the redundancy, for keeping all indices.

Y1 and Y2 (principal component used in Fig. 2), thus, are derived by the orthogonalization of the six-dimensional space composed by the indices: *Resources, Environment, Food services, Safety, Social capital and Challenge*.

It is interesting to note that in the case of the K12 school considered here, the position of the students on the Y1 axis is determined, at the same time, by an overall better perception of the school' smartness and by the worst perception of *Food services*, that anti-correlate with the other indicators.

In 2015 the overall perception by teachers and parents about the schools' smartness did not differ very much and increased slightly in 2016, mainly due to the larger discrepancy in the *Social capital* index.

Future work will concentrate on the detailed analysis of the collected data and on the extension of the investigation to others schools and, possibly, to others countries.

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