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An integrated evaluation framework - smartness, well-being, e-matury - for participatory evaluation of learning ecosystems: first application to two Italian high schools.

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Abstract. In this contribution, after a brief analysis of the critical issues associated with learning ecosystem evaluation frameworks, a participatory evaluation approach is proposed that aims to: (a) be people-centered and bring out the perceptions of all categories involved in educational processes - with particular reference to students, teachers and parents; this is in order to mitigate the objectivity bias associated with self-evaluations conducted by internal evaluation teams by means of top-down evaluation models; b) base the evaluation on an integrable set of multidimensional constructs such as smartness - capable of capturing both the "external" well-being associated with the quality of the context and the well-being perceived at an individual level - and e-maturity, i.e. the digital maturity of the context that defines its positioning (vision, plans and actions) with respect to the potential and opportunities offered by the digital transition; c) provide reference values with the intention of making evaluations of educational ecosystems both synchronically and diachronically comparable, as well as allowing for the elaboration of an adequate base of knowledge to facilitate the elaboration of improvement plans and to support evidence-based decision-making. The contribution includes also the description of a case study in which the participatory evaluation and the integrated evaluation framework were applied to two secondary schools in the city of Rome.

Keywords: smart learning ecosystems evaluation, participatory evaluation, smartness, well-being, e-maturity, high schools

1 Introduction

The evaluation of educational contexts (i.e. learning ecosystems), and in particular of schools, is a practice that has been affirmed and developed over the last fifty years but that still has not produced convincing and general standardisation, also because the culture of evaluation (Evaluative Thinking [1]) is still scarcely diffused.

The lack of standardisation and of adequate guidelines makes the evaluation practices of learning ecosystems a very complex process to implement, which would require the prior acquisition of a full awareness of what to do and, therefore, the ability to provide, already during the design phase, answers to many questions, such as: what is the purpose of evaluation? Who is to evaluate? What indicators are to be used? Which references to compare with?

There are many possible purposes of evaluation [2]: to capture the needs of a community; to monitor the progress of administrative and learning processes and verify

the extent of expected improvements, also with the aim to detect potential problems; to detect the impact actually produced by improvement actions, also in order to determine the cost-benefit ratio generated by the planned use of human and economic resources (outcomes very useful, for example, in an *evidence-based* social reporting). However, whatever the purpose of an evaluation process, it is beyond doubt that a fundamental aspect of this process is the identification of the *indicators* to be used. It is fundamental both in carrying out preliminary investigations useful to support a well-structured design; and in identifying the factors influencing the implementation of improvement actions in order to be able to grasp potential stickiness and barriers; and finally, in determining the impact produced by the processes put in place by the educational context, also for the purpose of effective communication to stakeholders.

The implementation of evaluation processes, therefore, is essential for the proper functioning and improvement of any learning ecosystem. Because of this reason, such processes cannot be the result of extemporaneous actions carried out by inadequately trained personnel who, as often happens, slavishly execute indications provided top-down by a central entity, for the sole purpose of complying with obligations imposed, without taking into account the peculiarities of the contexts and the expectations of the communities of reference.

Nevertheless, also because of the scarce diffusion of an adequate evaluation culture, it may be extremely useful to adopt evaluation frameworks, provided that they allow for a bottom-up strategy, that provide reference points (aggregated outcomes on a regional, national, etc. scale) with which to compare and from which get stimulation to criticallly reflect and foster co-design practices aimed at improving the learnings ecosystems. It is worth emphasising that having points of reference is quite different from producing rankings, which usually have the sole purpose of stimulating competition, often on the base of indicators which dependencies have not been properly investigated. A stimulus that can be very harmful, for instance, in self-evaluation processes, because of the objectivity bias it may induce. Evaluation practices, in fact, should never be carried out for the sole purpose of punishing or rewarding but, rather, as a useful moment to deepen knowledge of the context to be able to identify possible directions for improvements.

Taking such a perspective, however, is not sufficient to provide answers to the preliminary questions, listed above, one has to answer before to implement an evaluation process. This is because any evaluation practice presupposes and depends on the identification of a learning context model and, even more so, on the definition of the objectives that can be associated with the processes it puts in place.

For example, in models that focus on the achievement of standardised performance levels, the tendency is to impose top-down evaluation methodologies that must be implemented by internal evaluation teams. Often such self-evaluations, then, are possibly subjected, on a sample basis, to the scrutiny of external commissions, with the aim of identifying the necessary corrective measures to achieve the performance expected by those who proposed/imposed the top-down evaluation methodologies. In such evaluative approaches, there is usually a tendency to minimise listening to those for whom the educational processes are intended - the students - and to the stakeholders of the reference communities, such as families and entities operating in the territory; actors, the latter, with whom, usually, the schools attempt to develop profitable collaborations.

In Italy a concrete example of such an approach is represented by the RAV (Self-Assessment Report) [3], an evaluation framework realised by a central entity (Ministry of Education) in order to impose in schools the implementation of a self-assessment process and the triggering of an improvement process, mainly aimed at achieving better performance in the development of European key competences [4] and in standardised tests (see INVALSI tests [5], whose primary purpose is to allow a comparison between national systems based on the level of basic skills acquired by students) [6]. To tell the truth, the RAV would also provide for: a) an assessment of the school's management and organisational practices, even if, often, this is reduced to a reflection on the PTOF (Three-Year Educational Offer Plan) as a tool for achieving the objectives expected by the Ministry of Education, that allow for international comparisons; b) the possibility of supplementing the top-down evaluation questionnaire with questions relating to other aspects relevant to a specific learning ecosystem; unfortunately, however, this possibility remains unexplored by most of the internal self-evaluation teams (NIV). The RAV, in fact, tends, if not to neglect, to minimise many aspects relevant to determining the *smartness* (see next section) of a school ecosystem, such as the relationship with families and the territory, and the development of their adequate level of co-responsibility in the process needed to improve educational processes. So much so that the practice of systematically collecting the opinions of parents and stakeholders in the relevant territory is very rare. Completely neglected, then, is the identification of causal links between factors, which is particularly evident in the *evaluation of distance outcomes*, which are not linked in any way to the factors that might influence them. A further problem, which is not insignificant for this type a 'top-down' self-assessment approach, is the sustainability of a process of critical review of the RAVs produced by the schools, that are delegated to nuclei of external evaluators (NEVs, usually composed of three people). The critical review is necessary above all because of the bias caused by the tendency to self-evaluate more generously than necessary to provide a better image of the school (self-evaluation as a tool of positive representation and communication to stakeholders). This critical review, however, due to the limited resources available - both financial and human - can only be carried out for a limited sample of schools. A further problem with this type of critical review carried out by the NEVs can be identified in a further bias caused by the focus of the analysis, which tends to remain fairly confined to the objectives of interest to the central entity that prepared the evaluation scheme, i.e. the development of European key competences and, above all, the outcomes of the INVALSI standardized tests.

It is clear, therefore, that what is needed is the definition of an evaluation framework that can be supportive of and that can be integrated with the top-down imposed evaluation strategies, but that is also capable of involving bottom-up all the stakeholders of the educational processes.

2 The international landscape

Internationally, the topics of evaluation applied to organisations (especially learning ecosystems) and the development of an evaluation culture within such organisations are considered highly topical issues, as well as key factors for the success of

programmes and initiatives, for the implementation of improvement plans and for informed decision-making (*evidence-based decision-making*) [2].

Within the extensive literature that can be found on the web, it is possible to identify some key articles that illustrate both the various historical phases that the development of evaluation applied to schools (as organisations) has gone through, and the main evaluation models that are most in vogue today [8].

As far as the historical phases are concerned, it is pointed out that evaluation practices initially developed in the Anglo-Saxon context at the end of the 18th century, perhaps due to the influence of positivism but also because of the demand for evidence from a 'concrete' society largely influenced by the industrial revolution. As far back as the 19th century, the following were introduced: evaluative approaches aimed at testing basic competences such as knowing how to read, write and count [9]; the evaluation of student performance in order to assess the quality of the school environment and the processes it implements [10]; comparative evaluations between schools [10]. It was then in the so-called 'Tylerian Age' (1930-45) that evaluation was inextricably linked to the setting of objectives and the verification of expected results and, to some extent, long-term outcomes [10,11]. In the following decades, evaluation also began to be concerned with the relationship between the achievement of objectives and the resources invested [12]. Incidentally, this is an aspect that is too often neglected in system evaluations and that would be extremely necessary to enhance in order to assess the impact produced by the copious investments that have been allocated in recent years at European and National levels to projects focused on the improvement of both learning and management processes and on the support that digital technologies could provide to the improvement of these processes.

It is only since the 1980s, however, that a focus on standardisation developed in the field of evaluation, in particular for what concern the evaluation of school personnel. Since then, according to Hogan [8], evaluation approaches have progressively diversified both in terms of the focus - e.g. on the evaluation of objectives (also in terms of effectiveness) rather than on issues of interest for the improvement of management, etc. - and in terms of the type of actors involved - e.g. external experts (external evaluation) rather than leading actors (e.g. teachers and students) and stakeholders (families, etc.). However, in recent decades it would not appear that significant efforts have been made in the development of systemic approaches, both in terms of the constructs to be evaluated and in terms of the participation of the various protagonists and stakeholders in the evaluation process. For this reason, some of these approaches have often attracted criticisms for not being able to capture all the relevant dimensions of a learning ecosystem and/or all the significant spillovers produced by a given project/programme/activity. In spite of these limitations, the various approaches developed since the 1980s have produced a number of frameworks that still nowadays are taken by many as reference for the implementation of evaluation processes. Among the most popular are the CIRO (context, input, reaction, outcomes) [13] which considers the context in terms of needs, culture and objectives, and emphasises the design, students' expectations, and the outcomes of the process; Kirkpatrik's model [14] which integrates students' perceptions with the measurement of the effects on their knowledge and skills, as well as on the improvement of organisational aspects; the Phillips model [12] which, compared to the previous one, adds the evaluation of the return on investment (ROI); the CIPP (context, input, process, and product) [15] which,

although it may appear not far from the CIRO, would seem to be one of the most systemic, since it relates objectives and outcomes to the social acceptability, the cultural context and the technological adequacy of the educational context.

All of the above-mentioned frameworks - with the partial exception of the last one - tend, however, to be deficient when it comes to assessing the capacity of the educational context to benefit from the use of digital technologies (digital maturity). On this issue, as already described above [16], one can find in the literature the attempt to elaborate a sufficiently structured model carried out by Sergis & Sampson [17] and the DigCompOrg model [18] elaborated by the JRC-IPTS of the European Union. The latter can be used to conduct a self-assessment process of digital maturity both at the individual and context level thanks to a special online tool called SELFIE [19]. However, as already pointed out in [16], this tool cannot be used to assess regional and/or national ecosystems and does not offer benchmarks against which to compare, since access to the visualisation of aggregated results is not allowed. These are some of the reasons that recently prompted Giovannella et al. [16] to develop a new framework for assessing the e-maturity of the learning ecosystems.

The next section of this article, thus, will briefly describe the latest version of an integrated evaluation framework aimed at overcoming the critical issues listed above, and that is the result of ten years of constant revision and improvement. The following one will show this framework at work in a case study that involved two high schools in the city of Rome. As we shall see, it was possible to involve all stakeholders in the evaluation processes (participatory evaluation) and, furthermore, to produce a series of benchmarks. These latter can be used by other learning ecosystems wishing to adopt the same framework to self-evaluate, and to monitor the evolution of a given ecosystem with respect to the actions undertaken following, for example, an improvement plan (impact measurement). An evaluation approach and strategy that provide, thus, a solid base of evidence useful for the drafting of *evidence-based social reporting*.

In addition, it will be shown how the questionnaire approach also allowed us to study *the causal relationships existing between the indicators used to determine the* smartness, *individual well-being* and *e-maturity* of the learning ecosystem.

The article will conclude with a short section devoted to some final considerations.

3 The evaluation framework: smartness, wellbeing and e-maturity

The description that follows will be extremely brief because the evaluation framework used in this study has already been described in its general outline in a previous article (although in Italian) [16]. It is an evaluative framework focused on the *wellbeing* of the actors of the educational process. It takes in consideration all the macro thematic areas referred by the frameworks mentioned in the previous section (with the exclusion of return on investment, ROI), and integrates them into a single multilevel construct, called smartness (see Fig. 1), which includes both the relevant factors in determining the wellbeing inducible in individuals by the qualities of the context (in grey) and those that contribute to the definition of individual psychological wellbeing (SDT theory [20]: autonomy - competences - relatedness or relationality).

Fig. 1 shows how relatedness coincides with the need for satisfying social interactions, which can be considered as the basis of public appreciation and self-esteem and how, likewise, the highest levels of the smartness pyramid are connected to the ability of the techno-ecosystem to generate in the individual a state of strong involvement, i.e. flow state [21].

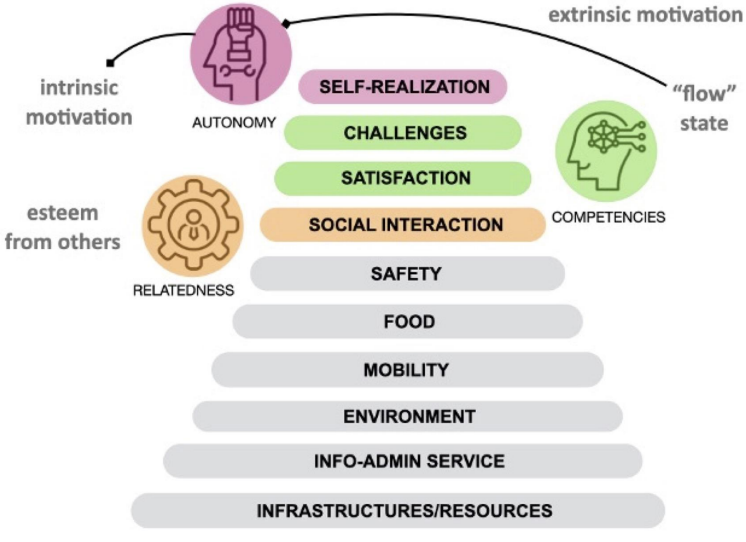

Fig. 1. ASLERD pyramid of the smartness/well-being of a people-centered ecosystem, from which it is possible to design a participatory evaluation process of any learning ecosystem [28,29], such as schools [22,25].

This framework can be integrated with the one useful to assess the level of e-maturity of the learning ecosystem (see Fig. 2). It is important to emphasise that e-maturity could be assessed as an independent construct, but it is preferable, and advisable, to carry out an integrated assessment of smartness and e-maturity because many of the factors that determine the latter also play a role in determining the former.
The result of the integration of the two frameworks is shown in Table 1 in Appendix A where are listed all the factors that were investigated in the case studies described in the next section.

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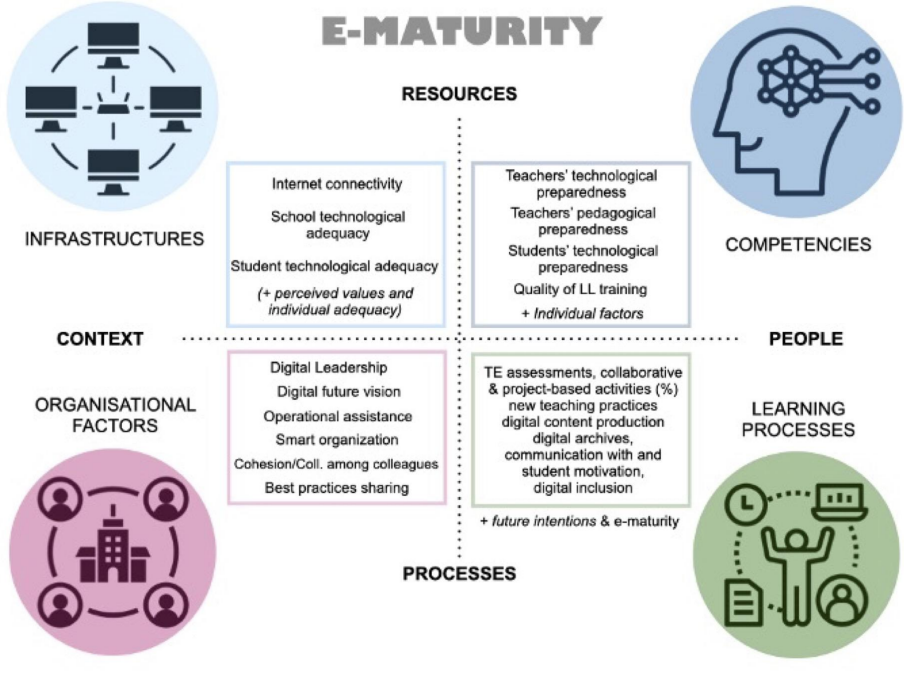

Fig. 2. Areas and factors contributing to the definition of the e-maturity construct of the school ecosystem broken down by blocks: Infrastructure, Competence, Organisational factors, Learning processes.

4 Case studies: the evaluation framework at work

The case studies involved two high schools in the city of Rome - which we will refer to as School A and School B - in which participatory evaluation of the smartness of the learning ecosystem had already been carried out previously, in 2016 and 2017, albeit using an earlier version of the evaluation framework [22].

The participatory evaluation process involved students, teachers and parents. A questionnaire was design for each category, containing a different number of questions - 106 for students, 85 for parents and 145 for teachers - in order to allow the evaluation of the factors of relevance to each category. Most of the questions required the selection of a numerical value on a 1-10 Likert scale and are the only ones that will be considered for the analyses described in the next subsections.

4.1 Socio-biographical background

In School A, 98 students (58F and 40M), 77 teachers (55F and 22M, average age 48.9) and 254 parents (209F and 45M, average age 47.9) participated in the evaluation process; previously, in the 2016 and 2017, respectively 1231 and 1567 students, 103 and 49 teachers, 29 and 26 parents contributed to the participatory evaluations.

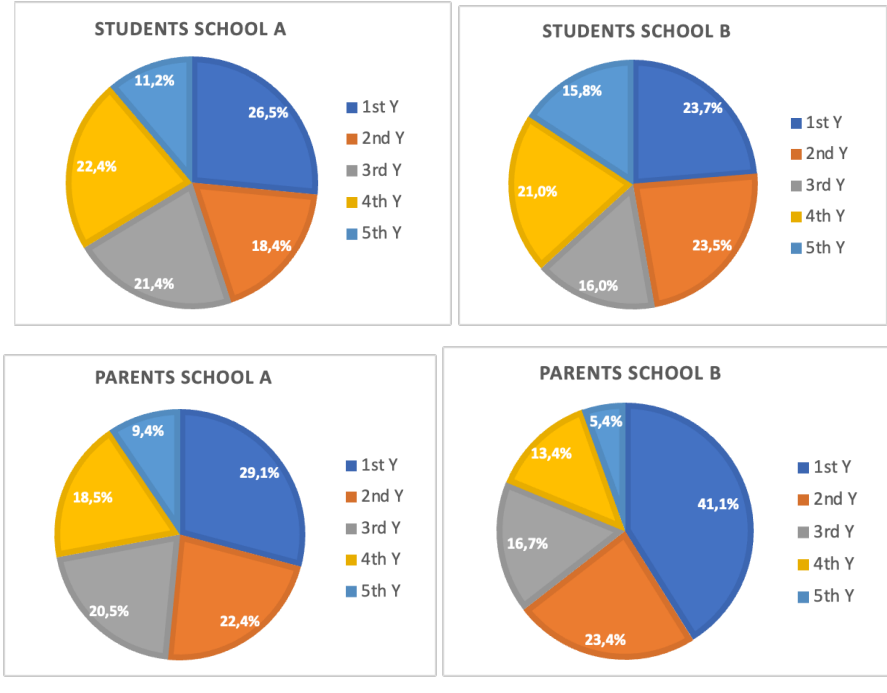

Fig. 3. Distribution of student and parents that took part to the evaluation process in 2023, according to the student's year of high school attendance.

Student participation was sharply reduced compared to previous evaluation campaigns due to the decision in 2023 to leave participation in the evaluation process optional. The student population was therefore represented by a sample of approximately 5-6% of the population. The adherence of teachers was on average the same as the adherence observed in previous evaluations, while the adherence of parents increased tenfold. A figure, the latter, that could be explained by an increased parental habit of 'digital participation' induced by the recent pandemic.

In School B, 695 students (126F and 569M), 102 teachers (69F and 33M, average age 48.4) and 209 parents (179F and 30M, average age 47.8) participated; previously, 515 and 510 students, 57 and 41 teachers, 28 and 47 parents, respectively, had participated in the 2016 and 2017 participatory assessments. It is noteworthy that parental adherence in School B also increased consistently with what was observed for School A. The increase in the number of teachers can be explained by the integration of several school sites into one school.

The distribution of students' and parents' according to the year of the student's attendance is shown in Fig. 3. It can be observed that the percentage of participation tends to be higher in the first year and to stabilise in the following years, and finally decrease sharply once they reach the fifth year, i.e. in the year in which the students leave school and in which the whole family is already mentally projected towards a new phase of life. This most likely tends to dampen the sense of belonging to the school

community. A partial exception is the distribution of school B students because in this case participation to the assessment process was not left optional.

4.2 Comparative analysis of indicators

Analyses conducted using the previous version of the smartness evaluation framework. For the sake of simplicity, we will not include in this contribution the tables containing the mean values of the indicator segmented for each category of participants, but only the tables of the aggregate values averaged over the various categories. We provide, as well, a table that indicate the factors that contributed to defining the individual indices, see Appendix B. This is to allow the reader to understand how the indices were calculated, which will then be used to perform both a comparison between schools and a comparison between categories of participants. The appendix contains two tables, the first shows the process of aggregating the indicators for the case of the evaluation framework used in the years 2016 and 2017 (which allowed for a temporal comparison with the outcomes of the participatory evaluation in 2023); the second shows how in the new framework the selected indicators and indices contribute to the definition of the values of the constructs *smartness* and *e-maturity* and, as well as, to the definition of the level of perceived *personal well-being*.
To compare the outcomes of the participatory evaluations conducted in the years 2016, 2017 and 2023 the average values of the following 8 indices were used: *Infrastructure, Environment, Food (services), Safety, Socialisation (support), Social Capital, Challenges, Process.* Again, to reduce the length of the article, the tables containing the average values of the indices corresponding to the perception of each category, used for the comparison between categories (see Figures 5-8), are not shown in the appendix.
The eight indices listed above, as one might expect, do not turn out to be completely independent - as shown by the correlation matrix - and, therefore, it was necessary to perform a base transformation to obtain a space whose axes were orthogonal to each other (principal component analysis [23-24]). Of such an orthogonal space, one usually considers the first two components, PC1 and PC2, on which most of the information is loaded. In such a two-dimensional plane, see Fig. 4, it is possible to represent the position of each school, as well as the contributions that each index makes to the two principal components.
As can be seen, almost all factors contribute significantly to the PC1 component, while the *food services* index contributes mainly to the PC2 component. This implies that higher PC1 values correspond to higher school smartness (the red line has been drawn as a guide for the eyes to show the direction of increasing smartness).
In fig.4, it is also possible to follow the evolution undergone by some learning ecosystem over the years. As far as our two case studies are concerned, the school corresponding to the case study A, was first characterised by a slight decrease of the level of smartness that occurred between the years 2016 and 2017 and then achieved a significant improvement over the following 6 years. On the other hand, the school corresponding to case study B after an increase of its smartness level observed between the years 2016 and 2017 has been subjected to a marked decrease in its value in the following years. Without going into the details of the variations of each individual indicator (of interest mainly to the actors of the learning processes and of the learning

ecosystems' stakeholders), such observed variations and trends in the smartness of the two schools have a macro explanation.

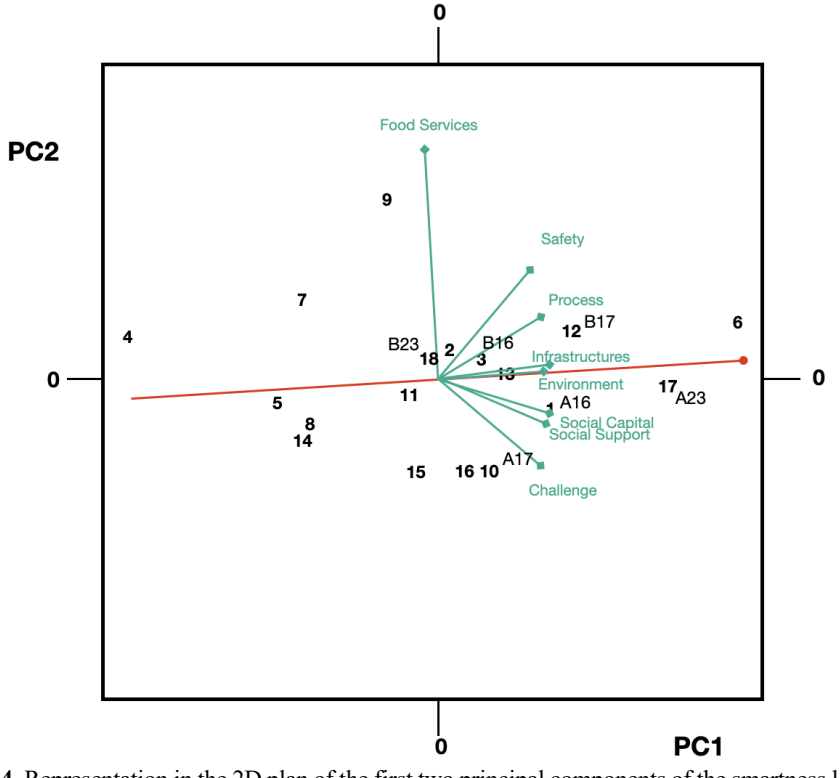

Fig. 4. Representation in the 2D plan of the first two principal components of the smartness level that characterize a set of the educational ecosystems (high schools). The participatory evaluation processes have been carried on between 2016 and 2023.

In case A, the trend can be explained by the replacement of the school principal that occurred between 2016 and 2017, and was followed by an initial period of necessary study and familiarisation with the processes in place, before a breakthrough could be imposed also in terms of sharing, co-designing and involvement of a large set of territorial stakeholders. In case B, on the other hand, the introduction of the participatory evaluation process and the subsequent involvement of all stakeholders in co-designing groups - with the following implementation of some of the suggested interventions - produced an initial increase of the perceived smartness level, which was thwarted in the following years due to the disempowerment of the co-design practice. A negative contribution could have been provided as well by the replacement of the school principal, who was faced with a difficult management of the relationships between two different school complexes that were merged after 2017.

Fig. 4 also shows the positions of other schools that were subjected to participatory evaluation between the years 2016 and 2023. The differences observed, of course, depend on one or more indices among those that contribute to the determination of the level of smartness of the learning ecosystem and thus may depend either on the social

context, on the management choices, on the infrastructural characteristics and resources deployed by the school and, finally, on the setting and quality of the processes implemented and delivered by school. It is important to emphasise that such analysis - albeit based on the evaluation framework defined and used in the years '15-'17 - does not only provide numerical reference (see Appendix B) but also a framework that can be used for diachronic and synchronic comparisons on the level of the perceived smartness of the learning ecosystem.

Analyses conducted using the present version of the integrated evaluation framework. Now we will show an example of the representations that can be obtained by using the new integrated evaluation framework described in the previous section and in Appendix A, applied to the two case studies of school A and school B. The representations in Fig. 5-8 were obtained again by mean a principal component analysis. Regarding smartness, the following indices were taken into consideration (see Appendix A): *Infrastructure and Resources, Environment, Safety, Organisation, Communication and Services, Educational Processes, Socialisation, Challenges, Flow*. Regarding the level of wellbeing perceived by individuals, the following indices were taken into account: *Wellbeing at work, perceptions regarding individual development and growth, perceptions regarding factors determining personal wellbeing*. Finally, regarding digital maturity, the following indices were taken into account: *technological infrastructures and resources, digital skills, organisational factors and relationships, and educational processes augmented by technology*.
In applying the new framework, the differences between the perceptions expressed by the categories that took part in the participatory evaluation - students, teachers, parents - were also studied and compared.

In fig. 5 we see the representation of the first two main components of smartness calculated using the new evaluation framework. Note that, as hoped and expected, the use of the new framework does not change the relative positioning of schools A and B.

Regarding the contributions of the indicators to the *smartness* of the educational ecosystem, fig 5 shows that *safety* contributes mainly to the PC2 component, the *environment* contributes almost equally to both components, while all other indices contribute mainly to the PC1 component. As usual, the red line indicates the direction of increase in smartness. The fact that all components contribute almost equally to the PC1 component attests the goodness of the model and the need not to neglect any of the indices that have been used to define the smartness of the educational ecosystem. In the same figure are also shown and compared the positioning of the smartness perceived by students (S), teachers (T) and parents (P). As has already been observed in the past, in similar studies in which the previous evaluation framework was used [29,30], the level of smartness of the context perceived by the students turns out to be decidedly lower than that perceived by the other stakeholders. More similar are the perceptions of teachers and parents who tend to differ mainly on the value of PC2.

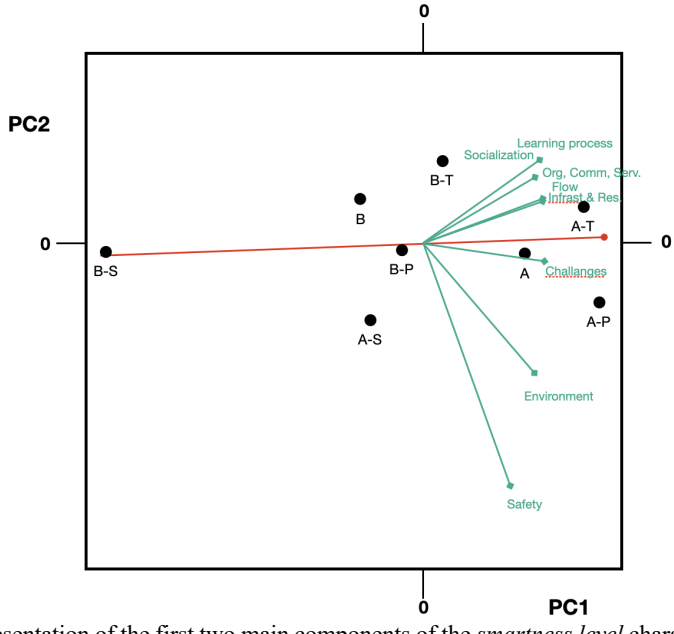

Fig. 5. Representation of the first two main components of the *smartness level* characterizing the two schools involved in the case studies; the evaluation processes have been conducted in 2023 using the new version of the integrated evaluation framework.

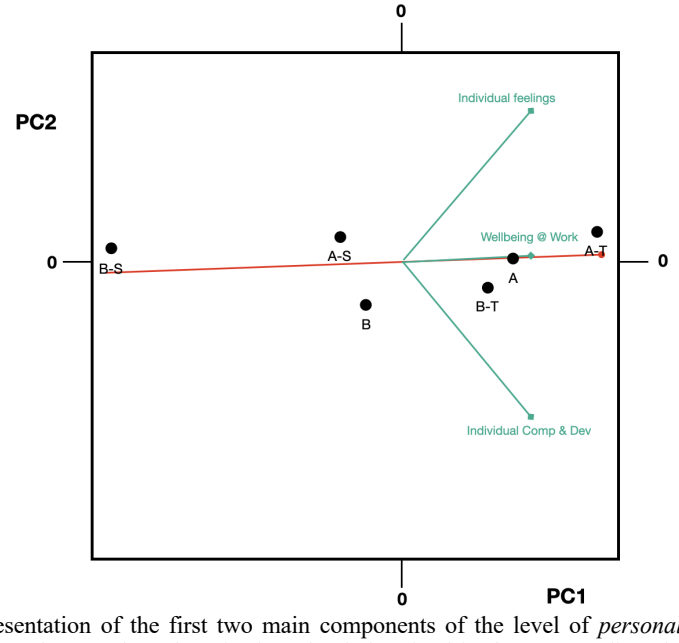

Fig. 6. Representation of the first two main components of the level of *personal well-being* perceived by students and teachers in the schools involved in the case studies; the evaluation processes have been conducted in 2023 using the new version of the integrated evaluation framework.

Figures 6 and 7 show the representations of the first two main components of, respectively, the level of *individual context-induced wellbeing* and the level of *e-maturity* of the context, as perceived by the categories of actors who assessed them, i.e. students and teachers. For these two representations the opinion of parents was not considered relevant because they are not directly involved in the activities managed and delivered by the school context.

In the case of the costruct *context-induced personal well-being*, the index *work-related well-being* contributes almost entirely to PC1, while the other two indices contribute equivalently to both components, albeit with opposite sign in the case of PC2. It is worth emphasising that all three factors contribute equivalently to PC1.

As far as *e-maturity* is concerned, all four indicators in the model (see fig. 2) contribute equivalently to PC1, while the intensity and sign with which they contribute to PC2 would tend to make them elide each other, obviously in the case where equivalent mean values were assigned to them by the stakeholders.

Also in the case of *personal well-being* and *e-maturity*, the levels perceived by students turn out to be lower than those perceived by teachers.

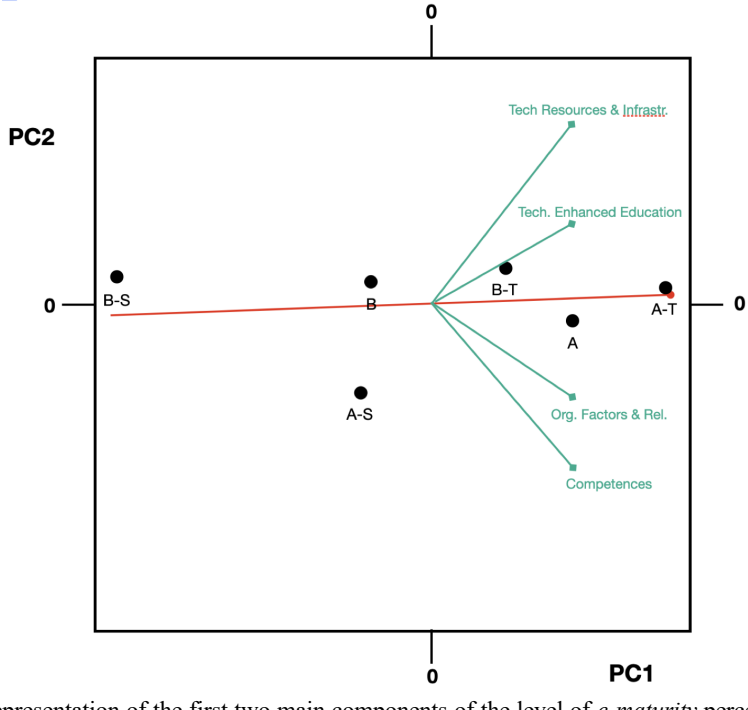

Fig. 7. Representation of the first two main components of the level of *e-maturity* perceived by students and teachers in the schools involved in the case studies; the evaluation processes have been conducted in 2023 using the new version of the integrated evaluation framework.

Figure 8, finally, shows how the three constructs *smartness, individual well-being* and *digital maturity* together contribute to the definition of a super-construct. *Individual well-being* contributes almost 100% of its value to the definition of the PC1 component of this super-construct, with an intensity equivalent to that of the other two constructs.

Digital maturity and *smartness*, on the other hand, contribute with opposite sign to the PC2 component.

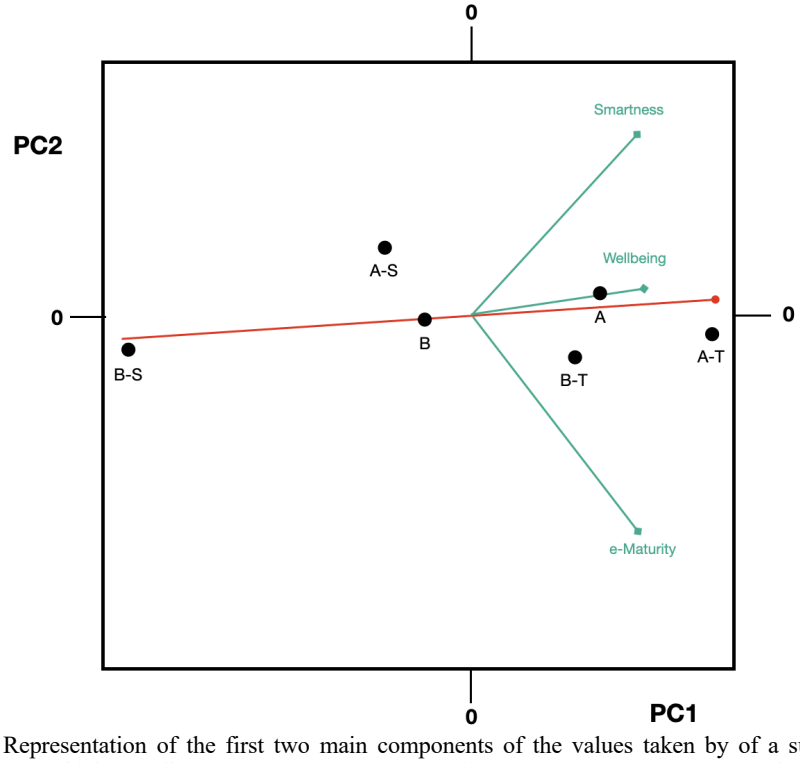

Fig. 8. Representation of the first two main components of the values taken by of a super-construct to which contribute *smartness, individual well-being and e-maturity*, as perceived by students and teachers from the schools involved in the case studies contribute; the evaluation processes have been conducted in 2023 using the new version of the integrated evaluation framework.

Causal relationship between indicators. The numerical data collected during the participatory evaluation do not serve exclusively to determine the value of the constructs described in the previous subsection and the positioning of the learning ecosystem on the 2D-planes of the first two principal components but, as already shown in previous works [16,30-33], in the presence of a substantial number of responses (a minimum of 100 for each group of stakeholders, although it would be desirable to exceed the threshold of 250), they can also be used to identify the causal relationships existing between the indicators taken into consideration by the evaluation framework [34].

As the study of the causal relationships between indicators is not an objective of this contribution, we limit ourselves here to show, Figs. 9-10 and 11, three examples of the causal networks extracted from the data of Case Study B (teachers, students and parents).

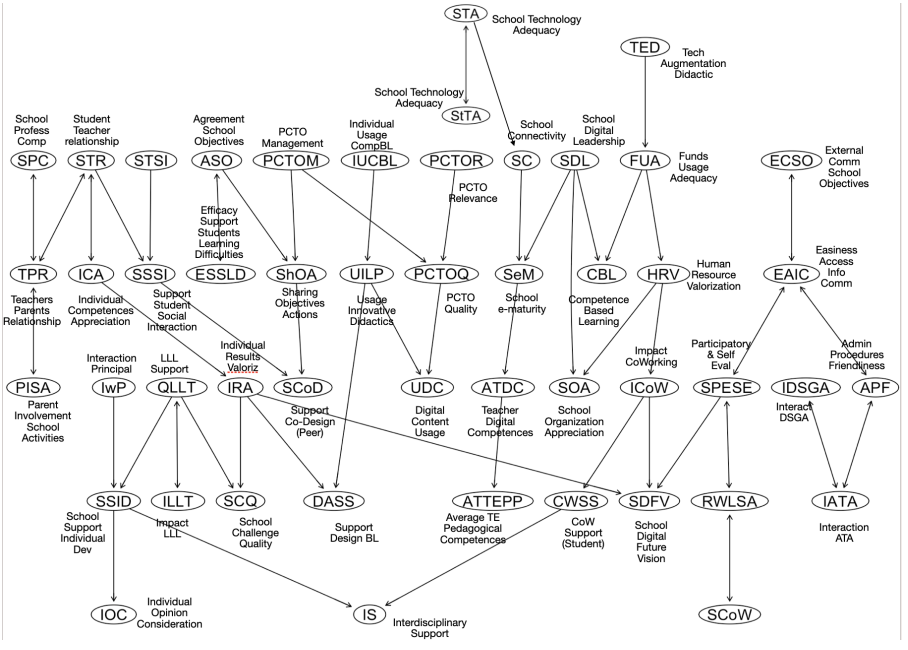

Fig. 9. Case study A: causal network linking the indicators assessed by the teachers.

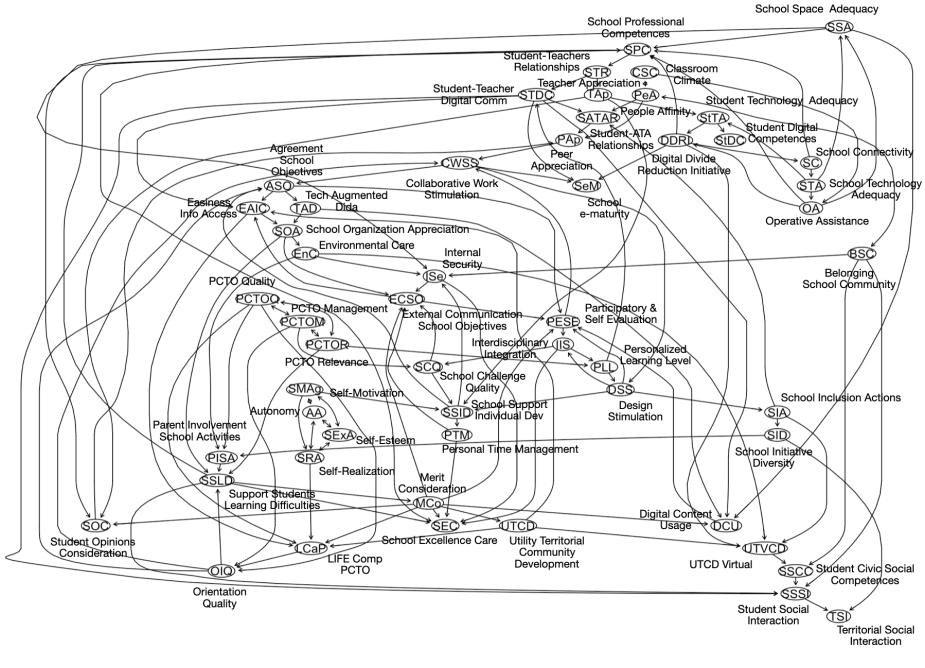

Fig. 10. Case study A: causal network linking the indicators assessed by the students.

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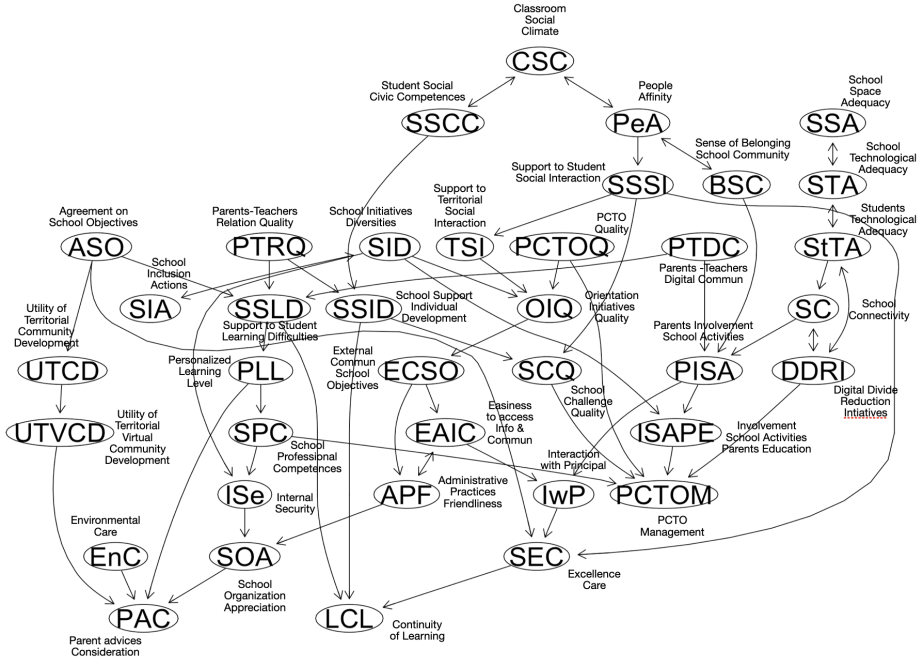

Fig. 11. Case study A: causal network linking the indicators assessed by the parents.

They offer only one example of the potential inherent in the evaluation framework described in this contribution (see Appendix A). Although we do not dwell on the analysis of the causal networks, we would like to point out that in the case of the teachers, since the number of participants in the evaluation process is just over 100, the causal network does not appear to be fully developed. It is also necessary to point out that in the case of the parents, the number of indicators represented in fig. 11 is smaller because they were asked to provide their opinion only on lower number of indicators.

5 Summary and future perspectives

In this article we have presented the evolution of a participatory bottom-up evaluation framework of learning ecosystems (schools, universities, work environments, etc.) that we can define as people-centred one. In fact, it has been constructed to gather the perceptions of all the stakeholders in relation to: a) the characteristics of the ecosystem that contribute to the wellbeing of the people involved in the processes provided by the ecosystem; b) the factors/indicators that more accurately describe individual wellbeing both as an independent construct and as part of a more general construct that defines the smartness of the ecosystem. Furthermore, considering the inevitable influence that can be produced by the use of technologies, it has been designed also to measure the ecosystem's e-maturity, i.e. the ecosystem's ability to take advantage of the digital transition underway.

Applying such framework to case studies the involved high schools of Rome, it was shown how, starting from the numerical data collected, it is possible to make both synchronic and diachronic comparisons between learning ecosystems, as well as being able to compare the opinions expressed by the various categories of stakeholders. It has also been shown how such comparisons can be expressed synthetically through a principal component representation in which it is possible to identify both the contribution made by each index to the value of the main constructs (*smartness, individual well-being, e-maturity*) and the direction in which the latter increase. As written above, from these analyses and representations it has been possible to grasp the difference of perception existing between the various categories of stakeholders. Such difference has shown that the evaluation of a learning ecosystem cannot be left solely to the self-assessment carried out by an internal evaluation nucleus of the learning ecosystem (NIV), usually composed only of members of the teaching staff. The latter, inevitably, will tend to be more generous in judging the learning ecosystem and the processes it delivers, since it is personally involved in them (*evaluative bias*).

This is even more so when a comparison is made between the perceptions of teachers and those of school principals who are responsible for managing the educational ecosystem and the processes it provides [16,27].

The perceptions of students, parents (in the case of schools) and territorial stakeholders (where it is possible to collect them) are fundamental in order to construct a descriptive framework that is as "objective" as possible and that can be used: a) as solid informative basis for co-design improvement plans and, hopefully, to stimulate an assumption of co-responsibility by all the actors involved in the learning ecosystem; b) to integrate self-evaluation processes that use proposed/imposed "top-down" methodology and tools.

The involvement of all stakeholders is fundamental because it makes possible to carry out both an internal evaluation - to which could participate the learning designers and those responsible for the delivery of the learning processes, as well as those who are the recipients - and an *external evaluation* - to which can contribute both families, (as the primary beneficiaries of the outcomes of the educational processes) and the stakeholders of the territory (organisations, associations, etc.) that, together with the whole of society, can be considered the secondary beneficiaries of such processes,.

It is important to emphasise how it is the repetition over time of participatory evaluation processes that makes it possible also to carry out a check on the effects/impact induced by the actions implemented to improve the learning context. The repetition of this evaluation practice therefore offers the possibility of drawing up an "informed", i.e. evidence-based, social reporting and, eventually, of assessing the return on investments (of capitals and human resources).

It is also important to emphasise, as shown in previous works [35,36], that the elaboration of both improvement plans and social reporting can be made more effective by the integration in the questionnaires of open-ended questions aimed at gathering detailed indications and justify the numerical values assigned to the various indicators.

Another fundamental aspect of the evaluation framework, which has emerged in the previous section, although not been examined in due detail, is the possibility of studying the causal relationship between indicators (possibly also by subgroups). This is a type of analysis that makes a qualitative leap forward in the evaluation process because the introduction of causality makes it possible, in principle, to understand how perceptions

concerning certain indicators can be influenced by those concerning other indicators. This makes it possible to identify factors on which future interventions should be focused on to achieve improvement along the entire causal chain.

Once the evaluation framework (which could obviously be subject to future refinement) and the analytics have been set up, the next step to be taken is to carry out a nationwide evaluation to elaborate bench markers for those who intend to adopt such a framework to carry out a bottom-up evaluation of the educational ecosystem they are affiliated to. Recently, thanks to an agreement between ANP (Associazione Nazionale Dirigenti Pubblici e Alte Professionalità della Scuola) and ASLERD, it was possible to carry out a preliminary survey of this kind involving school principals, teachers and parents. The results of this survey will be made public in a forthcoming publication.

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APPENDIX A

Table 1 - Factors making up the integrated evaluation framework *smarteness/well-being/e-maturity* grouped by domains. In brackets the acronyms that were used to identify the various factors/indicators in the analysis and representation of the results.

Domains	Factors/Indicators
Learning Ecosystem e-maturity: Technological resources and infrastructures Infrastructures	School Connectivity (SC); School Technological Adequacy (STA); Student Technological Adequacy (StTA) Individual Technological Adequacy (ITA) School Spaces Adequacy (SSA)
Learning Ecosystem e-maturity: Competences Other competences	Average Teachers' Digital Competences (ATDC); Average Teachers' Technology Enhanced Pedagogical Preparedness (ATTEPP); Average Students' Digital Competences (ASDC); Quality of Life Long Training (QLLT); Impact of Life Long Training (ILLT) School professional competences (SPC); Student Social & Civic Competences (SSCC)
Learning Ecosystem e-maturity: Organizational factors and relationships Other Organizational factors	School Digital Leadership (SDL); School Digital Future Vision (SDFV); Operational Assistance (OA); Enhanced Process Management (Smart Organization) (TESO); Technology Enhanced Process Management (TEPM); Technology Enhanced Peer Collaboration (TEPC); Easiness to Access Information and Communication (EAIC); Administrative Practices Friendliness (APF); Agreement on School Objectives (ASO); Sharing of Objectives and Actions (ShOA); Funds Usage Adequacy (FUA); Responsibilities and Working Load Sharing Adequacy (RWLSA); Human Resources Valorization (HRV); Support to Co-Working (SCoW); Impact of Co-Working (ICoW); Support to Co-Design (SCoD); Support to Participatory Evaluation and Self-Evaluation (PESE) -> SPESE; Cohesion among colleagues (CC); Best Practices Sharing (BPS) School Challenge Quality (SCQ); School Organization Appreciation (SOA); Parents Involvement in School Activities (PISA); External Communication of School Objectives (ECSO); Interaction with Principal (IwP); Interaction with DSGA (IDSGA); Interaction with ATA (IATA)
Personal factors: competences	Individual Digital Competences (IDC) + IDC1-5; Individual Technology Enhanced Pedagogical Preparedness (ITEPP)
Personal factors: wellbeing	Self-Fulfillment Increase (SFI); Self-Esteem (SEI); Esteem from Others (EfO); Autonomy Level Increase (ALI); variation in the Involvement Level (dIL); Self-Motivation Increase (SMI);
Personal factors: (Individual and Process levels)	Individual Competences Appreciation (ICA); Individual Results Valorization (IRA); Individual Opinions Consideration (IOC); School Support to Individual Development (SSID) Personal Time Management (PTM);

Technology enhanced educational e-maturity: activities	Technology Enhanced Didactics (TED); Technology Enhanced Collaborative Activities (TECA); Technology Enhanced Design Activities (TEDA); Technology Enhanced Evaluations (TEE); Technology Enhanced Personalized Learning (TEPL); Technology Enhanced Reinforcement (TER); Usage of Digital Content (UDC); Communication with Students -Teachers Digital Communication (STDC); Parents-School Digital Communication (PSDC); Digital divide reduction initiative (DDRI);
Educational activities/processes	Collaborative Work Support & Stimulation (CWSS); Design Activities Support & Stimulation (DASS); Competence Based Learning (CBL); Individual usage of CBL (IUCBL); Usage of Innovative Learning Practices (UILP); Interdisciplinary Stimulation (IS) PCTO Satisfaction/Quality (PCTOQ); PCTO Management (PCTOM); PCTO Relevance (PCTOR); Orientation Initiative Quality (OIQ); Personalized Learning (PL); Support to Excellence Development (SED); Efficacy of Support to Students with Learning Difficulties (ESSLD); Learning Continuity Assurance (LCA)
Outcomes e-maturity: Learning ecosystems	Degree of e-Maturity (SeM)
Smartness	
Smartness: Social Interaction Networking & Community (Pact)	Classroom Social Climate (CSC); Students-Teachers Relationships (STR); Teachers-ATA Relationships (TATAR); Teachers-Parents Relationships (TPR) School Initiative about Diversity (SiD); School Inclusion Action (SIA) Support to Student Social Interaction (SSSI) Peer Relationships Quality (PRQ); [School Networking Adequacy (SNA) (national & international level);] Belonging to School Community (BSC); Support to Territorial Social Interaction (TSI); Utility of Territorial Community Development (UTCD); Utility of Territorial Virtual Community Development (UTVCD); [Belonging to School Territory (BST) ; School Space4 2 students (SS4S); Availability to support the School Community (ASSC); Availability to support the School Territory (ASST)]
Smartness: Safety	Internal Safety at Work (ISeW); Internal Safety (ISe); External Safety (ESe)
Smartness: Food	Food Service Adequacy (FSA)
Smartness: Mobility	Internal mobility (IMo)
Smartness: Environment	Environmental Care (EnC)

APPENDIX B

Table 2 - Indices used to define the *smartness* of a learning ecosystem in the evaluation campaigns carried out in 2016 and 2017 with the relative average values found in the two case studies considered in this article. The two values shown correspond to the mean values weighted for the number of participants in each category and the unweighted mean values.

Indices	**2016 A** (MP/M)	**2017 A** (MP/M)	**2023 A** (MP/M)	**2016 B** (MP/M)	**2017 B** (MP/M)	**2023 B** (MP/M)
Smartness: integrated values						
Infrastructures/ Resources [SSA, STA, SPC)	6.48/6.77	6.98/6.59	7.23/7.19	5.97/6.56	6.50/6.94	6.15/6.38
Info-Admin Services [ECSO, APF, IwP, IDSGA, IATA]	7.47/6.86	6.55/6.48	7.01/6.75	6.74/6.67	6.99/6.79	6.52/6.30
Environment [EnC]	6.10/6.49	5.66/5.97	6.55/6.35	5.40/5.80	5.82/6.06	5.18/5.47
Mobility [Imo]	7.11/7.28	6.99/7.12	7.50/7.41	6.45/7.05	6.98/7.29	7.50/7.17
Food [FSA]	5.86/6.19	5.75/5.45	6.71/6.62	6.31/6.49	6.89/7.04	6.786.99
Safety [ISe, Ese]	6.52/6.59	6.42/6.69	7.21/7.14	6.13/6.48	6.59/6.82	6.30/6.44
Socialization	6.72/7.07	6.65/7.00	7.35/7.36	6.18/6.80	6.61/6.93	6.41/6.78
Socialization subindices						
School Climate [CSC, PRQ, SSCC]	7.01/7.10	7.03/7.16	7.18/7.25	6.46/6.82	6.84/6.78	6.42/6.61
Relationships [STR, TPR, TATAR]	6.85/7.39	6.68/7.09	7.49/7.53	6.29/.6.99	6.61/7.09	6.80/7.20
Support to socialization [(SSSI), SiD, SIA]	6.30/6.74	6.25/6.75	7.37/7.31	5.80/.6.61	6.37/6.93	6.02/6.54
Challenges [SCQ]	5.91/6.20	6.10/6.44	6.92/6.83	5.16/6.09	5.96/6.42	5.69/6.08
Flow [well-being at work, challenges, (ILTT), SSID PCTO]	-/6.04	-/6.11	-/6.89	-/6.23	-/6.45	-/6.31
Other indices						
Learning process	6.78/6.74	6.22/6.38	7.02/6.86	6.19/6.59	6.47/6.68	6.08/6.29
Learning process subindices						

Learning process: design [ASO, ShOA, FUA, RWLSA, SOA, SCoD]	6.56/6.88	6.22/6.54	7.24/7.10	5.96/6.64	6.35/.6.74	5.83/6.28
Learning process: activities [SCoW, ICoW, ESSLD, LCA, OIQ, SED, SPESE]	6.30/6.49	5.80/6.12	6.81/6.74	5.88/6.46	6.07/6.52	5.90/6.30
Well-being at work [HRV, ICA, IRA, IOC]	-/6.57	-/6.19	-/6.79	-/6.53	-/6.72	-/6.47
Social capital (community) [SSSI, SSCC, TSI, PISA]	6.03/6.55	5.92/6.15	6.88/6.83	5.82/6.48	6.03/6.49	5.92/6.36

Table 3 - Indices used in the new integrated evaluation framework to define the *e-maturity* and *smartness* of a learning ecosystem, as well as the level of *well-being* perceived at a personal level by the various actors in the educational processes. The average values found in the two case studies in this study are also reported. The two different numerical values correspond to the means weighted for the number of participants in each category and the unweighted means. For the personal be-ness, in addition to the mean values calculated on the entire population of respondents, the values corresponding to the individual categories: students (S) and teachers (T) are also reported.

Indici	**2023 A** (WM/M)	**2023 B** (WM/M)
e-maturity		
e-maturity factor [SeM]	**7.01/6.94**	**6.23/6.64**
e-maturity: mean of subindices	**6,82/6.82**	**6.26/6.56**
e-maturity subindices		
e-maturity: technological resources and infrastructures [SC, STA, StTA, ITA]	7.01/6.96	6.44/.6.64
e-maturity: competences [ATDC, ATTEPP, ASDC, QLLT , ILLT, IDC]	6.84/6.85	6.65/6.71
e-maturity: organizational factors and relationships [SDL, SDFV, OA, TESO, TEPC, EAIC, APF]	6.82/6.86	6.26/6.35
e-maturity: technology enhanced educational activities [TED, TECA, TEDA, TEE, TEPL, TER, UDC , STDC, PSDC, DDRI, IAE]	6.60/6.60	5.84/6.24
Smartness		
Average Total Smartness	**7.05/7.00**	**6.33/6.53**
Infrastructures/Resources & Competences [e-maturity factors + SSA, SPC)	7.05/7.01	6.42/6.58
Organization-Communication-Services [e-maturity factors + SOA, ECSO, IwP, IDSGA, IATA]	7.03/7.03	6.48/6.48
Learning Process (LE contextual index)	6.88/6.88	6.39/6.63
Learning process subindices		

Learning process: design [ASO, ShOA , FUA, RWLSA, SCoW, ICoW, SCoD, ICoD, BPS]	*7.03/7.01*	*6.65/6.72*
Learning process: activities [PL, ESSLD, LCA, OIQ, SED, SPESE, IS, UILP, CBL, CWSS, DASS]	*6.73/6.76*	*6.13/6.54*
Environment [EnC]	6.55/6.35	5.18/5.47
Mobility [IMo]	7.51/7.52	7.22/7.26
Food [FSA]	6.71/6.69	6.78/6.93
Safety [ISe, ISeW]	7.72/7.64	6.66/6.74
Socialization	7.15/7.13	6.31/6.70
Socialization subindices		
School Climate [CSC, PRQ, SSCC]	*7.11/7.11*	*6.31/6.58*
Relationships [CC, STR , TPR, TATAR]	*7.50/7.54*	*7.03/7.17*
Support to socialization [SSSI, SiD, SIA]	*7.23/7.20*	*6.06/6.56*
School community and networking [LSNA, ISNA, STSI, UTCD, UTVCD]	*7.20/7.12*	*6.18/6.64*
Social capital [PISA, BSC, BST, ASSC, ASST]	*6.70/6.69*	*5.96/6.52*
Challenges [SCQ]	6.92/6.83	5.69/6.08
Flow [QLTT, ILTT, SSID, PCTO]	7.00/6.96	6,21/6.49
Wellbeing (STUDENTS/TEACHERS)		
Average Total Wellbeing	6.69/6.72 (/6.25S /6.97T)	6.03/6.31 (/5.60S /6.65T)
Individual feelings [SFI, SEI, EfO/AbP/T, ALI, SMI]	6.03/6.08 (/5.64S /6.45T)	5.14/5.51 (/5.01S /5.92T)
Individual competencies & development [IDC, ITEPP, ICA, SSID)	7.04/7.06 (/6.51S /7.22T)	6.65/6.83 (/6.02S /7.09T)
Wellbeing at work	7.00/7.03 (/6.59S /7.23T)	6.30/6.58 (/5.78S /6.94T)
Wellbeing at work subindices		
Relational factors [HRV, IRA, IOC, ICA, PRQ]	-	-
Organizational factors [ASO, RWLSA, PTM, SOA, ISeW]	-	-
Other factors [EUDT]	-	-