Special issue
The "new normality":
Digital technologies
and learning environments
beyond the emergency

Edited by
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Activating teachers' epistemic agency to implement knowledge building in classroom: A case analysis of the "Classi in rete" project

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Abstract

In this study we examined whether a training oriented to activate Epistemic Agency (Scardamalia, 2002) of teachers can allow them to take the Knowledge Building (KB) perspective and to realise the appropriation of the use of the Knowledge Forum (KF) environment. During the project "Classi in rete", promoted by INDIRE, 22 teachers from primary and lower secondary Abruzzi small schools participated in an online discussion in KF, focused on problems in implementing the KB model. Data has been analyzed through content analysis of the KF notes and using analytics tools of KF. Results showed the teachers' assumption of KB perspective by the prevalent exploratory nature of the problems identified, by the focus both on technological and teaching aspects and by the work to find different solutions about a particular challenging problem. The appropriation of KF is shown by the increase, during the training, of reading and writing activity

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and by the correlations among reading, writing, and improving notes activity. Implications for teachers' training are discussed.

Keywords: Knowledge Building, Teachers' Training, Epistemic Agency, Problem Solving, Small School.

Introduction

Small schools are educational contexts often characterized by isolation, which does not refer only to the "physical distance" of the communities in which the small schools are located compared to urban areas, but also to a "cultural distance". Small and isolated schools face unique challenges associated with geographic isolation, difficult multicultural integration, and limited school and community resources (Curran & Kitchin, 2021; Johnson & Strange, 2007; Odell, 2017; Sze, 2004). In these contexts, the idea of educational fragility emerges (du Plessis & Bailey, 2000; Ryan, 2001) and a request from parents for interventions capable of supporting quality educational programs for their children.

In order to try to counter this risk, safeguarding small remote schools and ensuring quality education even in the most isolated and difficult to reach places, an experimentation project was developed by INDIRE (Mangione & Pieri, 2019, 2021; Mangione et al., 2021). The project intended to implement, in a network of small schools, the "Classi in rete" model, originated from the study of a Québec government initiative called *École éloignée en Réseau* (Allaire et al., 2009). The pedagogical approach of "Classi in rete" can be summarized as follows:

1. *classrooms as Knowledge Building communities* (Scardamalia & Bereiter, 2021). A setting that fosters collaboration and is characterized by a particular class dynamic which promotes respect, dialogue, and mutual help. The pedagogical intentions, like the students' learning intentions, are formulated openly, and everyone, according to their specific aptitudes, helps to achieve the desired learning objectives.

2. *problem-based teaching*. The study of authentic problems is at the heart of the pedagogical approach of "Classi in rete", given that it involves students in real-life problems, having time for their creativity and allowing them to take a deeper look at the individual and at a collective understanding of an issue.

3. *fostering dialogue within and among classrooms using technology*. Involved in studying a real-life problem, students are first invited to ask questions and to express ideas about their own understanding of the problem and, later, to work together on improving the seemingly most promising ideas to better understand the problem, or even solve it. The class dialogue progresses as students analyze the various aspects of a question, the results of their research and the data collected. It is incremented by written contributions published on forum and verbal exchanges in class or during videoconferencing.

In particular, the idea of a classroom as a Knowledge Building community (KBc) is borrowed from the Knowledge Building (KB) model (Scardamalia & Bereiter, 2010; 2021). In a KBc knowledge is viewed as a social product, with students collaborating to advance the community knowledge through social interactions starting from authentic problems identified by community members (Scardamalia & Bereiter, 2006). According to Hakkarainen (2003), it is possible to distinguish between *factual problems*, that is to say questions to be answered with factual information (who, where, when, how many etc.) and *explanatory problems*, questions satisfactorily answered with an explanation (why, how, what-if etc.). Successful knowledge building is characterized by the generation of explanatory questions. These types of questions are, in fact, those on which it is possible to activate the progressive problem solving to find explanations and solutions.

The KB model is defined through 12 principles that can serve as pedagogical guides, technology design specifications, and bases for evaluating existing practices (Scardamalia & Bereiter, 2010). One of these principles highlights participants' *Epistemic Agency*. Assuming Epistemic Agency means for KBc members to "recognize both a personal and a collective responsibility for success of knowledge building efforts" (ivi, 2010, p. 10). In other words, members are collaboratively engaged on creating knowledge useful for the community about

problems of common interest. Consequently, to implement a KBc it is important to activate the Epistemic Agency of participants, giving them the opportunity to identify problems of their interests on which to develop a collaborative inquiry.

In a KBc problems of inquiry are addressed thanks to the support of a technology developed in parallel to the KB model and in this experiment used to support the "Classi in rete" model: Knowledge Forum (KF) (Scardamalia, 2004). KF is a multimedia online environment created to support knowledge building activity. KF, indeed, provides specific spaces for discursive interaction called "view", where the members of a KB community can share their ideas, questions, and problems of understanding using notes, that is to say written contributions. Participants can connect their contributions to the notes posted by the other members using the build-on function. In a KB community, all members take "collective cognitive responsibility" (Scardamalia, 2002), for generating and advancing ideas that "live in the world", through the public community knowledge space of KF. As highlighted by Cacciamani (2017), an important indicator of collective cognitive responsibility is the interdependence between community members in the KB activity, shown by the relationship among the members' writing and reading activities in KF. When community members contribute to the community knowledge in KF, indeed, they read the contributions by their peers (informative participation) and post notes building on others' ideas (productive participation). Following this assumption Cacciamani (*ibid.*) studied the correlation between informative and productive participation as evidence of interdependence among community members, considered as an indicator of the collective cognitive responsibility (Cacciamani et al., 2021). The correlation between the two different kinds of participation indicates, then, the assumption of collective cognitive responsibility, and can be considered also evidence of the appropriation of the KF use.

When introducing an innovative work model and a new technology at school, it is very important to provide training that allows teachers to play an active role in innovation management (Bonaiuti et al., 2017). The present study, therefore, set out to analyse whether the training for the implementation of the "Classi in rete" model, aiming

to activate the teachers' Epistemic Agency, allowed them to take the perspective of the Knowledge Building model and to appropriate the use of KF online environment.

With reference to the assumption of the KB perspective the research questions are:

1. Are the problems formulated by the teachers mainly factual or explanatory?
2. In which thematic area are the problems identified by teachers located?
3. Which of these problems has been the most elaborated?
4. What solutions are proposed with respect to the most elaborated problem?

With reference to the appropriation of the use of KF the questions of inquiry are:

1. Is there any difference in the level of teachers' participation with reference to the different phases (supported by the training staff vs autonomous) of the training?
2. Is there any relationship among the different kinds of participation?

Method

Participants

The "Classi in rete" project involved 12 small schools of Abruzzo (Italy), 11 digital animators, 31 teachers, 6 observers (school principals). The present study examined, in particular, the data of 22 teachers (20 F, 2 M) of primary and lower secondary school and among them 7 digital animators.

Context

The training took place from September 2020 until January 2021, before the work with the classrooms, in an on-line laboratory mode. It

was supported by an online environment (Moodle) that integrated Video Conference System (Cisco WebEx), an asynchronous Computer-mediated communication (CMC) technology that provides a shared discourse environment (Knowledge Forum) and a Twin Design Spaces. The training addressed the educational processes underlying the principles of the "Classi in rete" model.

The presentation of the KB model was managed through videoconferences and KF version 6 was used (see Figure 1), whose analytic tools made possible to trace the participants' discursive interaction. KF, indeed, is an online environment developed to support the production of knowledge (Scardamalia, 2004).
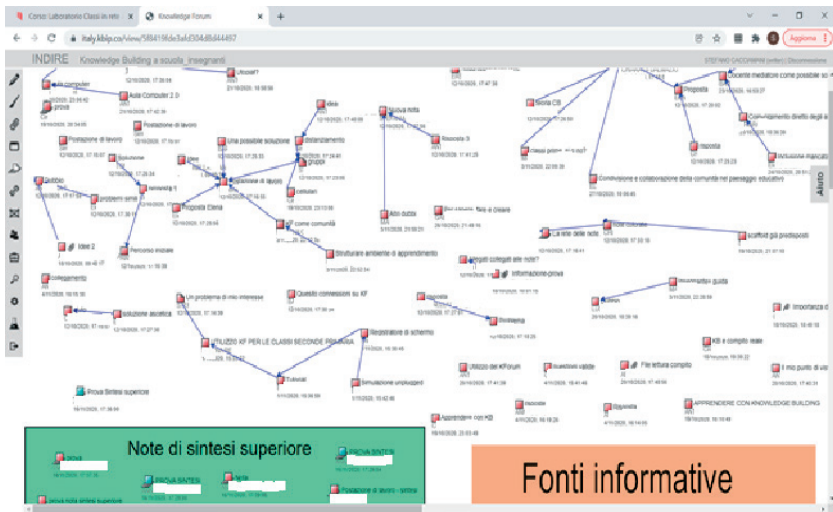
Figure 1. Knowledge Forum used during the teachers' course

The activity included a first meeting focused on the KB theoretical model and on KF instrument, and a second meeting in which a synchronous discussion activity was proposed to the teachers in KF on the use of the KB model in small schools (phase 1: supported by the training staff), which was followed by a discussion in KF in asynchronous mode (phase 2: autonomous) for about two weeks. In order to activate teachers' Epistemic Agency (Scardamalia, 2002), at the be-

ginning of the discussion activity teachers were asked to formulate problems of their interest, in the form of questions to which possible answers can be found together. The request was to focus the problems on the implementation of the KB model at their small school, considering the use of this model and of KF in their rural and multigrade classes. Each teacher was therefore invited to publish their own problem with the scaffold "I need to understand" in a note in KF, to read and interact with the notes containing the problems formulated by the other colleagues, by creating build-on. The corpus of data is made up of 63 messages (notes + build-on) in the view of "Knowledge Building at school-teachers", of which 10 opening notes of corresponding threads.

Procedure

With reference to the research questions concerning the assumption of the KB perspective by the teachers, a quali-quantitative approach has been used. Of the 10 opening notes of the discussion threads, 9 notes containing the scaffold "I need to understand", as indicator of the intention to report problems to be discussed, were considered. As a note contained two problems, the analyzed problems were found to be 10. For each problem the following aspects were considered:

– the *kind of problem* with reference to the distinction between factual and explanatory problems, proposed by Hakkarainen (2003);
– the *thematic area of the problem*, based on categories emerging from the analysis of the content;
– the *level of elaboration of the problem*, by detecting the number of build-on of the thread containing each problem on the use of the KB model at school.

Furthermore, by focusing the content analysis according to the *Grounded Theory* approach (Strauss & Corbin, 1997) for the problem with the highest level of elaboration, the solutions proposed by the teachers were identified.

The appropriation of the use of KF has been studied with a quantitative approach, with reference to an extension of the distinction

proposed by Cacciamani (2017), about three participation activities in KF:
– *informative*: number of reading;
– *productive*: number of written messages (notes and build-on);
– *ameliorative*: number of revisions of the messages (notes and build-on).

In particular, we compared the differences of the level of each kind of participation between the two phases (phase 1 guided vs phase 2 autonomous) of the small school teachers' training.

In addition, we analyzed the presence of a statistically *significant correlation* between the three kinds of participation, assumed as an indicator that teachers have understood that writing, reading and revising contributions are three important activities of the KB process and that they have appropriated all functions of KF that allow their realization.

Data analysis

With reference to the questions about the assumption of the KB perspective by the teachers, the kind of problem proposed has been identified through the categorization into *explanatory* and *factual problems* by two independent judges, with a degree of agreement of 90%.

Regarding the thematic area of reference of the problem, the identified problems were categorized by two independent judges with a degree of agreement of 90% in *problems related to teaching*, *related to technology* (in general and related specifically to KF), and others. In both cases the controversial categorizations have been discussed until reaching an agreement. The identification of the most elaborate problems took place by comparing the frequency of *build-on* of the thread containing each problem on the use of the KB model at school. The identification of the answers to the most elaborated problem was carried out using the three phases of the Grounded Theory (Faggiolani, 2011) with the software NVivo11: *open coding* (creating the first categories from the analysis of the notes content), *axial coding* (creating more general categories from the first categories), s*elective coding*

(identification of the core category to which all the previously identified categories are linked).

With references to the questions focused on the KF appropriation the differences about the level of each kind of participation between the two phases of the training have been analyzed through the T-test. The correlation between the three kinds of participation was calculated in each phase using Spearman's Rho Coefficient, taking into account the number of participants.

Results

With reference to the assumption of KB perspective by the teachers, considering the kind of problem under discussion, 7 problems were of an *explanatory nature* and 3 of a *factual nature*.

Regarding the thematic area (see Table 1), of the 10 identified problems, 5 concerned problems relating to *technology* (3 in general and 2 specifically related to KF), *5 problems relating to teaching*.

Table 1. Problems defined by the teachers

Problems	Kind of problem	Thematic Area	Number of buildon
1. How can a democratic access to knowledge and the use of technologies be guaranteed if not all pupils have personal digital tools at their disposal?	Explanatory	Technology in general	6
2. How to start a digital path with the use of the Knowledge Forum with a Grade I secondary school class?	Explanatory	Teaching	2
3. What are the indications to give and make the children understand?	Factual	Teaching	2
4. I would like to understand how to work with this platform with the children of the first and second grades	Explanatory	Teaching	2
5. How to use this platform if the network is not always available?	Explanatory	Technology in general	1

6. Should each pupil have their own workstation at school?	Factual	Technology in general	8
7. I would like to understand how to work with a class of 13 pupils with this platform	Explanatory	Teaching	2
8. How to organize the network of notes according to the different thematic nuclei, how it is possible to differentiate them	Explanatory	Knowledge Forum	1
9. I would like to understand how to best use the KB with the pupils of the first primary classes	Explanatory	Teaching	10
10. Can the attachment I want to upload, I mean an image or an audio file, be linked directly to a note or does it remain separate from the written comment?	Factual	Knowledge Forum	1

The problem that has had the most elaborations (N = 10) refers to teaching and it is of an explanatory nature. In particular, it concerns a very challenging situation such as how to use the KB in the first classes of primary small school. The note containing this problem had 5 first level responses three of which with the *My theory* (MT) scaffold and two with the N*ew information* (NI) scaffold (but one of these, in addition to information, also presents a solution), 2 second level answers of which 1 with the *My theory* scaffold and the other *New Information*, 2 third level answers of which 1 with the *This theory cannot explain* scaffold and one with the *My theory* scaffold. Teachers combined, in the elaboration of the problem, the creation of ideas for possible solutions with the sharing of information, with also, in one case, a critical analysis of proposed ideas. A total of 9 proposals for solution to the problem posed are put forward in the thread, which are identified through the analysis of the content based on the Grounded Theory approach: the results are shown in Figure 2.
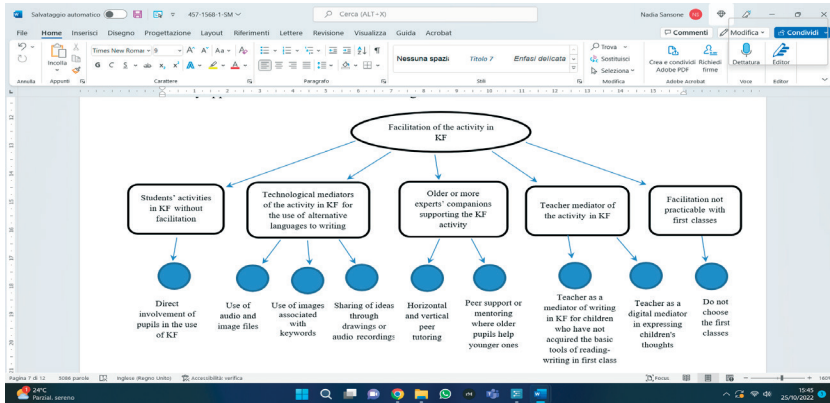
Figure 2. Solutions emerging through the discussion in KF

As can be seen from Figure 2, the theoretical coding identifies the "Facilitation of the activity in KF" as the core category, including five different areas (identified at the axial coding level), indicating some kind of possible facilitation strategies involving different actors or tools:

Area 1: Student activities in KF without facilitation: it includes the solution indicated at the first level as: a) Direct involvement of pupils in the use of KF.

Area 2: Technological mediators of the activity in KF for the use of alternative languages to writing: it includes the following solutions of the first level: b) Use of audio and image files; c) Use of images associated with keywords; d) Sharing of ideas through drawings or audio recordings.

Area 3: Older or more expert companions supporting the KF activity: it includes the following solution at first level: e) Horizontal and vertical peer tutoring; f) Peer support or mentoring where older pupils help younger ones.

Area 4: Teacher mediator of the activity in KF: it includes the following solution at first level: g) Teacher as a mediator of writing in KF

for children who have not acquired the basic tools of reading-writing in first class; h) Teacher as a digital mediator in expressing children's thoughts.

Area 5: Facilitation not practicable with first classes: it includes at the first level the following solution: i) Do not choose the first classes.

Considering the position of the contributions in the thread, it is possible also to identify the improvement of the ideas with reference to the problem of inquiry. In particular the build-ons connected to the problem of inquiry, at the second level of answers, contained three solutions: 1. Do not choose the first classes; 2. Use of images associated with keywords; 3. The teacher as digital mediator in expressing children's thoughts. The solution n. 3 received by another teacher a positive comment through a build-on, articulating the possible barriers to the children's activity in KF: "if the child is limited for the age or digital skills to manage the activity in KF, the help of the teacher as mediator can be a solution". A build-on to this intervention suggested as alternative the use of peer support or mentoring, where older pupils help younger ones, "because in KB school is considered a community". Another build-on contained a critical comment highlighting the risk of the teacher as mediator solution to reduce the students' responsibility in the knowledge building effort. Answering to this critical comment, the author of the solution n. 3 indicated also learning disabilities (e.g., dyslexia) in addition to the lack of reading, writing and digital skill due to age, as a condition that can prevent the participation in KF and that highlights the usefulness of the "teacher as mediator solution". From the discussion in KF, with reference to the idea's improvement, then, it seems to emerge not only different solutions, but also an analysis of the conditions under which the different solutions can be useful in the introduction of KB with students of the first classes of primary small schools.

With reference to the appropriation of KF by the teachers the results of the different kind of participation in the two phases of the training are reported in Table 2.

Table 2. Teachers' participation in the two phases of the training

Training phases	Readings *Mean (SD)*	Notes and buildon created *Mean (SD)*	Revisions *Mean (SD)*
1st phase (supported)	13.23 (15.20) *	1.27 (1.55)	2.18 (2.73)
2nd phase (autonomous)	26.86 (24.47) *	1.59 (1.53)	4.05 (4.08)

*p < .05

As is possible to see, we have a statistically significant increase from phase 1 to phase 2 of the readings (t (21) = -2.1, $p < .05$) and a little increase near statistical significance of revisions (t (21) = -2.02, p = 0.56. The notes and build-on created remained at the same level from phase 1 to phase 2.

Results concerning the correlations between the different kinds of participation are reported in Table 3.

Table 3. Correlation between the different kind of participation

	1st phase			2nd phase		
	Reading	Notes and buildon created	Revisions	Readings	Notes and buildon created	Revisions
Readings	1			1		
Notes and buildon created	.62**	1		.66**	1	
Revisions	.64**	.97**	1	.62**	.91**	1

**p < .01

As is possible to see, statistically significant correlations emerged between readings and written messages (phase 1: Rho = .62, $p < .01$; phase 2: Rho = .66, $p < .01$), between readings and revisions (phase 1: Rho = .64, $p < .01$; phase 2: Rho = .62, $p < .01$) and between written messages and revisions (phase 1: Rho = .97, $p < .01$; phase 2: Rho = .91, $p < .01$).

Discussion

In this study we wanted to examine whether a training based on promoting Epistemic Agency (Scardamalia, 2002) of teachers can allow them to take the Knowledge Building perspective and to realize the appropriation of the use of KF.

Concerning the assumption of the KB perspective by the teachers, results showed that the problems identified are mainly of an *explanatory kind*. Furthermore, with reference to the thematic area, there is a *balance between problems related to technology* and *problems related to teaching*. The most elaborate problem is about how to use the KB model in the first classrooms of primary small schools. The proposed solutions focus on the issue of how to facilitate the use of KF for first grade students. The explanatory nature of most of the problems formulated can be interpreted as an indicator of teachers' assumption of the KB perspective: according to Hakkarainen (2003), indeed, successful knowledge building is characterized by the generation of explanatory questions. These types of questions are in fact those on which it is possible to activate the progressive problem solving envisaged by the KB model. The presence of problems both in the technological area and in the teaching area shows that teachers have understood the need to relate the KF environment with the pedagogical model (KB) that guides its use. This awareness may have been favored by the part of the training that allowed teachers to directly use the online environment to discuss the use of the KB model at school.

The problems concerning teaching are focused on how to use the KB model and KF in the classroom. Teachers have probably become aware that introducing this innovation implies rethinking their actual practices. The presence of problems inherent in technology leads to the hypothesis that KF was recognized by teachers as a central tool for mediating the activity of knowledge building, in line with what is indicated in the literature of the field (e.g., Scardamalia, 2004). Consequently, teachers have tried to identify the best conditions for successful use of KF in their classrooms.

The strong attention paid by teachers to the technological dimension also emerges in the analysis of the most elaborate problem: al-

though the teacher's question is focused on how to use the KB model with the first classes of primary school, the discussion shifts on how to facilitate writing in KF for first grade students. The proposed solutions can be placed along a continuum having as extreme poles, on the one hand a high level of students' agency (Students activity in KF without facilitation), on the other the impossibility of pupils of first grades to exercise agency (Facilitation not practicable with first classes). Between these two extreme positions we have found, first of all, some solutions based on the social interaction, with more expert students that – we hypothesize – can provide some scaffolds during the collaboration with their less expert companions. For second, other solutions are based on the idea of the mediation in the writing activity, realized through digital devices or by the teacher. As suggested by Chen and Hong (2016), to nurture students' higher-level agency, KB teachers play important roles in facilitating epistemological, cognitive, and sociocultural aspects of KB (ivi, p. 6). Our teachers have identified a plurality of solutions to the common challenging problem, for the most part oriented towards the inclusion of first grade students. The proposed solutions contain different facilitation strategies in the use of KF, which can indicate that teachers have begun to be aware of the need to assume a role of facilitator regarding the different aspects involved in working with the KB, starting from the technological mediator. It is also interesting to notice, in order to the assumption of the KB perspective by the teachers, that the discussion in KF of the problem (how to use KB with students of first grade) improved the elaboration of the ideas not only in finding different solutions but also in identifying conditions under which the different solutions identified could be useful.

With reference to the appropriation of KF, results show a statistically significant increase from phase 1 to phase 2 of the readings and a little increase near the statistical significance of revisions. The notes and build-on created remained at the same level from phase 1 to phase 2. Significant correlations emerged between readings and written messages, between readings and revisions and between written messages and revisions, in both the phases of the training. These results show that thanks to the training, teachers have become au-

tonomous in managing the reading, writing and revision of notes and build-on in KF and therefore they are in the condition to use KF in the rural and multigrade classroom with their students. In addition, the correlations between different kinds of participation highlight, as suggested by Cacciamani et al. (2021), that this appropriation is realized in the perspective of assuming a collective cognitive responsibility about knowledge building (Scardamalia, 2002).

Teachers' Epistemic Agency has been promoted in the training using KF as a space to bring out the problems of the possible implementation of the KB model in the classroom, as perceived by teachers, and the common search for solutions. This choice introduced teachers to KB perspective and work, introducing the idea to create together knowledge of value for the community (Scardamalia & Bereiter, 2010).

The implications of the study concern how to design of a training that allows teachers to assume the KB perspective and to favor an appropriation of the KF use. As we have seen it is important first to create the conditions for teachers to take on Epistemic Agency by identifying problems of interest to them in the implementation in their work of a new theoretical model such as the KB. Secondly, it is necessary to introduce the supporting technology by making explicit the connections with the underlying theory and accompanying the teachers towards a progressive autonomy of its use. It is interesting to highlight, with reference to the studies inspired to the participatory design approach (Spinuzzi, 2005), that end-users (students and teachers) given the agency to contribute, can usefully become definers of learning spaces (Casanova et al., 2018). So, giving Epistemic Agency to teachers on how to implement KB in the classroom, may imply that they can design a more effective and situated KB environment for their students. In addition, this opportunity could help teachers to recognize to their students the cognitive responsibility of the knowledge building activity, allowing them to define the problems on which to carry out an inquiry activity in the classroom. Finally, the training experience created could help teachers to promote students' understanding of the focus of the activity on building collective knowledge useful for the community and not only on individual learning.

Future development of the present work could focus on how the analysis of the content of the problems and of the proposed solutions, emerging in KF discussions during the training activity, could help to identify the most promising solutions to be used by the teachers in the implementation of the KB model in the classroom. It would therefore be interesting to verify the effectiveness of these solutions once they were implemented. In addition, following a participatory design approach, it could be interesting to explore how to involve students in exploring problems and solutions in order to design an effective implementation of the KB model in the classroom. The training of teachers in the present study took place during the Covid-19 pandemic and the choice to manage it online allowed it to be carried out without significant difficulties. The condition of new normality towards which we are heading can allow us to capitalize on the indications coming from this study by easily extending this training method, thanks to its online way of working, to new networks of small and rural schools.

Author Contributions

Authors worked together on the design of the study and on the data collection. Stefano Cacciamani and Giuseppina Rita Jose Mangione contributed to the analysis and interpretation of the data. Stefano Cacciamani wrote the method and the discussion, Giuseppina Rita Jose Mangione wrote the results and Michelle Pieri wrote the introduction. All authors contributed to multiple iterations of manuscript revision and agreed to the final version.

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