Promoting Life Competences in the Knowledge Society: Contribution of the Knowledge Building Model for Educational Systems

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Abstract. This article analyzes the possibility of using the Knowledge Building model in schools to promote the skills and abilities indicated by the LifeComp framework. After placing the LifeComp framework in the current social and cultural context of the knowledge society, the principles of the Knowledge Building model are examined and the technological infrastructure to support it, Knowledge Forum , is presented. A hypothesis on how the design of a Knowledge Building community can promote the competences of the LifeComp Framework is proposed and research evidence to support the hypothesis is provided. Some implications of this analysis and recommended changes for educational institutions to pursue this perspective are then discussed.

Keywords: Life Competences, Knowledge Building, digital technologies, Competence-based learning.

1 Knowledge Society and Life Competences

"Knowledge society" is a central concept for both understanding contemporary societies and planning their future [1]. As reported by Nyhan [2], the development of the knowledge society was declared to be one of the key goals of the European Union at the Lisbon EU summit of 2000. But what exactly is a knowledge society? In the short historical review by Hakapää [1], the concept can be traced back to the 1960s, when Fritz Machlup [3] began his monumental inquiry into knowledge as the basis of economic production and coined the term, "knowledge production". A few years later, Peter F. Drucker [4] formulated the construct of "knowledge society" to describe a new type of economy, one that saw knowledge as a fundamental resource and represented a strong discontinuity with the vision of the society that had characterized previous historical periods.

At the core idea of this expression is the central role of knowledge in economic processes in the current post-industrial society, which is characterized by the strong presence of services. However, as Hakapää [1] emphasizes quoting Drucker [4], the centrality of knowledge not only concerns the economic aspects, but also pervades all areas of social life. The pervasiveness is evident in the most recent definition by UNESCO (n.d.) [5]: "knowledge societies are about capabilities to identify, produce, process, transform, disseminate and use information to build and apply knowledge for human development". Therefore, knowledge has become a fundamental resource not

only for the growth of the economy but also in a broader vision, for the promotion of human development. From the latter perspective, an empowering social vision that encompasses plurality, inclusion, solidarity and participation are required. This scenario has led to calls for educational reform around the world, with different countries committing to explore how to create school systems that are aligned with the move towards a knowledge society. Not surprisingly, these reforms face many challenges, including social and economic challenges of retooling and redevelopment, with the rapidly emerging and constantly evolving digital technologies that alter the landscape of professional and personal life [6].

In fact, digital technologies play an increasingly important role in many areas of daily life, leading skills to quickly become obsolete and producing new working models [7]. To cope with such uncertainty and complexity, citizens must develop skills to successfully manage the challenges posed in a society where knowledge plays a central role to identify, produce, process, transform, disseminate, and use knowledge in everyday life. Furthermore, citizens are called to "upskill" to learn and expand their existing skill set or "reskill" to learn new skills to adapt to the numerous transitions taking place in their work, in their personal sphere, and in society more generally.

At the institutional level in Europe, the challenge to reform educational systems has been addressed by developing models that identify the key competences that equip students to be an active part of a knowledge society and emphasize lifelong learning. Recently, the Joint Research Centre (JRC) [8] ended the process of developing models and published LifeComp, which offers a conceptual framework for the "Personal, Social, and Learning to Learn" key competences for education systems [7], as described below.

LifeComp is a conceptual framework that can be used as a basis for the development of curricula and learning activities. The goal of the framework is to initiate an agreed upon set of guidelines for the flexible implementation of "Personal, Social, and Learning to Learn" key competences.

The framework (see Figure 1) describes nine competences that are structured in 3 intertwined competence areas: Personal, Social and Learning to Learn (P1-3, S1-3, L1-3; [7].

As shown in Figure 1, starting from the left and moving clockwise, in the first area, Personal (P), we can find three competences:

- P1: Self-regulation: awareness and management of emotions, thoughts and behaviors.
- P2: Flexibility: ability to manage transitions and uncertainty, and to face challenges.
- P3: Wellbeing: pursuit of life satisfaction, care of physical, mental and social health, and adoption of a sustainable lifestyle.

The second area, Social (S), includes the following three competences:

- S1: Empathy: the understanding of another person's emotions, experiences and values, and the provision of appropriate responses.
- S2: Communication: use of relevant communication strategies, domain-specific codes and tools depending on the context and the content.
- S3: Collaboration: engagement in group activity and teamwork, acknowledging and respecting others.

The third area, Learning to Learn (L), is articulated in the following three competences:

- L1: Growth Mindset: belief in one's and others' potential to continuously learn and progress.

- L2: Critical Thinking: assessment of information and arguments to support reasoned conclusions and develop innovative solutions.

L3: Managing Learning: the planning, organizing, monitoring and reviewing of one's own learning.

Fig. 1 LifeComp at a Glance [*Note.* LifeComp at a Glance by [7] is licensed under Creative Commons Attribution International 4.0.]

2 The Knowledge Building Model

The Knowledge Building (KB hereinafter) model was developed by Carl Bereiter and Marlene Scardamalia of the University of Toronto from the late 1980s and introduces a real "Copernican Revolution" in envisioning education, proposing to transform the school class and university courses into knowledge-building communities [9].

Scardamalia, Bereiter, and Lamon (1994) introduce the concept of KB in a chapter where the authors are inspired by Popper's [10] philosophy of science that distinguishes between three different Worlds. According to Popper, in the human experience of reality we can identify: World 1, made up of the concrete elements of physical reality; World 2, representations existing in the minds of individuals which constitute the personal knowledge of World 1; and finally World 3, or the world of socially shared knowledge, as an intersubjective system of ideas, theories, strategies or methods (conceptual artifacts) existing in the social community or the culture of a society. Following Popper, the objective of science is to improve and advance the state of World 3. Thus, Scardamalia et al. [11] wondered, Could schools include among their educational goals, the goal to have students working to improve the state of knowledge of their classroom community (World 3)? The positive answer to this

question opens up a perspective of great innovative impact for education: it is possible for students to work with knowledge by treating it as an object belonging to the community (World 3), rather than as content of individual minds (World 2). Therefore, it is possible to rethink school work and university study as activities oriented towards the co-construction of knowledge useful for solving problems of understanding for the community. Learning and knowledge construction are considered different but interconnected activities in Knowledge Building. Learning is no longer considered the ultimate purpose of schooling, but rather the activity through which the student acquires and elaborates knowledge and procedures that they use with the aim of working towards the common goal of building knowledge useful for their community.

The KB model has been systematized since the beginning of the 2000's in a set of 12 social and technical principles [12; 9], reported in Table 2. These KB principles describe the organizational conditions necessary to operationalize this model in a school classroom or a university course, which can be considered as a KB community (KBC).

Table 1. The Knowledge Building Principles

Knowledge Building (KB) Principle	Description
Real Ideas, Authentic Problems	Knowledge problems arise from efforts to understand the world. Ideas produced or appropriated are as real as things touched and felt. They cause things to happen, they develop momentum, they create reactions and counter-reactions.
Improvable Ideas	The working assumption in Knowledge Building is that all ideas are improvable. Although some ideas may turn out to be unimprovable, this is not to be judged in advance of efforts to improve their quality, coherence, and utility. According to this principle, it is all right for students to advance ill-conceived or half-baked notions, provided they subsequently work to improve them.

Idea Diversity	Idea diversity is essential to the development of knowledge advancement, just as biodiversity is essential to the success of an ecosystem. Ideas are improved through comparison, combination, and alignment with other ideas, and enriched by distinctions and re-combinations. To understand an idea is to understand the ideas that surround it, including those that stand in contrast to it. Idea diversity creates a rich environment for ideas to evolve into new and more refined forms.
Rise Above	Creative knowledge building entails working toward more inclusive principles and higher-level formulations of problems. It means learning to work with diversity, complexity, and messiness, and out of that achieve new syntheses. By moving to higher planes of understanding, knowledge builders transcend trivialities and oversimplifications and move beyond current best practices.
Epistemic Agency	Participants recognize both a personal and a collective responsibility for success of knowledge building efforts. Individually, they set forth their ideas and negotiate a fit between personal ideas and ideas of others, using contrasts to spark and sustain knowledge advancement rather than depending on others to chart that course for them. Collectively they deal with problems of goals, motivation, evaluation, and long-range planning that are normally left to teachers or managers.
Community Knowledge	Knowledge Building has as its aim to produce knowledge of value to others. This distinguishes knowledge-building activity from learning and accordingly it needs to be kept clearly in mind, especially in educational contexts where personal learning is also an objective.

Democratizing Knowledge	All participants are legitimate contributors to the shared goals of the community; all take pride in knowledge advances achieved by the group. The diversity and divisional differences represented in any organization do not lead to separations along knowledge have/have-not, or innovator/non-innovator lines. All are empowered to engage in knowledge innovation.
Symmetric Knowledge Advancement	Expertise is distributed within and between communities. Knowledge does not move only from the more knowledgeable to the less knowledgeable group; the idea arrangement is one in which both groups gain in knowledge through their participation in a joint effort.
Pervasive Knowledge Building	Creative work with ideas is integral to all knowledge work, ad all tasks and activities represent an occasion for knowledge work.
Constructive Uses of Authoritative Sources	To know a discipline is to know the authoritative sources that mark the current state of knowledge and its frontiers. Knowledge innovation requires respect and understanding of these sources, combined with a critical stance toward them.
Knowledge Building Discourse	The discourse of Knowledge Building communities results in more than the sharing of knowledge; the knowledge itself is refined and transformed through the discursive practices of the community – practices that have the advancement of knowledge as their explicit goal.
Concurrent, Embedded, and Transformative Assessment	Assessment is part of the effort to advance knowledge—it is used to identify problems as the work proceeds and is embedded in its own internal assessment, which is both more fine-tuned and rigorous than external assessment and serves to ensure that the community's work will exceed the expectations of external assessors.

Note. Adapted from *A brief history of knowledge building*, by Marlene Scardamalia and Carl Bereiter under a Creative Commons Attribution-NonCommercial 4.0 International license.

In KB, students work on knowledge problems that emerge from the commitment to understand the world around them. The ideas produced to achieve this understanding are treated as real and tangible objects that create events, reactions and counter-reactions (*Real ideas, Authentic problems* principle). In KB it is assumed that all ideas can be improved unless otherwise confirmed, and students have the right to propose their ideas even if they are ill-conceived or semi-processed and to be supported in their work to improve them (*Improvable Ideas* principle). Diversity of ideas is also essential for the advancement of knowledge. This diversity creates a rich environment that makes ideas evolve towards new and more refined forms (*Idea Diversity* principle). Using the diversity of ideas as a resource, students formulate complex problems, work to advance their level of explanation and create new explanatory synthesis (*Rise Above* principle). In this work, students assume both individual and collective responsibility towards the construction of knowledge (*Epistemic Agency* principle). It should be emphasized that knowledge construction has as its objective the production of knowledge of value for others and this distinguishes it from personal learning, on which they usually work in educational contexts (*Community Knowledge* principle). In the KB community, knowledge is democratized in the sense that all participants are entitled to contribute to the shared objectives of the community and to the progress of knowledge achieved (*Democratizing Knowledge* principle). Knowledge is not only transmitted from more expert individuals or groups to less expert ones but is acquired by participating in the joint effort to build knowledge (*Symmetric Knowledge Advancement* principle). Creative work with ideas is not confined to specific activities or circumscribed spaces, but all tasks and activities represent an opportunity to build knowledge (*Pervasive Knowledge Building* principle). In their work, students use authoritative sources that reveal the current state of knowledge, to which they address with an attitude of respect combined with a critical position towards them (*Constructive Uses of Authoritative Sources* principle). The discourse in the communities that build knowledge occupies a central position and is something more than the sharing of knowledge. Through discursive interactions, knowledge is refined and transformed with the explicit objective to advance knowledge (*Knowledge Building Discourse* principle). Evaluation is part of the effort to advance knowledge. It is used to identify problems as the work progresses and is integrated into the daily work of the community (*Concurrent Embedded and Transformative Assessment* principle).

The principles are linked to each other by creating an organized system that globally ensures the conditions for knowledge creation. A school classroom or a university course in which these principles are implemented is defined as KB community (KBC). The main purpose of the KBC is to focus on real problems and build useful knowledge for the classroom community, and by extension, the larger social community to which the class belongs. In a KBC, the activity often starts from introductory lessons that frame a topic in a real world context from which to identify authentic research problems of interest for the community [13]. This process often involves subject matter experts, but students take responsibility for formulating their first interpretative hypotheses. For example, students can contribute written online discussion “notes” (messages) labeled with special scaffolding tools such as "My theory" or “I wonder”, to underline their explanatory function with respect to the problems addressed. Students develop their explanation by referencing information from various bibliographic sources (e.g., textbooks, journal articles, websites) and carrying out field surveys or experiments, which allow them to collaboratively analyze their hypotheses and work on improving their knowledge. These activities are accompanied by asynchronous online discussion of ideas in a common virtual space, Knowledge Forum , which we will discuss below. The sharing of ideas also takes place in synchronous meetings called *Knowledge Building Circles.* The teacher

coordinates the live discussions that take place, called *Knowledge Building Talks*, but the discussion agenda is centered on the students' ideas.

A distinctive feature of the KB model is certainly the promotion of a culture of innovation. Students are considered Knowledge Builders, capable of creating innovative ideas and working to improve them. The knowledge construction activity in a KBC takes place through the combination of two modes of working with the knowledge itself, called "Design mode" and "Belief mode", as described below. More recently, Belief mode has also been characterized as "Critical/Analytic" mode [14; 15].

Belief mode is a way of working with ideas aimed at evaluating knowledge, whose central question is: "Is this idea true?" On the other hand, the Design mode is, a way of working with ideas based on the creation and improvement of ideas, whose central question is: "How can we improve this idea?". The two ways of working are associated with two different types of thinking: the Belief mode to critical thinking and the Design mode to elaborative thinking. Critical thinking is defined as an intellectually disciplined process of active and competent conceptualization, application, analysis, synthesis or evaluation of information gathered or generated by observation, experience, reflection, reasoning or communication, as a guide to belief and to action [15]. On the other hand, elaborative thinking is that type of thinking oriented towards building and improving an idea which, if proven to be valid, achieves a result, such as explaining a phenomenon or solving a problem. In the work of building knowledge there is a continuous interaction between critical thinking and elaborative thinking. Critical thinking, in fact, focuses on the analysis of knowledge, regarding the veracity of the ideas elaborated and their relationship with the facts; the elaborative thinking examines the proposed ideas to establish they are "promising", i.e., to identify opportunities for improvement, which justify a common commitment in this direction [16].

3 An Environment to Support Knowledge Building: Knowledge Forum

Knowledge Forum (KF) and its precursor, Computer-Supported Intentional Learning Environment (CSILE), are specially designed to support KB (17; 18). They are not only the first networked, digital technologies designed to support KB, but also the most widely used technologies for knowledge creation in education (6; 19). Hence KF technology has been iteratively designed based on KB theory and pedagogy based on over 30 years of educational research with students in kindergarten to graduate education and workplace contexts (9, 18).

Similar to other online discussion technologies, users can contribute their ideas in "notes" (messages) in a virtual space called a "view" (discussion forum), and other users can write "build-on notes" (replies) to ask questions and bring in new information from authoritative sources, using text or multimedia. In addition, KF has sophisticated features to support higher-level cognitive work missing in other online discussion technologies such as different interfaces of the shared space, "scaffold supports" that can be inserted while writing notes to support higher-level thinking types (e.g., theory building, explanation), a special kind of note called the "Rise above" to synthesize ideas in the discussion, and a built-in learning analytics system.

For example, in KF, instructors can choose a traditional threaded discussion interface that displays the title, author(s), and date and time the note was posted to different discussion threads or trees, in chronological order. Alternatively, instructors can choose a graphical user interface that displays notes represented as squares and build-on notes represented as squares connected to the original note with a blue

arrow. New, unread notes are represented by green squares, whereas read notes are represented by red squares. Black arrows connecting squares indicates referencing. Thus the graphical interface enables users to visualize the ideas and links between them, like a dynamic concept map of the community's collaborative discussion.

Additionally, KF users can select a "scaffold support" (scaffold) or sentence opener while composing a note to identify the nature of their contribution to the KB discourse, such as "My theory" and "I need to understand". Users can also use a "Rise above" note that synthesizes ideas from multiple notes within a view to summarize and advance the state of the community's knowledge.

Learning analytics built-in to KF provide summary statistics of the users' reading, writing, and interactions in student-facing and instructor/researcher-facing dashboards. Thus, KF allows users to visualize the evolution of their ideas in the graphical interface and use the learning analytics' data representations (i.e., tables, graphs, network diagrams).

For example, Figure. 2 shows a discussion on the topic, "School after the pandemic" in a view in web-based KF version 6.11.15. The discussion unfolded among a group of five second-year undergraduate students in an online Educational Psychology seminar at University of Valle d'Aosta, Italy. After viewing a brief video on the impacts of the Coronavirus pandemic on Italian students, the participants identified some questions to explore arising from the topic. Each student wrote a note using the KF scaffold, "I need to understand" with a question about the topic they wanted to explore with the course KB community. The community selected questions of common interest, which can be considered the object of their collaborative inquiry. In the right part of Figure 2, it is possible to see a note titled "Valorizzare" that translates to "Value", containing one of the questions that they selected. The bolded text indicates the KF scaffold they selected in writing the note:

> **I need to understand** *I would like to understand how to highlight all the skills and resources that have been acquired by students during the pandemic. How to recognize and value.*

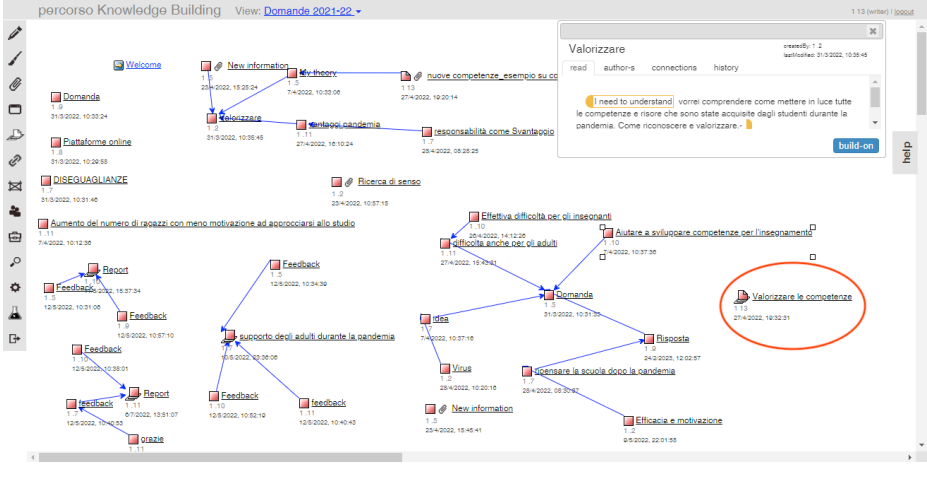

Fig 2. A view in Knowledge Forum

Participants responded with their ideas by writing build-on notes, indicated by the blue arrows. They used the "My theory" scaffold support to highlight, with yellow brackets, intentional attempts to answer the question based on their personal knowledge. For instance, one student formulated a possible answer using the "My theory" scaffold in a build-on note to suggest some hypotheses about the skills acquired by the students during pandemic (note title: "vantaggi pandemia" or "Advantages of the Pandemic"):

> My theory *In my opinion, the skills that have been acquired by the kids during the pandemic are: further use of digital platforms to communicate with each other and, therefore, increase their digital skills. Another advantage could be knowing how to organize yourself without the teacher constantly monitoring what you are doing (therefore greater autonomy and responsibility on the part of the students.*

The members of the community read the other participants' ideas and wrote build-on notes in response. In this example, another member of the community created a build-on note to the "Advantages of pandemic" note to express a critical point of view on a colleague's hypotheses (note title: "responsabilità come Svantaggio" or "responsibility as a disadvantage"):

> **This theory cannot explain** *On the other hand, it is possible to read the increase in student responsibility as a disadvantage of the pandemic. This occurs where responsibility, rather than developing spontaneously as self-management skills in students, has been delegated to them by teachers without the possibility of choice. Thinking that "it is the responsibility of the students to keep up with the program" learning becomes the total prerogative of the students, leaving out their experiences and increasing difficulties / differences already present in the pre-Covid period.*

In addition, in order to support their position, the author inserted the "New information" scaffold to quoted an information source. She reported inequities among students exacerbated by distance learning, and suggested that the lack of technological skills and professional development opportunities among teachers reduced online teaching to a mere transmission of information [20].

At the end of the discussion, students wrote a report to synthesize their inquiry activity using a special note called "rise above", shown with a red oval in Figure 2. In our example, the rise-above note is organized with the structure of an inquiry report with the following sections:

1. Research question;
2. First hypotheses;
3. How the inquiry was carried out;
4. Results obtained;
5. New emerging questions; and
6. References.

For the "Results obtained" section in the rise-above note, a student suggested the possibility of continuing to use interactive digital technologies at home after the pandemic. She referenced the specific technologies that the students had found to help

them develop skills, for example, Prodigy Math app to develop math skills. Interestingly, a student describes how the inquiry unfolded, as follows:

> *I essentially searched for the sources on Google Scholar, making sure they were published in peer-reviewed journals with impact factors, and that were relevant to the subject of investigation. The reliability of some bibliographic sources was very low, not coming from universities and published on the web.*

Thus, the student critically evaluated the sources of information that she found and selected only reliable ones to address the question of inquiry, following the KB principle "Constructive Uses of Authoritative Sources".

In summary, KF is a technological environment designed to support knowledge building activities of a community. The design affordances of KF include a virtual environment called a view, where participants can contribute their ideas in notes or a build-on notes with scaffolds, which are like sentence openers or epistemic markers of their thinking or discourse move. The view can be displayed in a threaded discourse view or graphical view that helps the participants visualize the relationships between ideas. Doing so helps participants improve their ideas through asking questions, providing new information, presenting alternative ideas or theories in personal and social ways that foster intentional, self-regulated learning. Although beyond the scope of the present paper, community members can also leverage innovative learning analytic tools embedded in KF to conduct self-assessments and group-assessments of their contributions towards collective understanding and knowledge creation.

4 The KB model and the LifeComp Framework competences promotion

Can the KB model be useful for promoting LifeComp framework competences at the school level? How? Considering the definition of the KB principles we have seen previously we can hypothesize that some principles can create the conditions in the design of a Knowledge Building Community (KBC) in the classroom to promote the Competences of the LifeComp framework, as we indicated in Table 2.

Table 2. Competences of the LifeComp framework that can be promoted through the implementations of the KB principles.

Life Area	Comp	Competence	KB Principles
Personal	(P1-3)	P1 Self-regulation Awareness and management of emotions, thoughts, values, and behaviour.	*Epistemic Agency* Recognition of personal and collective responsibility for the success of KB efforts. Participants set forth their ideas and negotiate a fit between personal ideas and ideas of others, using contrasts to spark and sustain knowledge advancement rather than depending on others to chart the course for them.
		P2 Flexibility Ability to manage transitions and uncertainty, and to face challenges.	*Real Ideas, Authentic problems* Knowledge problems arise from efforts to understand the world. Ideas are real, cause things to happen, and create reactions and counter-reactions. *Improvable Ideas* Working assumption in KB is that all ideas are improvable. It is all right for students to advance half-baked notions as long as they subsequently work to improve them.
		P3 Wellbeing Pursuit of life satisfaction, care of the physical, mental, and social health, and adoption of a sustainable lifestyle.	*Community Knowledge* Pursuit of knowledge of value to others, which can contribute to the well being of the community.

Social (S1-3)	S1 Empathy The understanding of another person's emotions, experiences, and values, and the provision of appropriate responses.	*Symmetric Knowledge Advancement* Expertise is distributed within and between communities. Knowledge moves not only from the more knowledgeable to the less knowledgeable. *Idea Diversity* Ideas are improved through comparison, combination, and alignment with other ideas, and enriched by distinctions and re-combinations. To understand an idea is to understand the ideas that surround it.
	S2 Communication Use of relevant communication strategies, domain specific codes and tools, depending on the context and the content.	*Knowledge Building Discourse* Discursive practices have advancement of knowledge and problem solving as their explicit goal. *Democratizing Knowledge* All participants are legitimate contributors to knowledge innovation and have equal access to resources.
	S3 Collaboration Engagement in group activity and teamwork acknowledging and respecting others.	*Symmetric Knowledge Advancement* Expertise is distributed within and between different communities. Knowledge moves not only from the more knowledgeable to the less knowledgeable. *Knowledge Building Discourse* More than sharing of knowledge, this collaborative discourse refines and transforms knowledge.

Learning to learn (L1-3)	L1 Growth mindset Belief in one's and others' potential to continuously learn and progress.	*Improvable Ideas* Working assumption in KB is that all ideas are improvable. It is all right for students to advance half-baked notions as long as they subsequently work to improve them.
	L2 Critical thinking Assessment of information and arguments to support reasoned conclusions and develop innovative solutions.	*Constructive uses of authoritative resources* Knowledge innovation requires respect and understanding of authoritative sources of the current state of knowledge, combined with a critical stance towards them. *Concurrent, embedded and transformative assessment* Assessment is part of the effort to advance knowledge, used to identify problems as the work proceeds, and is embedded in the internal assessment of the community. *Epistemic Agency* Participants set forth their ideas and negotiate a fit between personal ideas and ideas of others, using contrasts to spark and sustain knowledge advancement rather than depending on others to chart the course for them.
	L3 Managing learning The planning, organising, and monitoring and reviewing of one's own learning	*Epistemic Agency* Recognition of personal and collective responsibility for the success of KB efforts. Deal with problems of goals, motivation, evaluation and long-range planning. Collectively deal with problems of goals, motivation, evaluation and long-range planning.

4.1 Personal Area of the LifeComp framework and KB

In the Personal area (P1-3) of the LifeComp framework, the assumption of the Epistemic Agency that occurs when KBC members collaborate towards achieving long-term goals to solve problems of understanding and create knowledge [13], can enhance students' P1 (Self-regulation). Promisingly, several studies have shown that the acquisition of self-regulation skills can be developed through collaborative interaction among peers, because when group members co-regulate their activity, this may support the acquisition and refinement of self-regulation skills [e.g., 21]. Cacciamani et al. [22] also found that in an online course where KB had been implemented, university students showed self-regulation skills through a significant correlation among written contributions in KF for the knowledge building activity and their metacognitive reflections on the strategy of work It is conceivable that the overall knowledge building activity foreseen by the KB model contributes to promoting self-regulation skills, but the assumption of Epistemic Agency remains the crucial element in which students take control of their own activity of knowledge creation and therefore of self-regulation in this activity.

For P2 (Flexibility), as stated by the Real Ideas, Authentic Problem principle, in a KBC students explore problems that really they care about; indeed they are encouraged to identify their own problems of understanding instead of following predefined tasks and activities [13]. With reference to the problems of inquiry identified, students are also invited to share in KF their ideas, containing their "theories", new information derived from authoritative sources, or new questions arising during the online discourse. The emerging questions introduce flexibility in creating opportunistic groups around them and in the development of inquiry work to improve ideas (Improvable Ideas), which is a core aspect of KB. In fact, KB operates mainly in design mode, where design thinking plays the leading role in knowledge creation and idea improvement [15]. While critical thinking in belief mode is assigned a supporting role rather than a dominant role in the improvement of ideas in KB, as Scardamalia and Bereiter [15] states, shifting flexibly between the two kinds of thinking is essential for knowledge building.

The Community Knowledge principle highlights the idea that the main goal of a KBC is to produce knowledge of value to others [9]. This "Copernican Revolution" about classroom activity [12], can promote students' P3 (Well-being) by introducing a prosocial attitude in creating useful knowledge for the community. Adopting this prosocial attitude can induce a sustainable lifestyle within the community. In this sense it is interesting to notice that a recent Knowledge Building Design studio, promoted by the KB International Association is focused on the topic "Saving Planet, Saving Lives" [23].

4.2 Social Area of the LifeComp Framework and KB

For the Social area (S1-3) of the LifeComp framework, as Baumeister and Vohs [24] note, empathy has many definitions in social psychology, and may refer to an emotional response, a cognitive response, or both. Notably, the KB model does not emphasize emotional empathy, where students respond emotionally to other students' ideas. However, cognitive empathy, where a student perceives or has evidence that they have "guessed" a more complete and accurate knowledge of another student's ideas or beliefs, including perhaps how they feel [24], is relevant in the KBC. The KB principle of Symmetric Knowledge Advancement, in which knowledge is distributed within and between communities, and the principle of Idea Diversity, in which ideas are improved through comparison, combination, and alignment with other ideas in a

KBC, can also be beneficial for the development of S1 (Empathy) in the LifeComp Framework.

Concerning S2 (Communication), the principle of Knowledge Building Discourse puts the discursive practices to refine and transform knowledge at the center of the KBC activity. Pedagogical designs by KB teachers encourage student collective responsibility by nurturing a safe, inclusive socio-cultural environment for KB discourse and reminding students of each other's contributions [25]. As epistemic agents, students contribute to KB discourse in a variety of "discourse moves", including posing questions, theorizing, introducing new information, making synthesis, monitoring discussion, and so forth [26]. In addition, as we have seen, KF provides some scaffolds (or epistemic markers) in order to make explicit the use of these moves and allows reflection on them at a meta-discourse level [27]. Thus KBC represents an epistemic environment that can promote communicative students' competence.

The development of S3 (Collaboration) can be sustained by the Symmetric Knowledge Advancement principle. This principle introduces in the design of a KBC, a "culture" of collaboration, foreseeing that different groups of work in the classroom (or in a university course) are engaged in a joint effort to advance community knowledge. The focus on ideas and their improvement led, indeed, to opportunistic collaboration, with small groups formed and reformed based on emergent needs to address new or refined problems identified by students [13]. Each member and each group can gain knowledge through participation in this joint effort. Collaboration in the community is achieved through discursive interaction (according to the Knowledge Building Discourse principle), supported by Knowledge Forum which allows to build collaboratively knowledge on the problems under investigation.

4.3 Learning to Learn Area of the LifeComp Framework and KB

For the Learning to Learn (L1-3) area of the LifeComp framework, L1 (Growth mindset) promoted particularly by the Improvable Ideas principle. The Idea improvement principle is a central focus in KB. Design-mode thinking for continual idea improvement requires a high level of epistemic agency (Chen & Zhang, 2016). Shiri and Hod (2002) suggest that this kind of work within a KBC also transforms students' identities as knowledge builders, and develops students' growth orientations.

L2 (Critical thinking) is a relevant competence that can be enhanced by the Constructive Uses of Authoritative Resources; Concurrent, Embedded and Transformative Assessment; and Epistemic Agency principles. In schools, authoritative information is presented as material "to be learned"; however, following the Constructive Uses of Authoritative Sources principle, a critical stance towards information and arguments is needed to build upon previous knowledge [28]. As indicated by Chen and Hong [13], assessment is integral to knowledge advancement, with moment-to-moment productive feedback as work proceeds. Critical thinking allows us to identify critical points and weaknesses of ideas created by the members community and works with design thinking in order to improve them. Furthermore, critical thinking can be promoted by community members assuming Epistemic Agency. The Epistemic Agency principle stipulates that the members of the community "set forth their ideas and negotiate a fit between personal ideas and ideas of others, using contrasts to spark and sustain knowledge advancement" (Scardamalia and Bereiter, 2010, p.10). Therefore, critical thinking involves assessment of information and arguments to support reasoned conclusion as well design thinking to solve identified problems and develop innovative solutions.

Finally, L3 (Managing learning) seems strongly connected with Epistemic Agency principle. As suggested by Chen and Zhang [25], high-level epistemic agency inspires proactive engagement in one's learning processes. Successful learners take charge of their own learning and demonstrate a high degree of self-regulation, self-awareness, self-determination, and self-direction. But in KB classrooms, to create new knowledge, all students assume high-level decisions and choices normally in the hands of the teacher. Students exercise epistemic agency by defining knowledge goals and deciding what they need to learn; choosing important problems to work on; engaging in long-term planning; assessing progress; analyzing idea connections; monitoring challenges; and choosing promising directions among multiple alternatives [12].

4.4 KB Research Evidence for Promoting LifeComp Competences

Evaluation of research on the KB model supports our hypothesis and highlights some interesting findings that suggest that the KB model can actually promote competences in the LifeComp Framework. For example, Braojos, Gámez, Vilches and Jiménez [29] used a mixed methodological approach combining a scientometric analysis (based on a quantitative method applied to articles selected based on citation criteria) and a systematic review of the literature (based on the qualitative analysis of the content of the selected articles) on studies using the KB model from 2013 to 2017 indexed in the Web of Sciences database. In the 45 selected studies, content analysis of the research findings reveals several benefits of implementing the KB model. Among these, the first dimension concerns the improvement of students' collaborative learning skills, highlighted in 60% of the articles. Social skills related to collaboration, active participation, collective reflection and communication were found to be enhanced using KB. The authors point out that these skills also make it easier to build a KBC. We can therefore see how the use of the KB model fosters the development of the S2 (Communication) and S3 (Collaboration) skills of the LifeComp Framework.

A second dimension that Braojos et al. (2020) identify in studies using the KB model are active learning skills, reported by 44% of the articles examined. These competences include higher motivation to discuss and learn, more interest in the topics of discussion, greater creativity, development of informal learning processes, greater adaptation to this kind of pedagogy, and greater responsibility taken by students in advancing in shared knowledge. These competences partly correspond to those of the Personal area of the LifeComp framework. For example, we can consider the development of informal learning processes, and the adaptation to the new methodologies introduced by KB as aspects of flexibility (P2) and motivation to learn and responsibility in advancing shared knowledge as aspects of self-regulation (P1).

A third dimension concerns the development of metacognitive skills, related to students' learning to learn, highlighted by 55% of the articles. These skills concern the creation of deeper discourses, use and development of scaffolds to generate more complex ideas, capacity of asking and answering higher level questions, acquisition of specialized vocabulary, reflective self-assessment and ability to create knowledge to solve real problems. In particular, we can consider generating complex ideas and asking and answering high-level questions as aspects related to critical thinking (L2) competence and the reflective self-assessment and ability to create knowledge to solve real problems as aspects related to the competence of managing learning (L3).

4. Conclusion

This article analyzed the possibility of using the Knowledge Building (KB) model in schools to promote the competences indicated by the LifeComp framework. In the current social and cultural context of the knowledge society, the principles of the KB model were examined along with the technological infrastructure, Knowledge Forum (KF), designed to support the implementation of this model. We hypothesized that the design of a KB Community (KBC) can promote the competences of the LifeComp Framework through mapping the KB principles to each of the competences in the Personal, Social, and Learning to Learn areas of the framework. In addition, we provided evidence from the literature on KB research to support our hypothesis. Thus, the LifeComp Framework can draw on over 30 years of KB research to develop curricula and learning activities for schools jointly with the stakeholders. To do so, educational reforms are needed and one idea from the KB model would be to propose an alternative framing centered on "schooling as participating in the work of society," conceptualizing schools as knowledge-creating communities in their own right. This participatory approach "using digital technology extends beyond students to include teachers and other educational stakeholders throughout the system as active participants in knowledge creation" [6, p. 2]. In this way it could be possible to prepare students to be active participants and lifelong learners who can thrive with emerging technology, uncertainty and complexity in a knowledge society.

CRediT author statement.
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