A Novel Approach for Cooperative Scientific Literature Search and Socialization

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Abstract. The scientific literature search is a crucial enabler for the research process and one of the most problematic and inefficient activities that researchers must face. Most University students never experience scientific literature search, although research is the primary mission of the universities and one of the major activities of their professors and a primary parameter for their careers. The aim of this paper is to i) present a new approach for scientific literature search based on virtual team collaboration, ii) explore the team dynamics of the knowledge building process in a virtual environment and, iii) propose a blog tool for open knowledge sharing both for experienced researchers and beginning students. An experiment on a collaborative scientific literature search on five virtual teams for a total of 25 students at the 2nd edition of the 2nd level Master in Valorization of different abilities and education research proposed by the CAFRE Interdepartmental Center for Lifelong Learning, Training and Education Research at Pisa University has been developed. The collaboration result is a Google Sites embedding individual blogs where each virtual team can build and share organized knowledge based on literature search.

Keywords: methodologies for distance learning · collaborative literature search · edublog · virtual teamwork

1 Introduction

Recent digitalization has expanded the boundaries of self-learning, offering a tremendous amount of easy to access information [1], modernizing tools for student communication [2], and also differentiating forms and methods for teaching [3, 4]. At the same time, the increasing size of the Web delivers significant complexities. For example, pertinent information retrieval (IR) via queries (i.e., a structured sequence of keywords used to formalize the search of information on a given database or search engine [5]) has become a big challenge even for experienced users [6]. This fact is mainly due to the Big Data revolution that made the management of hundreds of Gigabits (i.e., Volume) of unstructured (i.e., Variety) data uploaded per second (i.e., Velocity) on the Web extremely challenging

[7]. Bounding our interest in structured information sources (i.e., scientific papers), as depicted by Fig. 1, it is evident that the volume of published articles is growing exponentially. As highlighted in [8], science is a cumulative endeavor as new knowledge is often created in interpreting and combining such existing published works. Therefore, the major challenge is to untangle the explosive growth of scientific papers published in various databases and transmitted over the Internet [9].

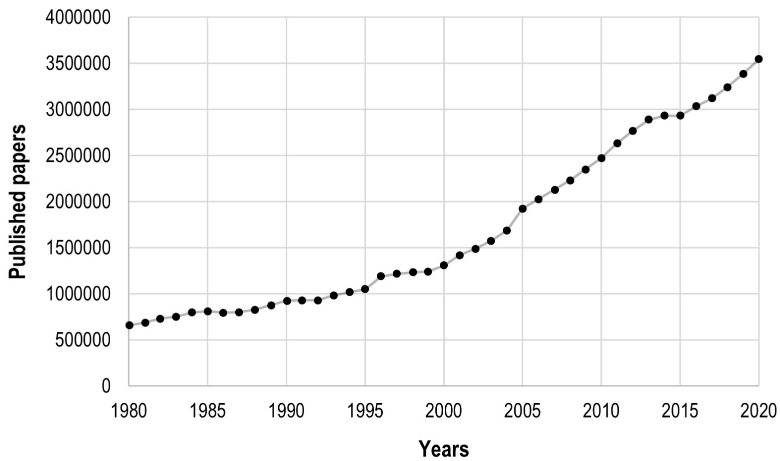

Fig. 1. Global number of scientific published papers in the Scopus database over the last 40 years. Published papers in the current year (2021) have been excluded due to the partial (biased) information. The already massive number of annual papers and its increase seems not yet reaching its asymptote.

Many students in research universities are involved in research projects during or immediately after attending their courses for various reasons: because they choose research for their career as PhD students or hired by research institutions or by the same university by fellowships; during their final projects or in research-oriented teaching projects [10]. This usually happens during graduate degree and master's programs; however, early research involvement may benefit all university students. Not only research, but all the industrial world can benefit from the new knowledge coming from millions of papers published every year. According to these facts, the ability of accessing this latent and enormous potential should be included in the skills of every student going through a University level program [11].

At the same time, in a globally and digitally interconnected world, there is a growing need to equip students with crucial competences such as critical thinking, interpersonal communication, collaborative skills, and global awareness [12]. To develop these skills, educational institutions would need to consider using innovative teaching methods to provide students with the opportunity for active learning [13]. Based on rewarded studies such as [14], cooperative learning has been presented as a useful strategy toward this revolutionary teaching and learning approach. In a nutshell, it can be said that cooperative learning emphasizes cooperation between students in groups helping them in understanding concepts and reaching goals [15]. In view of the above, cooperation learning within and among students' team is highlighted as a critical enabling factor for the proposed method, which aims to improve the students' soft and literature search skills. This method can be especially useful in interdisciplinary study programs, where the hard skills of each student is such that all of them can strongly benefit from a deeper interaction as a learning community [16, 17]. In this context, instead of scientific literature searches made by individual users, a group could significantly improve the effectiveness of this activity by enabling a better knowledge space covering and benefit from cooperative learning. Team collaboration provide an actual approach to switch from a single point of view to multiple perspectives [18], increasing the likelihood to retrieve information that autonomous exploration is not able to do [19, 20].

In this work, therefore, we propose a method based on virtual cooperative and active learning [21, 22] for cooperative literature search and socialization at a high-level educational framework. Experiments on the proposed methodology via a real case study conducted by five self-controlled virtual teams for a total of 25 students have pointed out the main benefits and criticalities along with a software tool implementation.

2 Background

Significant work has been carried out on literature search optimization, and collaborative search has been identified as a practical solution in the sharing of experts' knowledge that leads to faster and higher quality information seeking. This paper seems one of the first attempts to define a structured approach for virtual collaborative literature search and results in dissemination.

In section 2.1, an overview of cooperative learning theory is provided. Section 2.2. introduce the second ingredient of this article: literature search and share. To conclude, a brief overview of the digital transition is offered in section 2.3.

2.1 Cooperative learning theory

Interest in cooperative learning gathered momentum in the early 80s as a structured form of construction of skills and knowledge through the interactions among learners, which results in attaining shared goals at any level of education and domain [13, 23, 24]. In this framework, the instructor's role concern setting the goals; planning the tasks; assigning students into small-group to facilitate social interaction among one another [25]; acting as a coach or facilitator, monitoring the learning process of each group; providing students with ongoing feedback and assess group progress [26]. Two main benefits of cooperative learning can be identified in academic and social competences improvement [13, 23]. Concerning the former, scientific methodology are involved in moving the students from a passive to a more active role in the learning process, and exploration of information by reinforcing academic skills [27–29]. It also appears that cooperative learning allows students to analyze problems via multiple perspectives helping them to think in more complex ways [13, 30, 31]. In addition to academic benefits, emotional (i.e., appreciation, enthusiasm, motivation, values, commitment) and interpersonal social (i.e., communication, leadership, trust, decision making, conflict resolution) skills have been highlighted by several authors as enablers that boost learners to develop better cognitive abilities [23, 32–34].

2.2 Literature search and share

Systematic literature review refers to the reproducibility of results by following a structured research method based on queries in the IR domain [35–39]. Despite literature search is a crucial milestone for scientific methodology, yet, surprisingly, search is often thought of as a solitary user activity with related limitations on the actual covering of knowledge space given a specific topic [40]. Among promising solutions, the idea of intelligence amplification (i.e., symbiotic interaction between human and machine [41, 42]) has been proposed. Other approaches based on collaborative search (e.g., [40, 42, 43]) provide evident benefits. However, significant room for improvements in this field seems to be still present. For example, tools like blogs, in addition to being open access and easy to use platforms, are a valuable way to build an indexed knowledge storage system (e.g., hyperlinks) [44]. Moreover, these tools provide a nourishing environment that encourages collaboration and an interchange of skills among users (e.g., students or other stakeholders) by building a learning community based on shared knowledge [45] and able to improve the amount and pertinence of the retrieved documents. As highlighted in [46] all major search engines (e.g., Google Scholar) are designed for solo use. However, many tasks in both professional and casual settings can benefit from jointly searching the Web with others or through cooperative public sharing (e.g., ResearchGate).

2.3 Digital transformation

Virtualization is one of the most speculated topics in the transition of the last decades of the "digital era" and which the current pandemic scenario exalted [47]. The digital aspect is an additional opportunity for the proposed method since literature search is suitable for online, blended, and in-person approaches. The current COVID-19 pandemic has imposed virtualization in every context, even in a higher education environment [48]. Virtual teams have been treated and re-discovered in the enhancement of social and professional skills through processes of sharing, exchange, and motivation [49, 50]. Contrary to many other activities that have suffered from forced digitization, a collaborative scientific literature search can be boosted by the distance approach and maximize the capabilities of related virtual tools and practices.

3 Methodology

The methodology for a collaborative scientific literature search based on virtual team cooperation to improve the search's performance and teamwork skills is proposed. The main four phases of the methodology presented in this article and boundary conditions are shown in Fig. 2 and summarized below.

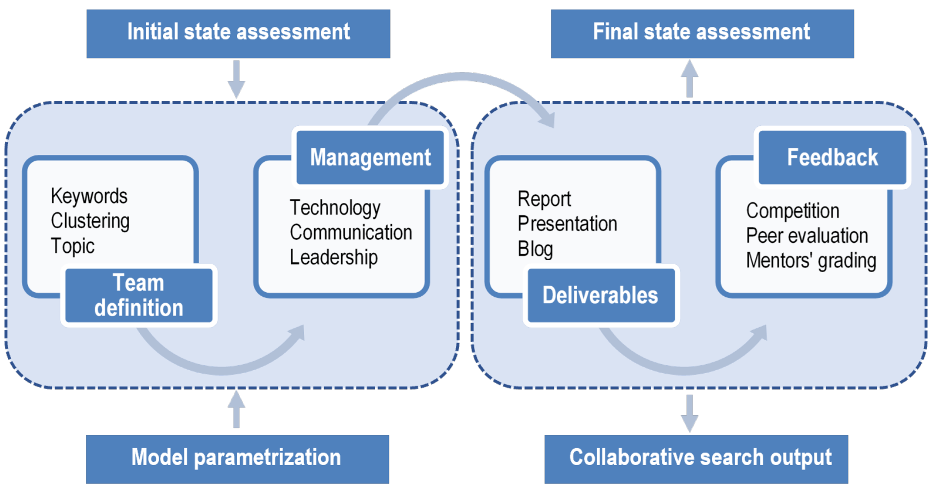

Fig. 2. The methodology of collaborative scientific literature search in a virtual team environment.

Before describing each phase in the linear flow of Fig. 2 (i.e., team definition, management, deliverable, and feedback), a set of boundary conditions must be defined to initiate the model (i.e., initial state assessment, and model parametrization). As detailed in section 2.1 about cooperative learning theory, instructors must be assumed as leaders in all these initial activities and mentors in the operative phases. During the initial state assessment, the number (n) of students involved in the activity must be defined. A lower bound can be at least four students. Moreover, students' skills must be mapped by the instructors (e.g., proficiency in the use of technology, expertise in communication and leadership as well as scientific topics interest). Concerning n, a specific interview mode or questionnaire can be considered in this preliminary activity. Therefore, based on this assessment, it is possible to set up each phase of the model to maximize the outcome of the process (i.e., the final state assessment and collaborative search output). Peer-review evaluations and mentors' grading are used in the final state assessment to provide feedback on the collaborative search output (e.g., report, presentation, blog). In the following, the main phases of the linear flow are detailed.

Team definition: Firstly, the instructors must define a set of $t \approx n/mean(m)$ topics, where m is the team size. As highlighted in section 2.1, a small group often achieves better cooperation among members, and $3 \leq m \leq 6$ seems to be a good experimental size. If no clear pattern is depicted by the initial assessment of students on scientific interests, it is up to the instructors to choose the topics. Secondly, the students define one keyword (and eventually related synonyms) for at least three of the given topics (if $t > 2$). As additional information, the students are required to specify a degree of interest (e.g., I, II, or III choices) for each topic. Thirdly, the final association of students to a given topic is conducted by the instructors. During this activity, the instructors assign students to teams mainly based on the degree of interest. At the same time, skills in the use of technology, expertise in communication, and leadership assessed in the preliminary stage are also considered. Negotiation in case of not enough or too many students for a given topic could be necessary. To conclude, the instructors provide basic notions about query generation and the literature search process, creating an initial query for each team by arranging the generated keywords and synonyms logically and following proper syntactic rules.

Management: based on instructors' guidelines, each thematic team should define specific tasks, time schedules, and responsibilities to accomplish the literature search for the given topic starting from the initial query defined in the previous phase. Each group is free to plan the preferred approach for collaborative search. The most crucial aspect is that each student brings hard and soft skills to a contaminated environment with a high level of interaction and specific sub-tasks fulfillment. Formal and informal leaders will emerge in this planning phase. After an internal drafting stage, each group must communicate and discuss the drafted management approach with the instructors. Moreover, at least two iterative rounds of meetings with the instructors to show partial results must be scheduled for ongoing feedback. As for technology and tools for collaboration, Microsoft Teams channels could help formal exchanges or meetings; Google Drive could help in paper collection and analyses; WhatsApp for informal and quick-response discussions. As for the scientific databases, a freely accessible Web search engine such as Google Scholar that indexes the full text or metadata of scholarly literature seems suitable for such initiating activities. Comments, observations, and generated material should be collected and organized for Web communication (e.g., short text and hyperlinks) into the educational blog (aka *edublog*).

Deliverable: each thematic team can develop intermediate (i.e., draft) and final (i.e., rigorous) reports following a given scientific literature review format. For example, the instructors could provide a template embedding the main areas required for the literature search (e.g., problem definition, state of the art solutions, open challenges, and future development). Then, it is up to the instructors to select the preferred report structure. As already highlighted in the management phase concerning digital tools, the material can also be reformatted for *edublog*. A team presentation in front of the class can be considered an additional deliverable to improve the overall collaboration.

Feedback: peer-to-peer feedback must be shared along the whole process. Moreover, a formal vote is assigned by the instructors after the final presentation, and mentors' tips are embedded to improve the final deliverable.

4 Experimental setting

An actual experiment involving five teams was carried out at the 2nd edition of the 2nd level Master in Valorization of different abilities and education research proposed by the CAFRE Interdepartmental Center for Lifelong Learning, Training, and Education Research at Pisa University. The master provides skills ranging from knowledge and assessment of diversity to tools and technological methodologies, organizational and pedagogical skills transmitted in an interdisciplinary and integrated way for the most profitable enhancement of the person.

In this context, 25 students participated in the experiment. The students' skills levels (i.e., poor, average, good, excellent) on the three main enabling tools of the online cooperative scientific search via a virtual team (i.e., collaborative tools, website editing, search engines) have been summarized in Fig. 3.

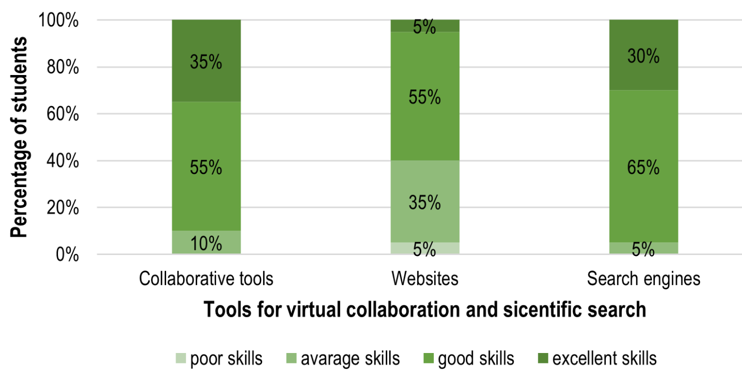

Fig. 3. Collaborative tools: Google Drive, Microsoft teams, Whats App. Websites editing: Blogger, Word Press. Search engines: Google Scholar.

As for additional information, the students ranged from 24 to 59 years old and presented heterogeneous cultural backgrounds and scientific interests (e.g., continuing education and pedagogical sciences, management and control strategy, modern philology, history of art, agricultural sciences, medicine). The defined keywords by each student and scientific interests as well as proficiency in the use of technology, expertise in communication and leadership have been considered in the generation of the five thematic teams (i.e., Italian language pedagogy

(T-ILP), motivation (T-M), sport (T-S), caregiving and diversity (T-CD), work and innovation (T-WI)). Additional information can be found in Table 1.

Table 1. Thematic teams additional information.

Team name	**members**	**Website link (in Italian)**
T-ILP	6	*https://valorizzazione.cafre.unipi.it/didattica-dellitaliano*
T-M	5	*https://valorizzazione.cafre.unipi.it/motivazione*
T-S	4	*https://valorizzazione.cafre.unipi.it/attivit%C3%A0-fisica*
T-CD	6	*https://valorizzazione.cafre.unipi.it/cura-e-disabilit%C3%A0*
T-WI	4	*https://valorizzazione.cafre.unipi.it/opposta*

A two-month experiment took place in the middle of a pandemic, which necessitated virtual collaboration. The main results due to the implementation of the phases in section 3 are presented and discussed in section 5.

5 Results

A major deliverable of this work is the *edublog* developed as a platform for a collaborative scientific literature search and results in presentation (Fig. 4).

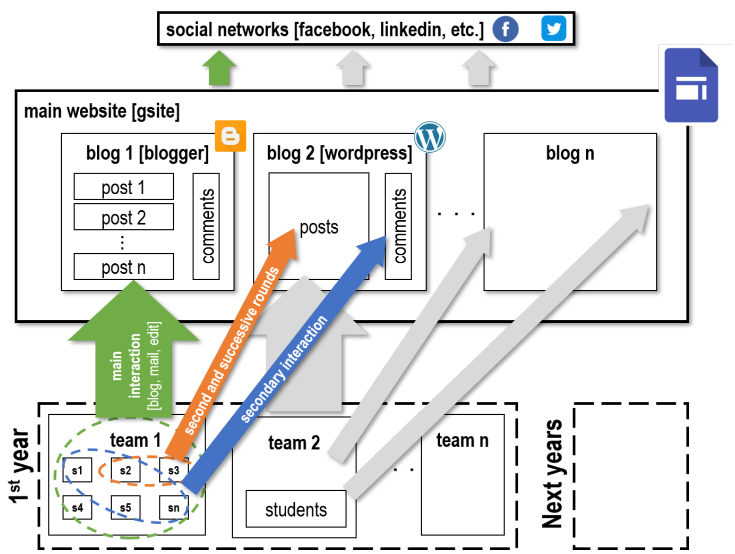

Fig. 4. The proposed *edublog* structure [*http://valorizzazione.cafre.unipi.it*] (in Italian) showing the intra- and inter-team cooperation.

The *edublog* embeds individual blogs where each virtual team can collaborate in building and sharing organized knowledge. Over 100 original posts that received 2k visits in less than six months have been published. In the following sections 5.1 and 5.2, intra- and inter-team socialization and assessment activities of the experiment are respectively reported.

5.1 Socialization during literature search and peer evaluation

As the main leading social result, the interaction among students via the *edublog* has been pointed out as the most appreciated aspect of the offered master program. Similarly, oral presentations have also benefited from the work done within the teams and cross-comments provided by the external members. In addition, the students set up a survey, filled, analyzed, and reported it. These activities have enormously increased the interaction among students and easier monitoring by the instructors with relatively low load, reliable assessment, objective evaluation tools (i.e., survey), and distributed responsibility among the students. Furthermore, each student has evaluated the other under several parameters, including topic adherence, subtopic organization, search depth, extension, schedule adherence, and presentation quality. This process has significantly impacted their awareness and shows that socialization is a solid enabler for stimulating students' engagement and quality of work.

5.2 Assessment

The two most used parameters that formally assess the performance of the query are precision (i.e., purity of retrieval) and recall (i.e., completeness of retrieval) [51]. Fig. 5 offers a representation of three standard sets in IR.

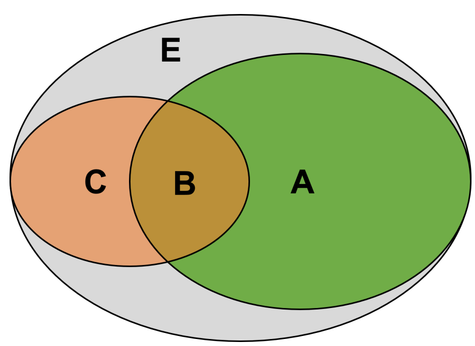

Fig. 5. A= not-retrieved pertinent documents, B= retrieved pertinent documents, C= retrieved not-pertinent documents, E=not-pertinent not-retrieved documents.

Without considering additional sets, precision is quantified as follows:

$$Precision = B/(C + B)$$

This quantity can be computed without approximation since the denominator is directly available as the query's output, and the numerator can be obtained after classifying each retrieved item as pertinent or not-pertinent. The higher the precision, the better the semantic abstraction of the underlying problem. On the other side, the recall is still an open challenge since it can be only "estimated" by the following ratio:

$$Recall = B/(A + B)$$

Unfortunately, even if B can be computed to date, the denominator is unknown since A can only be estimated. For the above reason, various automatic query expansion (QE) techniques (aka query augmentation) have been implemented to stretch B as close as possible to A [52, 53]. In a few words, QE techniques try to add (in a manual, automatic, or user-assisted way) new meaningful terms to the initial query improving its recall [54].

With this aim, the current work can be seen as a practical QE approach based on a collaborative search. As depicted in Fig. 6, clear benefits can emerge on recall calculation by the addition of a new set obtained thought collaborative search (i.e., the additional set D), since D reduce the amount of missed good documents (A'=A-D) and increase the number of the good ones retrieved (B'=B+D).

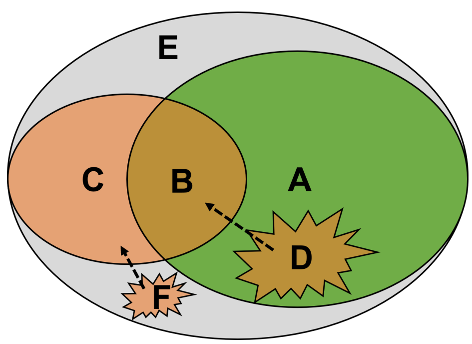

Fig. 6. The additional sets of retrieved documents via collaborative search. D= collaboratively retrieved pertinent documents and F= collaboratively retrieved non-pertinent documents.

In order to compare autonomous and collaborative search from a QE (i.e., recall augmentation) perspective, sets B and D obtained during the experiment have been quantified. Set B has been approximated considering the output of the initial query generated autonomously by the instructors in the preparatory step. Switching to the collaborative mode search, and after the interaction between students and customization of the query, citation-chain search, as well as the two iterative rounds of meetings with the instructors, the set D has been generated. Thus, the initial set B has increased to B'=B+D. Please note that the "pertinence" or "not pertinence" of a retrieved document has been delegated to the instructors judging if a given article is or not in-scope with respect to the given topic.

Table 2 summarizes the experiment results highlighting the previously defined IR sets and the % variation of the recall (i.e., $\Delta R\%$) switching from autonomous to a collaborative search for each thematic team. Considering A'=A-D and thanks to this relative approach, $\Delta R\%$ can be computed by the following equation although the set A is unknown:

$$\Delta R\% = \frac{B'/(A'+B')}{B/(A+B)} - 1 = \frac{(B+D)/(A+B)}{B/(A+B)} - 1 = \frac{B+D}{B} - 1$$

Table 2. The results of the experiment. IR sets and the % of improved recall switching from an autonomous search (i.e., B) to a cooperative approach (i.e., B'=B+D) are provided for each thematic team.

Team name	**B**	**D**	**B'**	$\Delta R\%$
T-ILP	30	33	63	+110
T-M	25	60	85	+240
T-S	40	3	43	+8
T-CD	24	15	39	+63
T-WI	52	8	60	+15

Despite these early promising results in the recall augmentation (+87% on average), additional studies and experiments are required to expand the proposed approach further. For example, as previously highlighted, this work aims to improve query recall; however, an analysis about the impact of collaborative search on the overall precision also deserves attention. As shown in Figure 6, the effect on precision due to collaborative search is highly dependent on the additional set F. In this case, contrary to the recall, direct benefits on precision cannot be claimed a priori since F increases the amount of worst documents retrieved (C'=C+F), and the relative size of D and F can negatively or positively impact the % variation of precision (i.e., the efficiency). An interesting research topic could be the exploration of the recall and precision relation in a collaborative framework as an extension of the well known inverse correlation in autonomous search (i.e., the trade-off problem [51]). Similarly to the proposed equation for $\Delta R\%$, the following $\Delta P\%$ equation is suggested for those who will explore both the aspects variation when switching to cooperative search:

$$\Delta P\% = \frac{B'/(C'+B')}{B/(C+B)} - 1 = \frac{(B+D)/(C+F+B+D)}{B/(C+B)} - 1$$

6 Conclusion

In this work, we present an approach for scientific literature search based on virtual team collaboration, explore the team dynamics of the knowledge building process in a virtual environment, and propose a blog tool for open knowledge sharing for experienced researchers and beginning students. Our experience has shown that the method can be adapted to different education environments by developing an initial state assessment and tuning the methodology accordingly.

The developed collaboration platform (i.e., *http://valorizzazione.cafre.unipi.it*) is a Google Sites (in Italian) embedding individual blogs (i.e., *edublog*) where each virtual team can build and share organized knowledge based on literature search.

Among the key elements of the experience are: team formation and keyword negotiation in a supervised way; platform creation; team oral presentations in two rounds, 5 mins per presenter; self-assessment based on a self-created online survey; training on literature search; cooperative editing and blog creation.

The method was tested in an entirely virtual environment due to the pandemic but seemed suitable for blended or in-person as well. This work has several merits, which can be individually explored further: the objective assessment of the deliverable quality coming from a cooperative search in contrast to autonomous search (please refer to the % improved recall in Table 2); the virtual team dynamics generated in an educational environment by enabling the production of new knowledge and soft skills; the infrastructure of the developed *edublog* for sharing knowledge.

References

1. AlRyalat, S.A.S., Malkawi, L.W., Momani, S.M.: Comparing bibliometric analysis using pubmed, scopus, and web of science databases. JoVE (Journal of Visualized Experiments) (152), e58494 (2019)
2. Santos, H., Batista, J., Marques, R.P.: Digital transformation in higher education: the use of communication technologies by students. Procedia Computer Science **164**, 123–130 (2019)
3. Lupi, F., Mabkhot, M.M., Finžgar, M., Minetola, P., Stadnicka, D., Maffei, A., Litwin, P., Boffa, E., Ferreira, P., Podržaj, P., et al.: Toward a sustainable educational engineer archetype through industry 4.0. Computers in Industry **134**, 103543 (2022)
4. Frolova, E.V., Rogach, O.V., Ryabova, T.M.: Digitalization of education in modern scientific discourse: New trends and risks analysis. European journal of contemporary education **9**(2), 313–336 (2020)
5. Chiarello, F., Trivelli, L., Bonaccorsi, A., Fantoni, G.: Extracting and mapping industry 4.0 technologies using wikipedia. Computers in Industry **100**, 244–257 (2018)
6. Azad, H.K., Deepak, A.: Query expansion techniques for information retrieval: a survey. Information Processing & Management **56**(5), 1698–1735 (2019)
7. Oussous, A., Benjelloun, F.Z., Lahcen, A.A., Belfkih, S.: Big data technologies: A survey. Journal of King Saud University-Computer and Information Sciences **30**(4), 431–448 (2018)

8. Brocke, J.v., Simons, A., Niehaves, B., Niehaves, B., Reimer, K., Plattfaut, R., Cleven, A.: Reconstructing the giant: On the importance of rigour in documenting the literature search process (2009)
9. Mwangi, W., Cheruiyot, W., et al.: A survey of information retrieval techniques. Advances in Networks **5**(2), 40 (2017)
10. Bhattacharyya, P., Chan, C.W., Waraczynski, M.: How novice researchers see themselves grow. International Journal for the Scholarship of Teaching and Learning **12**(2), 3 (2018)
11. Ruescas-Nicolau, M., Sánchez-Sánchez, M., Espí-López, G.: The use of a cooperative-learning activity about scientific literature search in physiotherapy students: an experience. In: INTED2017 Proceedings. pp. 2196–2203. 11th International Technology, Education and Development Conference, IATED (2017)
12. Johnson, D.W., Johnson, R.T.: An educational psychology success story: Social interdependence theory and cooperative learning. Educational Researcher **38**(5), 365–379 (2009)
13. Loh, R.C.Y., Ang, C.S.: Unravelling cooperative learning in higher education: A review of research. Research in Social Sciences and Technology **5**(2), 22–39 (2020)
14. Baloche, L., Brody, C.M.: Cooperative learning: Exploring challenges, crafting innovations (2017)
15. Silalahi, T.F., Hutauruk, A.F.: The application of cooperative learning model during online learning in the pandemic period. Budapest International Research and Critics Institute-Journal (BIRCI-Journal) **3**(3) (2020)
16. Studente, S., Ellis, S.: Enhancing the online student experience through creating learning communities—the benefits of chatbots in higher education. In: Tertiary Online Teaching and Learning, pp. 25–33. Springer (2020)
17. Jan, S.K., Vlachopoulos, P., Parsell, M.: Social network analysis and learning communities in higher education online learning: A systematic literature review. Online Learning **23**(1) (2019)
18. Kagan, S.: Cooperative learning. Kagan San Clemente, CA (1994)
19. Tannenbaum, S.I., Traylor, A.M., Thomas, E.J., Salas, E.: Managing teamwork in the face of pandemic: evidence-based tips. BMJ quality & safety **30**(1), 59–63 (2021)
20. Vygotsky, L.S.: Mind in society: The development of higher psychological processes. Harvard university press (1980)
21. Johnson, D.W., Johnson, R.T.: Learning together and alone: The history of our involvement in cooperative learning. In: Pioneering Perspectives in Cooperative Learning, pp. 44–62. Routledge (2021)
22. Venton, B.J., Pompano, R.R.: Strategies for enhancing remote student engagement through active learning (2021)
23. Gillies, R.M.: Cooperative learning: Review of research and practice. Australian Journal of Teacher Education (Online) **41**(3), 39–54 (2016)
24. Johnson, D.W.: Social interdependence: interrelationships among theory, research, and practice. American psychologist **58**(11), 934 (2003)
25. Johnson, D.W., Johnson, R.T.: Cooperative learning: The foundation for active learning. Active Learning—Beyond the Future (2018)
26. Slavin, R.E.: Classroom applications of cooperative learning. APA educational psychology handbook, Vol 3: Application to learning and teaching pp. 359–378 (2012)
27. Biggs, J.: What the student does: Teaching for enhanced learning. Higher education research & development **18**(1), 57–75 (1999)

28. Cavanagh, M.: Students' experiences of active engagement through cooperative learning activities in lectures. Active learning in higher education **12**(1), 23–33 (2011)
29. Shimazoe, J., Aldrich, H.: Group work can be gratifying: Understanding & overcoming resistance to cooperative learning. College teaching **58**(2), 52–57 (2010)
30. Lim, D.H.: Cross cultural differences in online learning motivation. Educational Media International **41**(2), 163–175 (2004)
31. Van Knippenberg, D., Schippers, M.C.: Work group diversity. Annu. Rev. Psychol. **58**, 515–541 (2007)
32. Du, C.: The effect of cooperative learning on students' attitude in first-year principles of accounting course. Business Education Innovation Journal **7**(2) (2015)
33. Thanh, P.T.H., Gillies, R., Renshaw, P.: Cooperative learning (cl) and academic achievement of asian students: A true story. International education studies **1**(3), 82–88 (2008)
34. Felder, R.M., Brent, R.: Understanding student differences. Journal of engineering education **94**(1), 57–72 (2005)
35. Müller-Bloch, C., Kranz, J.: A framework for rigorously identifying research gaps in qualitative literature reviews (2015)
36. Torres-Carrión, P.V., González-González, C.S., Aciar, S., Rodríguez-Morales, G.: Methodology for systematic literature review applied to engineering and education. In: 2018 IEEE Global Engineering Education Conference (EDUCON). pp. 1364–1373. IEEE (2018)
37. Brendel, A.B., Trang, S., Marrone, M., Lichtenberg, S., Kolbe, L.M.: What to do for a literature review?–a synthesis of literature review practices (2020)
38. Vivekavardhan, J., Chakravarthy, A., Ramesh, P.: Search engines and meta search engines great search for knowledge: A frame work on keyword search for information retrieval. In: Advances in Decision Sciences, Image Processing, Security and Computer Vision, pp. 435–443. Springer (2020)
39. Boell, S.K., Cecez-Kecmanovic, D.: On being 'systematic'in literature reviews. Formulating research methods for information systems pp. 48–78 (2015)
40. Andolina, S., Klouche, K., Ruotsalo, T., Floréen, P., Jacucci, G.: Querytogether: Enabling entity-centric exploration in multi-device collaborative search. Information Processing & Management **54**(6), 1182–1202 (2018)
41. Dobrkovic, A., Döppner, D.A., Iacob, M.E., van Hillegersberg, J.: Collaborative literature search system: An intelligence amplification method for systematic literature search. In: International conference on design science research in information systems and technology. pp. 169–183. Springer (2018)
42. van Hillegersberg, J.: Collaborative literature search system: An intelligence amplification method for systematic literature search. In: Designing for a Digital and Globalized World: 13th International Conference, DESRIST 2018, Chennai, India, June 3–6, 2018, Proceedings. vol. 10844, p. 169. Springer (2018)
43. Fu, X., Kelly, D., Shah, C.: Using collaborative queries to improve retrieval for difficult topics. In: Proceedings of the 30th annual international ACM SIGIR conference on Research and development in information retrieval. pp. 879–880 (2007)
44. Carley, S., Beardsell, I., May, N., Crowe, L., Baombe, J., Grayson, A., Carden, R., Liebig, A., Gray, C., Fisher, R., et al.: Social-media-enabled learning in emergency medicine: a case study of the growth, engagement and impact of a free open access medical education blog. Postgraduate medical journal **94**(1108), 92–96 (2018)
45. Duarte, P.: The use of a group blog to actively support learning activities. Active Learning in Higher Education **16**(2), 103–117 (2015)

46. Morris, M.R.: A survey of collaborative web search practices. In: Proceedings of the SIGCHI conference on human factors in computing systems. pp. 1657–1660 (2008)
47. Amankwah-Amoah, J., Khan, Z., Wood, G., Knight, G.: Covid-19 and digitalization: The great acceleration. Journal of Business Research (2021)
48. Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P., Lam, S.: Covid-19: 20 countries' higher education intra-period digital pedagogy responses. Journal of Applied Learning & Teaching **3**(1), 1–20 (2020)
49. Gibbs, J.L., Sivunen, A., Boyraz, M.: Investigating the impacts of team type and design on virtual team processes. Human Resource Management Review **27**(4), 590–603 (2017)
50. Herrera-Pavo, M.Á.: Collaborative learning for virtual higher education. Learning, Culture and Social Interaction **28**, 100437 (2021)
51. Buckland, M., Gey, F.: The relationship between recall and precision. Journal of the American society for information science **45**(1), 12–19 (1994)
52. Sharma, D.K., Pamula, R., Chauhan, D.: A hybrid evolutionary algorithm based automatic query expansion for enhancing document retrieval system. Journal of ambient intelligence and humanized computing pp. 1–20 (2019)
53. Choi, J., Park, Y., Yi, M.: A hybrid method for retrieving medical documents with query expansion. In: 2016 international conference on big data and smart computing (BigComp). pp. 411–414. IEEE (2016)
54. Bhogal, J., MacFarlane, A., Smith, P.: A review of ontology based query expansion. Information processing & management **43**(4), 866–886 (2007)