An analysis of social aspects in CSCL: a SML on design and evaluation of sociability to (re)qualify these environments

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Abstract. *In computer-supported cooperative work, especially in Computer Supported Collaborative Learning (CSCL), there is a high dependence on interpersonal relationships in the learning process. Therefore, sociability is an essential aspect for the success of this approach. CSCL systems have as their fundamental principle the intermediation of relationships between people to share resources, facilitate teamwork and facilitate the flow of information in the teaching-learning process. CSCL environments tend to bring together many students with a wide range of social and cultural characteristics. They interact with their peers to learn and build knowledge collaboratively. This article aims to present the results of a systematic mapping of the literature that presents challenges and solutions related to sociability in the design and evaluation of CSCL systems. The systematic mapping of literature was carried out through searches in four scientific databases, adopting quality criteria to refine the findings into categories. We identify techniques, methods and formalisms and categorize them according to conception or evaluation, focusing on sociability in CSCL. We hope that the explicit tools and approaches described in this study can enable projects and evaluations of these environments that prioritize essential social aspects in interaction, verifying the quality of sociability in these environments.*

1. Introduction

Sociability can be defined as a community-oriented skill because the environment (system) creates a social space [Kreijns et al. 2002]. More specifically, sociability pertains to the fulfillment of social policies to support the community's goal achievement [Preece 2001]. The ability to provide an environment with characteristics that offer and influence socialization among people when using the system is inherent in the level of sociability presented by the computational environment [Gao et al. 2008]. These characteristics must be designed and incorporated throughout the process of creating social software, such as groupware.

Collaborative Systems or Groupware are based on the intermediation of relationships among people (users) to share resources, favor teamwork (collaboration) and enable the flow of information [Fuks et al. 2003]. Computer-supported collaborative learning (CSCL) is a particular type of groupware that, through peer interaction with support of information and communication technologies (ICT), promotes learning among people in their environment [Stahl et al. 2006]. Computational mediation and collaboration in remote education make learning even more complex in CSCL by adding computational tools as active agents in the educational process. In other words, the tools available in the environment can favor or hinder the students' purpose. Therefore, sociability becomes an essential factor in qualifying the CSCL since it impacts the environment quality.

CSCL environments can be diffuse, without a single or specific environment (system), using a strategy that groups students by integrating social networks, online forums, and wikis to share information and interaction among peers. It can also be concise, like a MOOC (Massive Open Online Course) environment that provides tools and resources to promote student learning in a single environment [Garrido 2018]. In this sense, we understand MOOC as a specific type of CSCL, and we have that reference in mind for the design of this environment.

From this context it is necessary to conduct studies that help designers and evaluators to handle the complexity of the social and learning applications present [Harrison et al. 2007, Sellen et al. 2009]. Based on this, the present study aims to present the results of a systematic mapping of the literature that presents challenges and solutions related to sociability in the design and evaluation of CSCL systems. With the results, it was possible to identify the challenges and solutions related to sociability in the design and evaluation of CSCL, especially in MOOCs. The studies (articles) found were examined under specific quality criteria to filter and present tools, techniques, approaches related to the design or evaluation of CSCL.

The following text is structured in six more sections: theoretical foundation, the methodology applied to perform the SML, results and answers to questions, discussions and reflections, validity threats, and the conclusion section.

2. Theoretical Foundation

The interaction between students in CSCL environments is important for socio-affective processes, such as trust and friendship and cognitive learning processes. In this sense, the CSCL environment can be considered as a social space, that is, an environment that favors social relationships through sociability [Kreijns et al. 2002], which can be a noticeable attribute depending on the platform.

In several scientific areas, the concept of sociability presents itself in different ways from the specific perspective of the area. Each possible definition of these approaches highlights different aspects of the general concept. According to the American Psychological Association (APA), sociability is the tendency and accompanying abilities to seek companionship, engage in interpersonal relationships, and participate in social activities [VandenBos 2007].Thus, several elements can be added to a CSCL system to provide sociability to the environment, such as chats and discussion forums. This way, students will be able to have tangible elements to understand sociability through the social spaces designed in the system.

In terms of sociability, MOOC systems, such as Coursera, Udemy, Open2Study, Udacity, EdX, provide many tools through which students can communicate with pairs (e.g., social networking). MOOCs are an educational environment built by the involvement of self-regulated students in their learning objectives without requiring prior experience to enter courses [do Rêgo et al. 2021, McAuley et al. 2010]. In addition, a MOOC can be a system developed with design and engineering practices common to all social software.

In the MOOC context, student-instructor/tutor or student-student interaction can help learners better understand the educational content and allow students to give feedback through responding to announcements and guides, asking and answering questions, and participating in forums discussions. Higher levels of sociability can increase social interactions, create affective collaborative relationships [Kreijns et al. 2007].

3. Methodology

The methodology of this mapping followed the guidelines proposed by [Kitchenham 2004, Keele et al. 2007]. Following these guidelines, the following steps were taken: (i) planning and definition of research questions; (ii) application of the inclusion and exclusion criteria; (iii) carry out the review and (iv) summarize the results.

3.1. Planning and Research Questions

The research questions and their respective foundations, presented in this subsection, guided the search carried out while reading the articles returned in the scientific bases chosen to meet the objectives mentioned earlier. To know: (RQ1) which theories, models, formalisms, techniques, practices of Human-Computer Interaction (HCI) adopted in design of CSCL environments under the sociability approach are adequate to conceive a development model/process?; (RQ2)) which theories, models, formalisms, techniques, practices of HCI adopted in evaluation of CSCL environments under the sociability approach are adequate to conceive a development model/process?; e, (RQ3) what are the research gaps/opportunities evidenced from the analyzed studies?.

3.2. Inclusion and Exclusion Criteria

Articles that did not meet all inclusion criteria or at least one exclusion criteria were removed (excluded) from the mapping. The other studies were kept in the subsequent steps. The inclusion and exclusion criteria were based on the guidelines expressed in Kitchenham (2007) [Keele et al. 2007].

To this end, we listed inclusion and exclusion criteria to select the articles returned in searches using the string on the platforms that house study reports. Inclusion criteria: (IC1) studies where the term *sociability* is related to *CSCL* or *Massive Open Online Course*; (IC2) studies dealing with the *design* or *evaluation* of *CSCL* or *Massive Open Online Course* from the perspective of *sociability*.

Regarding the criteria for exclusion, we indicate seven of them for filtering. Exclusion Criteria: (EC1) duplicate articles; (EC2) gray literature[1]; (EC3) articles with less

[1]Reports (technical, preliminary, advanced), Theses, Position papers - position paper presenting a debatable opinion on a question/theme - and White papers - unreviewed content that is used to disclose data or successful actions by an organization.

than 5 pages (short paper); (EC4) secondary studies (reviews and mapping of the literature on sociability in/for CSCL or MOOC); (EC5) unavailable items (paid or not found); (EC6) articles with insufficient content for the purposes of this review; (EC7) non-English articles.

3.3. Execution

The execution of the SLM was carried out by three HCI researchers under the guidance of an expert HCI researcher with background in Computing in Education field. All of those are authors of this article and have experience with systematic reviews and mappings published in other conferences and journals.

Database searches were done with a string created to support this SLM (see Table 1), that was composed of the terms sociability & CSCW and CSCL, acronyms that were also used in their full form "Computer Supported Cooperative Work" and "Computer-supported collaborative learning", respectively. The terms "design" and "evaluation" have also been added to the search string to better filter the results.

It is worth noting that we use the term CSCW in our search string to try to find studies that by chance have not used the term CSCL, even if it is a collaborative system in the educational field. Only as a safeguard in our search for scientific bases.

Table 1. Sociability and Related Terms

sociability AND (CSCL OR CSCW OR "Computer-Supported Collaborative Learning" OR "Computer Supported Cooperative Work") AND(design OR evaluation)

We considered the studies published until February of 2021, whose searches occurred in the following bases, considering the expressive number of indexed papers and their relevance to the Computer Science: **ACM Digital Library**[2], **IEEE Xplorer**[3], **Scopus**[4] and **Science Direct**[5].

Searches at selected bases returned 189 papers (considering duplicate articles). The graph of Figure 1 shows the number of papers found in each base, presenting the percentage in relation to the total. The next step of the revision was started.

We applied the exclusion and inclusion criteria while reading the *titles*, *abstract*, and *keywords* of each of the 189 papers returned. This step was supported by the tools: **Mendeley**[6], Google Drive, and **Parsifal**[7]. For both reading and selection of papers and collaboration among the reviewers. After running the first stage, forty-six (46) papers were selected.

After applying the inclusion and exclusion filters, *Introduction* and *Conclusion* sections of all papers selected were read, totaling twenty four (24) papers to judge on

[2]https://dl.acm.org/

[3]https://ieeexplore.ieee.org/Xplore/home.jsp

[4]https://www.scopus.com/

[5]https://www.sciencedirect.com/search/advanced

[6]https://www.mendeley.com/

[7]Web software for reading and storing articles served as a support tool for systematic mapping/review activity (https://parsif.al/).

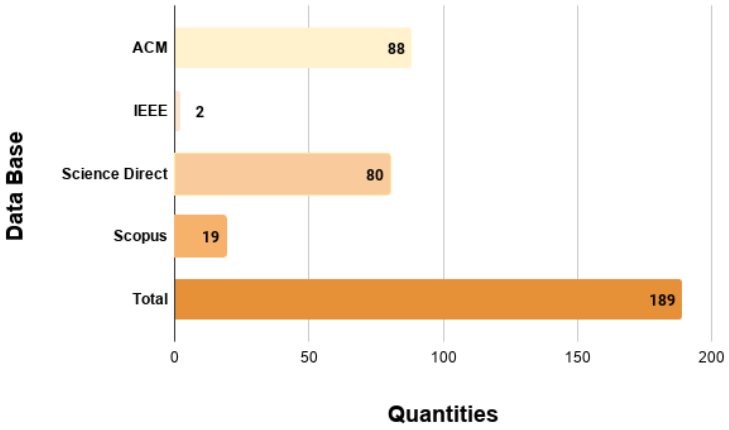

Figure 1. Number of articles found in each database

adherence to the objective of this research. In order to establish which articles among those present so far would be considered for the extraction and composition of this paper, we applied qualitative notes on several elements of the articles in order to guarantee the answer to the research questions. For this we composed the following quality assessment checklist.

Quality Assessment Checklist: (I) is the structure / organization of the article adequate and easy to understand? (II) does the study clearly define your problem? (III) does the study clearly define its purpose? (IV) does the study describe and use a clear and objective methodology? (V) does it describe a process for designing or evaluating a CSCL/MOOC from a sociability perspective? (VI) does it have a guideline(s) or similar with the best practices or sociability requirements for CSCL/MOOC ? (VII) does it describe the design or evaluation process in detail from the perspective of sociability? (VIII) does it contribute to innovations/ractices for MOOC design from the perspective of sociability? (IX) does it contribute with innovations/practices for the evaluation of MOOC from the perspective of sociability? and (X) does it present future research possibilities that are similar to the proposal of this investigation?

For each quality criterion one of the following marks was assigned: **zero** (0), **half point** (0.5) or **one** (1.0). Those notes were derived from the researcher' assessment of the level of compliance with the quality criterion. Numeric values represent **No** (0), **Partially** (0.5) and **Yes** (1.0). A minimum score of five (6.0) was stipulated for the paper to be considered selected for the data extraction phase. Therefore, after applying the quality criteria, the studies that obtained a score equal to or greater than five (6.0), by adding the scores assigned by criterion in the classification, were selected for the next phase, data extraction.

Figure 2 highlights the number of papers in each stage of the SLM and the current quantity of papers in the quality assessment phase for data extraction. We emphasize that among the 24 (twenty-four) papers, one could not be fully assessed for receipt. After reading the entire paper set and applying the quality criteria, twelve (12) papers were selected for data extraction.

The presentation of papers divided by publication year highlights the recent inter-

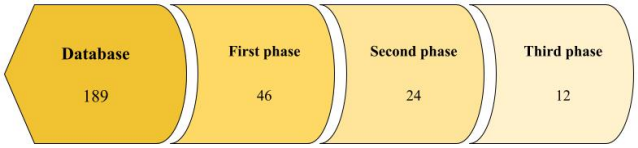

Figure 2. Papers per phase - numbers

est in the topic sociability in CSCL. *Computer and Education* and *Computer in Human Behavior* are the two journals that have the oldest papers of the theme. Since 2019, at least one (1) article has been made available each year on the subject of this study. Another point to be highlighted is that twelve (12) selected studies were published in journals, no study was published in conference proceedings.

Table 2 shows the list of the papers selected after application of the quality criteria. The papers was sorted alphabetically by title. To check the quality score achieved by each paper, check the identification number assigned in the first column of the table.

Table 2. List of selected papers - After quality criteria

#	Title	Authors	Year
1	A framework for analyzing and understanding online communities	De Souza, Clarisse Sieckenius e Preece, Jenny	2004
2	Before and during COVID-19: A Cohesion Network Analysis of Students' Online Participation in Moodle Courses	Dascalu, M. D., Ruseti, S., Dascalu, M., McNamara, D. S., Carabas, M., Rebedea, T., Trausan-Matu, S.	2021
3	Designing sociable online learning environments and enhancing social presence: An affordance enrichment approach	Weidlich, Joshua e Bastiaens, Theo J.	2019
4	Determining Sociability, Social Space, and Social Presence in (A)synchronous Collaborative Groups	Kreijns, K; Kirschner, P A; Jochems, W e Van Buuren, H	2004
5	Enhancing non-task sociability of asynchronous CSCL environments	Abedin, Babak; Daneshgar, Farhad e D'Ambra, John	2011
6	Explaining social presence and the quality of online learning with the SIPS model	Weidlich, Joshua and Bastiaens, Theo J.	2017
7	Measuring perceived quality of social space in distributed learning groups	Kreijns, K; Kirschner, P A; Jochems, W e Van Buuren, H	2004
8	Measuring perceived sociability of computer-supported collaborative learning environments	Kreijns, K; Kirschner, P A; Jochems, W e van Buuren, H	2007
9	Social interaction regulation in virtual web environments using the Social Theatres model	Paredes, Hugo e Mario Martins, F.	2012
10	Technological environment, virtual experience, and MOOC continuance: A stimulus–organism–response perspective	Zhao, Yiming; Wang, Afeng e Sun, Yongqiang	2020
11	Understanding factors affecting perceived sociability of social software	Gao, Qin; Dai, Yusen; Fan, Zao e Kang, Ruogu	2010
12	Using online collaboration applications for group assignments: The interplay between design and human characteristics	Koh, E. e Lim, J.	2012

4. Results and answers

This section was organized to show answers to each research question from the data obtained through the analysis of the selected papers.

4.1. RQ1. Which theories, models, formalisms, techniques, practices of HCI adopted in the design of CSCL environments under the sociability approach are adequate to conceive a development model/process?

Some studies present the project or design process of a CSCL explicitly focused on sociability. Several authors address the adoption of social aspects as a requirement in a CSCL environment [Kreijns et al. 2002, Kreijns et al. 2004a, Kreijns et al. 2004b, Kreijns et al. 2007, Abedin et al. 2011, Weidlich and Bastiaens 2017, Weidlich and Bastiaens 2019, Zhao et al. 2020]. These studies will be essential in the design of good practice guidelines for the design of CSCL, especially in a MOOC environment, with attention to student socialization.

In response to this question, Kreijns *et al.* (2004) [Kreijns et al. 2004a] present three important artifacts that make up a conceptual framework: the Sociability Scale, the Social Presence Scale, and the Social Space Scale. These instruments guide the design of a CSCL, as well, as they can conduct an evaluation process, as carried out in another study [Weidlich and Bastiaens 2017]. Kreijns *et al.* (2004) do not deal with pedagogical

techniques, focusing only on sociability. They also highlight the importance of social affordances in the composition of social spaces. However, the authors indicate that they should run more experiments to validate the instruments.

In the paper, entitled "A framework for analyzing and understanding online communities" [De Souza and Preece 2004], the authors present a framework called Online Community Framework (OCF). Whose objective is supporting evaluators, designers, moderators, and users to identify and understand sociability problems and related usability problems in online communities and other software that support online social interaction. A highlight of this framework is its understanding of semiotic analysis in the interpretation of communication in interactions and tools of the environment.

De Souza and Preece (2004) [De Souza and Preece 2004] inform that sociability is concerned with social interactions in the online community, while usability is mainly concerned with the human-computer interface. At first, designers are encouraged to focus on users' social needs before deciding on software design, according to the authors. In addition, online communities evolve, and change, so many design decisions will need to be reviewed regularly. The OCF has a broad capability to support the design project of a CSCL, as it takes a holistic view of essential quality aspects in a computer system, such as usability, communicability, and sociability. It needs an update to include aspects related to the design of the accessibility of the environment.

None of the studies returned explicitly mention any proposed CSCL solution from the design of MOOC. However, we highlight that some studies can be analyzed under this bias, as in Kreijns *et al*. (2007) [Kreijns et al. 2007] social referencing *affordances* that can be interpreted as social functionalities for CSCL, consequently adopted in the conception of MOOCs.

4.2. RQ2: Which theories, models, formalisms, techniques, practices of HCI adopted in the evaluation of CSCL environments under the sociability approach are adequate to conceive a development model/process?

To predict student success, several sources were analyzed with information about students' performance, including linguistic and semantic features of their posts, clickstream data, and aspects of their interactions [Dascalu et al. 2021]. The authors reported that there was an increase in the degree of complexity of the students' posts. It was possibly encouraged by the absence of face-to-face discussions due to the epidemic.

The Sociability Scale, mentioned earlier in Kreijns et al. (2004 and 2007), operationalizes different aspects of sociability so that designers can take into account which resources the environment must have from the project onwards. On the other hand, this Sociability Scale seems to be approached more as a tool to measure the level of sociability of existing environments.

4.3. RQ3: What are the research gaps/opportunities evidenced from the analyzed studies?

The Online Community Framework (OCF) [Preece 2001] (see Figure 3) is indicated to complement an assessment made by usability heuristics, once the tool analyzes the communication among users and interactions on the interface. The authors also suggest that the framework can be modeled and tested with other theories extracted from Sociology,

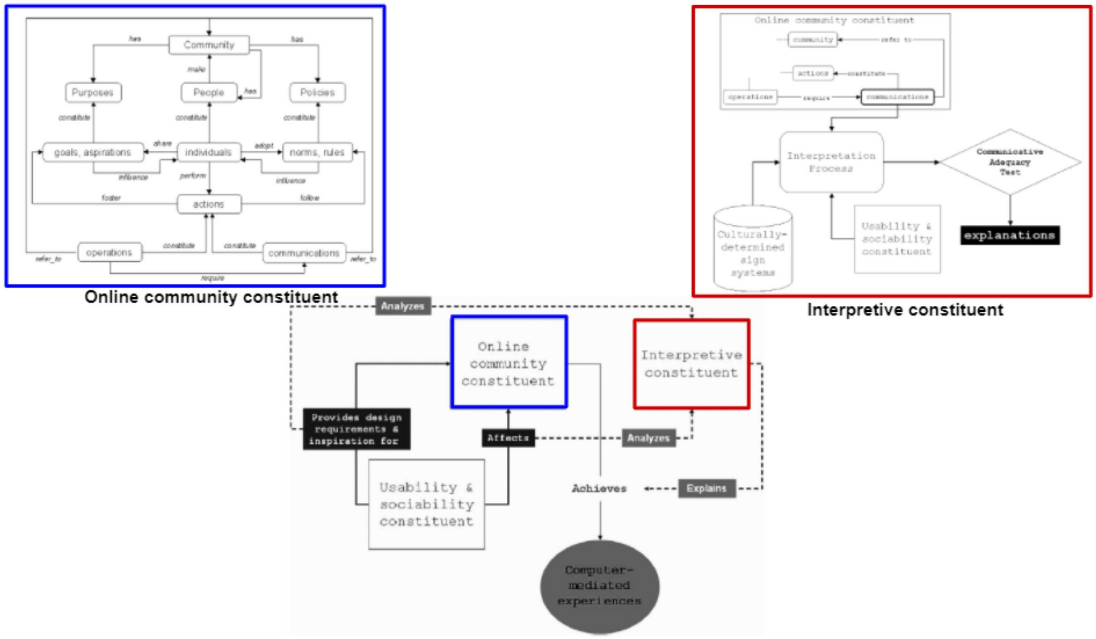

Figure 3. Online community framework (OCF) [De Souza and Preece 2004]

Psychology, indicating Decision Theory, Conversation Theory, or political theories. Finally, it is recommended to use OCF to redesign online environments and compare users' performance.

Designing sociable online learning environments and enhancing social presence: an affordance enrichment approach - does not have future works explicitly indicated by the authors. However, it presents a series of questions in the research limitations section that can be interpreted as modifications for future replications of the study.

The indication of the investigation of the relationship between sociability in aspects other than tasks (evaluative activities) in the CSCL and orbital factors around collaborative learning is indicated for future work [Abedin et al. 2011]. A similar case was reported by Weidlich and Bastiaens (2017) [Weidlich and Bastiaens 2019] who carried out an investigation in a CSCL environment with a focus on asynchronous communication since only 32% of the participants use the synchronous chat. Thus, they indicated in a future analysis with the social presence scale in synchronized communication environments, such as chats.

5. Validity threats

We analyzed the validity of this SLM considering the following taxonomies: ”construction validity”, ”internal validity ”, ”external validity”,and” reliability”. The identified validity threats that may limit the ability to understand the data obtained and therefore should be minimized [Alves et al. 2010].

The use of the expression ”construct validity” reflects that the study planning, summarized in the protocol for conducting the mapping, represents the researchers' intention in the investigation conducted through the research questions. In this context, to avoid threats to construction validity, the search terms in the string use the acronym

CSCL and CSCW, as well as the terms in full quotes ("Computer-Supported Collaborative Learning" and "Computer Supported Cooperative Work") to return strictly within the expected scope. Likewise, we add the terms sociability, design, and evaluation with the necessary logical connectives (AND and OR).

This last aspect also reflects data collection and analysis reliability since the returned papers passed through the scrutiny of peers from the academic-scientific community [Alves et al. 2010]. Furthermore, the adoption of a protocol with a search string and well-defined procedures positively impacts the reliability of this mapping. Finally, due to subjective criteria in the analysis of studies, it is not guaranteed that another researchers will achieve the same result presented here.

6. Discussions and Reflections

The Results (see Section 4) of this systematic mapping of literature provides valuable insights into the appropriate ways to analyze sociability in CSCL. The studies analyzed in this mapping present frameworks, models, techniques, and tools to assess sociability in CSCL environments. These frameworks and models take into account the individual, community, and technological elements that influence social aspects in a CSCL .

Some studies analyzed presented frameworks or models to evaluate the sociability of an environment. For example, one study proposed a model that considers individual, group, and community levels of analysis to assess the sociability of a CSCL environment [Kreijns et al. 2002].Proposing a framework that considers the social, cognitive, and teaching presence dimensions to assess the effectiveness of a CSCL environment [*ibid*].

We believe that the appropriate ways of analyzing sociability in CSCL include the use of these references and models, which can be developed by bringing together different areas of the humanities, such as Sociology, Anthropology, Political Sciences and Psychology. These frameworks and models can be used to assess the sociability of an environment and to identify areas for improvement.

The findings of this mapping can be used as design and evaluation guidelines to develop a MOOC environment from the perspective of sociability since MOOCs are considered a type of CSCL. For example, one study proposed a model that considers the social, cognitive, and teaching presence dimensions to evaluate the effectiveness of a MOOC environment [Weidlich and Bastiaens 2019]. We can indicate the sociability scale presented in Kreijns et al. (2004 and 2007) to benchmark the quality of sociability of an environment and serve as a parameter for adequacy in case of (re)design.

Overall, the discussions and reflections presented in this document highlight the importance of sociability in CSCL and provide guidance on how to design and evaluate successful CSCL environments. By taking into account the challenges and solutions related to sociability, researchers and practitioners can create CSCL systems that promote social relationships and cognitive learning processes . The frameworks and models proposed in the studies analyzed in this mapping can be used to evaluate the sociability of a CSCL environment and to identify areas for improvement.

7. Conclusion

Through the findings in this mapping, we present the results of primary studies that presented challenges or solutions related to sociability in CSCL to enable the design or eval-

uation of these environments. We explain models, techniques, tools, approaches adopted in the papers, as well as their possibilities for future research indicated by the authors. The results were subdivided according to the three questions (RQ1, RQ2, RQ3) guiding this SLM.

Although few of the selected studies deal specifically with MOOC, it is entirely possible to use the findings resulting from this SLM as design and evaluation guidelines to develop a MOOC environment from the perspective of sociability since we consider MOOC environments to be a type of CSCL.

Many of the studies analyzed presented frameworks or models to assess the sociability of an environment. It is highlighting the large number of elements (individual, community, technological) that influence social aspects in a CSCL. Thus, the evaluation or design process is not a trivial task and requires a holistic view that brings together several areas of the humanities to compose these frameworks or models, such as Sociology, Anthropology, Political Sciences, and Psychology.

The Sociability Scale referenced in several studies is an important artifact that should be revised to compose a set of best practices for CSCL design. The elements analyzed in this scale can be observed from the perspective of software requirements to design features of the MOOC environments, for example.

In view of the set of studies analyzed, we indicate that a major factor for the existence of a solid social space is an agent that encourages socialization in environments. In this sense, we intend to investigate the addition of an agent (or even a set), human or non-human, to foster interaction in specific environments of a MOOC, such as chats and discussion forums. To check if there is an increase in interaction due to the performance of this agent, interacting with students favors dialogue and, consequently, sociability.

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