Towards a Reference Model for Mass Collaborative Learning

Majid Zamiri(✉) and Luis M. Camarinha-Matos

Faculty of Sciences and Technology and UNINOVA - CTS,
NOVA University of Lisbon, 2829-516 Lisbon, Portugal
zamiri_majid@yahoo.com, cam@uninova.pt

Abstract. The rapid development of collaborative activities (particularly beyond geographical boundaries) and the increasing demand for lifelong learning have opened immense opportunities for learners worldwide. Mass Collaborative Learning, as an emerging approach, shifts away from traditional teacher-centered milieu to self-driven learning practices where a large number of learners at various performance levels collectively work toward reaching a common goal. The implementation and development of mass collaborative learning communities however requires both further progress in understanding the involved processes and addressing the key affecting factors. Therefore, as a contribution in this context, a reference model for mass collaborative learning is pursued, aiming to facilitate the understanding of related concepts and highlighting the main internal and external components. Preliminary results of this research work are discussed.

Keywords: Mass collaborative learning · Collaborative Networks · Reference model · ARCON modeling framework

1 Introduction

The progress in Collaborative Networks (CNs) and the increasing demand for pervasive networked communities have given rise to an emerging new trend and powerful models of collaboration involving large numbers of participants. Away from hierarchy and control, this new method of collective action shifts towards self-organizing and autonomy that, per se, shapes mass collaboration. We are now entering an age of collaboration explosion towards massive contribution where reaping the benefits of diverse minds in solving complex problems becomes a major goal. When this fascinating phenomenon is applied to social learning contexts, standing for limitless public contribution, and benefiting from collective knowledge building and sharing, the notion of Mass Collaborative Learning (MCL) evolves. Under the umbrella of CNs [1], MCL occurs "*when a large number of scattered and self-directed contributors share their partial knowledge, information, data, and experiences with each other (typically by means of ICT platforms) in order to learn something new. In this collective action, knowledge is jointly and continually created, shared, and developed*" [2].

This evolving phenomenon is altering the boundaries and basic mechanisms of both collaboration and learning at an unprecedented rate. MCL moves for example, from

Published by Springer Nature Switzerland AG 2020
L. M. Camarinha-Matos et al. (Eds.): DoCEIS 2020, IFIP AICT 577, pp. 18–30, 2020.
https://doi.org/10.1007/978-3-030-45124-0_2

funneling all learning programs through instructors (consumer culture) towards proactive public engagement (culture of participation), from confrontation in traditional learning to collaboration in online environment, from a formalized and centralized form to an informal and decentralized form of learning, from a passive role of knowledge acquisition (at individual level) to an active participation in knowledge creation (at community level) [3]. On this basis, a learning ecosystem can and should take the advantages of the unique opportunity that mass collaboration has brought today where plenty of contributors collectively, proactively, and positively engage in the process of knowledge acquisition, building, sharing, and developing.

However, despite notable progresses in understanding the MCL and achievements gained in this context, not all its aspects, characteristics, and components have explicitly defined yet. For instance, different researchers have different viewpoints about this approach, so there is not yet an integrative view about the concept and we are still far from having a common understanding and unified definition of MCL. The boundaries of MCL have not been precisely determined, the processes of formation, organization, and development of MCL communities are still vague [4]. All these points show that this field of study is still evolving and requires further investigation and contribution to provide better clarification.

To fill part of this gap, we believe that MCL requires a proper reference model for some reasons: to provide an abstract representation of the system, to address the environment characteristics, to guide the process of foundation and operation, and last but not least, to elucidate its inherited complexity. Given that, by inspiration from the ARCON (A Reference model for Collaborative Networks) [5], this study proposes a contribution to reference model in order to comprehensively and systematically cover different aspects of MCL. The overarching goal of developing this reference model for MCL communities is to enhance the understanding of the related concepts, environments, entities, relationships, and interactions. Therefore, the main contribution of this study is proposing a preliminary reference model for MCL (based on ARCON reference model framework) aiming to facilitate the understanding of related concepts and underlying the main internal components and external interactions with the surrounding environment.

The remainder of this paper is structured as follows: the relationship between the topic of this work with technological innovation for life improvement is explained in Sect. 2, the research directions and plans are addressed in Sect. 3, our proposed reference model for MCL is presented in Sect. 4, a discussion around the main findings of this study is developed in Sect. 5, and the paper ends with some concluding remarks and a brief look into possible future work.

2 Relationship to Technological Innovation for Life Improvement

Learning is one of the world's largest and fastest-growing fields of study (or even industry), and a major contributor to societies' growth. Traditionally learning was driven by instructors, contained planned curriculum, followed by strict timetable of the academic year, occurred in a physical location, and stand on face-to-face interactions. Despite, traditional learning is still a predominant method for training, innovative

methods in meaningful ways are now reshaping the learning process and creating radical or incremental changes in learning ecosystems. Innovative methods of learning mainly focus on benefiting of new technologies, pedagogies/methods, and environments in alignment with learners' expectations. These methods are trying to move beyond existing routines. That is, they are not necessarily led by an instructor, nor do they follow a structured curriculum, or result in formal certification (particularly in informal method of direction) [6].

MCL as a holistic concept and an innovative learning approach introduces a social climate that stimulates interested learners who might be dispersed through time and space to work and learn together, and to grow up as an individual and community in the shadow of autonomy and flexibility. From the MCL point of view, learning is ubiquitous, it can take place over the lifetime, anywhere and anytime and in different formats (specifically informal). MCL provides concrete cases of innovative learning environments that "people acquire the intellectual heritage of their community" [7] where they can also create a bridge between educational contents and the issues that matter to their lives.

In order to support promoting the innovative methods of learning in MCL, it is essential to build and develop networks or Communities of Learning (CoL). Such type of virtual community creates a learning-centered environment in various shapes and sizes that in which group of interested learners actively and intentionally attempt to construct knowledge together. A CoL is, indeed, a dynamic and democratic learning society that shifts toward lifelong learning, rather than formal educational institution such as universities, schools, and colleges. It is predominantly generated by self-motivated voluntaries who individually and collectively not only share a range of values, beliefs, experiences, and knowledge, but also assist others in this process through developing heated discussions.

From the MCL perspective, a CoL embraces three major centered elements: (a) learners: the main asset of the community and contributor in learning process, (b) collaboration: the core process of performing activities, and (c) knowledge: the key concerning object. Even though communities of learning vary in form and context, an MCL community basically serves several significant purposes, from encouraging engagement in open collaboration to nurturing the culture of knowledge sharing, advancing the general knowledge of the domain, improving the shared body of knowledge developed in the community, sparking meaningful discussions, triggering self-reflection, reinforcing the links between participated entities, etc. [8].

A CoL can potentially benefit everyone involved in through diverse ways. It is also advocated that a strong CoL can "set the ambience for life-giving and uplifting experiences necessary to advance an individual and a whole society" [9]. Evidences show that CoL can positively influence the capacity, growth, and life of not only the participants, but also the community and society, directly or indirectly [10, 11]. Some of these benefits are separately listed below:

Participants

- Participants will find the chance to actively learn even outside the conventional educational frameworks.
- Participants can acquire useful information (that is generated and developed within the community), skills, talents, and potential (e.g., basic life management) that are applicable in any walk of life.

- Participants can contribute to the process of collective knowledge building, sharing, and development.
- Participants can choose and utilize the potential source(s) of information in the community that best suits their personal goals and aspirations.
- It can help participants to become active and informed citizens.
- It amplifies collaborative abilities and interpersonal relationships.
- It can help participants to put learning at the center of everything.
- It can help participants to enrich their education in unexpected ways.
- It can assist participants to advance their careers.
- It can assist participants to build relationships with new faces and minds.

Community

- It gives chances to the community for long-term, deeper, and problem-driven learning.
- It escalates the productivity of community with widespread availability of the various range of knowledge, information, and data.
- It increases the capacities of community for openness, diversity, and difference.
- It can address the learning needs of its locality.
- It opens the opportunities for productive collaboration with others (e.g., similar communities, public, private, and non-profit organizations, partners, competitors).
- It enables communities to create added value and social capital.
- It may enable communities to evaluate the validity and reliability of the knowledge (both, received and created) by means of collective intelligence and wisdom.

Society

- It creates in societies rare opportunities for inclusion in global and social learning.
- It offers societies a free, accessible, and reliable source for casual learning.
- It can promote the level of general knowledge and awareness of the societies.
- It can help societies to find better solutions for their issues (e.g., social, economic, health, safety).
- It helps societies to promote systematic societal change.
- It opens some doors and breaks down walls to honoring diversity and embracing novelty.
- It can promote social cohesion, culture, and economic.

In addition to these benefits, there are also risks if proper organizational structures and support mechanisms to guarantee quality of knowledge are not put in place.

3 Research Approach

This research work is part of a PhD thesis research about mass collaboration and learning. For the thesis, a systematic literature review was initially conducted to get an overview of the area, basic concepts, affecting factors, required organizational structure for MCL, and to identify the relations, contradictions, and gaps in related literature. In order properly guide the survey, a number of research questions were formulated.

Inclusion and exclusion criteria were then identified. Next, relevant works were picked out and required data extracted from. Then the collected data were qualitatively and quantitatively assessed. Subsequently, all collected evidences were synthesized and summarized. Finally, after interpreting the findings of the study, they were published in the form of one survey [2] and two articles [3, 12] in recognized journals and conferences. In this process, the received comments and feedbacks from the reviewers have greatly helped improving the understanding of the area.

As an extension of this study, at this stage, it is essential to identify an appropriate reference model for foundation and designing of the proposed MCL. It is believed that such reference model should provide an abstract representation with a high-level view of the MCL environment and related components. This model should also form the conceptual basis to derive more concrete models from which implementations could be developed. Prior to definition of such reference model, it is significant to consider the previous contributions from related works in the context of CNs. Although the current literature still lacks a well-developed and validated reference model for CNs, the investigation of relevant studies shows that the ARCON (A Reference model for Collaborative Networks) modeling framework is a promising proposal for this purpose. According to [13], ARCON can provide a generic abstract framework and representation for understanding of base concepts, involved entities, significant relationships, interfaces and data flow among the entities of CNs. As such, it can be used for the development of specifications supporting CN environments. The positive features that can be attributed mostly to the ARCON include:

- *Simplicity*: it is a simple, easy to understand and explicit model.
- *Comprehensiveness*: it tries to cover and involve the main relevant components of the environment characteristics of CNs.
- *Neutrality*: it tries to address different aspects of CNs from a neutral point of view.

In addition to these specific characteristics of ARCON, in comparison with other relevant previous approaches (e.g. Zachman, VERAM, CIMOSA, GERAM, IFIP-IFA TFAEI, GERAM, FEA, EGA, and SCOR) that contributed to related areas, it has less limitation when a holistic modeling is pursued, being focused on networked organizations [14]. The literature shows that ARCON has potential applications in variety of domains. It has, for example, been applied to the PROVE initiative (a Portuguese network in the agri-food sector that enables small farmers to sell their goods directly to consumers) [15]. ARCON has also been applied for different purposes including but not limited to, e-government and e-services [16], trust management [17], decomposing value for the customer [18], and learning in on-line and local University of the Third Age (U3A) in Australia [19].

It is note taking that defining a reference model for a new system like MCL is not an easy task. Since, from one side, the MCL is an emerging paradigm and not all its aspects are well understood and developed yet, and from another side, very few inputs are available in the literature regarding to reference models for CNs. In this context, our findings from reviewing previous studies along with our understanding from ARCON modeling framework are complementarily used in the current study as a basis to propose a reference model for MCL. This development, as a contribution to the area, is presented in Fig. 1. In addition to literature review, an analysis of emerging cases of

mass collaboration was done in order to identify their relevant characteristics [12]. Since, identifying the positive and negative factors in existing and emerging successful examples of mass collaboration is one possible way of supporting community learning through mass collaboration. The 14 reviewed case studies of mass collaboration along with a short explanation are presented in Table 1.

Table 1. 14 reviewed case studies.

14 reviewed case studies
Wikipedia – a web-based, free-content encyclopedia used as an open collaboration project developed by a very large (open) community of volunteer editors.
Digg – a social networking and news aggregating website. Contributors submit their stories for consideration and promotion, and they are either voted to be digged, or buried.
Yahoo! Answers – a question-and-answer website driven by a community in which participants can ask and/or answer questions about anything.
SETI@home – an Internet-based public volunteer computing project which intends to evaluate radio signals, searching for signs of extra-terrestrial intelligence.
Scratch – a block-based visual programming language and online community which enables participants to build and share their stories, games, animations, and music on the web.
Galaxyzoo – a crowdsourced astronomy project that classifies the morphology of large numbers of galaxies through co-operation of interested participants.
Foldit – an online puzzle video game about protein folding. It invites people to fold the structures of selected proteins (cancer) by using tools provided in the game.
Applications of the Delphi method – a structured communication method that evaluates the results of multiple rounds of questionnaires sent to a panel of experts to gain group consensus.
Climate Colab – an online crowdsourcing platform that invites people to address the global climate changes.
Assignment Zero – an experiment in crowd-sourced journalism in which participants collectively produce a piece of work.
DonationCoder – a website hosting a community of programmers and software fans that collectively organize and finance software development.
Experts Exchange – a trusted global online community that tries to solve the world's technology problems.
Waze – a community-driven GPS and navigational app that provides navigation information, route details, and travel times.
Makerspaces – a collaborative workspace where people can come together to use tools for exploring, making, sharing, learning, and and/or completing a project.

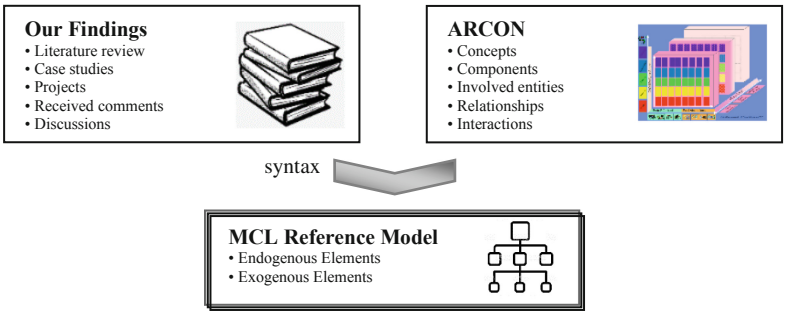

Fig. 1. Approach towards building a MCL reference model.

In our previous research study [12] the organizational structures of the above-mentioned 14 case studies were evaluated aiming to derive a general organizational structure for MCL through the analysis of their most significant features. The developed general organizational structure provides us helpful guidelines and directions in this work to help proposing a reference model for MCL.

4 Mass Collaborative Learning Reference Model

The ARCON modeling framework for CNs represents the involved environment features and specifications namely, internal aspects and external interactions. Internal aspects mainly concentrate on controllable entities, properties, function, and features of the network and thus address network's *Endogenous elements*, whereas external aspects focus on external interactions between the network and its surrounding area and thus address network's *Exogenous interactions* [14].

Endogenous elements comprise four dimensions, including:

- Structural dimension – refers to participants in the network, and their relationships and roles. This dimension also deals with compositional characteristics of the network (e.g. typology).
- Componential dimension – refers to all tangible resources (e.g. technologies) and intangible resources (e.g. knowledge) of the network.
- Functional dimension – refers to all those functions, operations, processes, procedures, and methods that are related to the network.
- Behavioral dimension – refers to the principles, policies, and governance rules that drive the behavior of the network.

Exogenous interactions also include four dimensions, as follows:

- Market dimension – refers to issues that are related to interactions between the network and its customers, competitors, and potential partners. Part of this dimension embraces the mission of the network, its value proposition, joint identity, etc.

- Support dimension – refers to interactions with those support services (e.g. financial, technical) that are provided by third-party entities outside the network.
- Societal dimension – refers to general interactions between the network and the society (e.g. public and private organizations).
- Constituency dimension – refers to interactions between the network and its potential new members (e.g. attracting and recruiting).

Given the above-mentioned environment characteristics of the ARCON and considering the basic requirements of mass learning communities, we accordingly adapt a general reference model for MCL (MCL-RM). See Tables 2 and 3.

Table 2. Endogenous elements for MCL.

Endogenous Elements for MCL			
Structural Dimension Network structure (e.g., participants, relationships, roles, and network typology)	Componential Dimension Individual tangible/intangible elements (e.g., different resources) of the community	Functional Dimension Base functions, operations, running, and procedures in the community	Behavioral Dimension Principles, policies, and governance rules that drive the behavior of the community
Participants • Participants are volunteer • Participants are from diverse background • Participants are autonomous • Participants are distributed *Roles* • Based on participants' skills and interests ➢ Managerial roles: • Identity controllers • Content controllers • Administrators • Technical operators ➢ Participatory roles: • Experts • Ordinary members *Roles Relationship* • Based on collaboration, conversation, inquiry, discussion, friendship • Mutual trust • Internal and external of the community *Network Typology* • Community is open for everyone and for all interests, but may have access criteria ➢ Type: • Strategic alliances ➢ Size: • Unlimited	*Resources* ➢ Technological Resources: • CSCL tools • Internet • Social software • Web-based ➢ Human Resources: • Two types of groups: - User group - Managerial group • Two types of participants - Ordinary participants - Experts participants • Two types of members: - Active - Inactive ➢ Knowledge Resources: • Knowledge • Information • Data ➢ Community outcomes: • Developed knowledge • Findings • Gained successes	*Processes* ➢ Fundamental processes: • Managing, decision making, executing are done by managerial group and participants ➢ Background processes: • Network forming, setting up, operating, and developing, creation of repository, ontology evolution and management, rewarding system are supported by managerial group ➢ Knowledge management processes: • Knowledge building, sharing, developing, evaluating, sorting, storing, and voting are carried out by participants *Procedures* ➢ Community building: • Goals establishment • Rules setting • Foundation building • Facility provision • Member attracting • Contribution managing ➢ Knowledge evolution: • Knowledge creation is emphasized not knowledge acquisition • knowledge turns from tacit into explicit form • Knowledge quality assurance • Continual knowledge assessment • Learning from successful communities ➢ Community operation handling: • Community uses common sense • Community uses voting system • Experts' opinions are given special attention	*Governance Model* • Self-governed community *Power within the Community* • Distributed • Equally divided (not create influential effect) • Hierarchy of permission is considered *Rules and Policies* • Freely publish the findings • Participants provide reliable materials • Contents are written from neutral viewpoint • Participants take full responsibility of their contributions • Participants keep the community safe and respectful *Culture* • Following the rules • Supporting others • Criticizing ideas, not people • Flagging bad behaviors

Table 3. Exogenous interactions for MCL.

	Exogenous Elements for MCL			
	Market Dimension Interaction with customers and competitors, and also the mission of community	Support Dimension Support services provided by the third-party entities (outside of the community)	Societal Dimension Interactions between the community and the society in general	Constituency Dimension Interaction with the universe of potential new members of community
Network Identity	*Mission* • Boundary extension (new/wider markets) • Comprehensive lifelong learning *Network Profile* • Virtual community of practice • Connection building by online platforms (e.g., website, social media, ICT) *Market Strategy* • Market development • Being served as an innovative library • Being served as an open knowledge lab	*Network's Social Nature* • MCL is inherently a not for profit community • MCL can also provide monetary services	*Status* • MCL is informal community of learning • MCL cultivates decentralized and deregulated learning	*Attracting and Recruiting Strategies* • Community visibility (e.g., in social media) • Word-of-mouth recommendations • Partnerships • Up to date online platform • Easy approaches to inclusion and exclusion
Interaction Parties	*Customers* • Public/Private organizations • Individuals • Problem-solving markets • Knowledge intensive business services *Competitors* • Similar MCL projects (e.g., Wikipedia) *Potential Suppliers* • Massive Open Online Courses (MOOC)	*Financial Entities* • Investors • Sponsors *Technical Entities* • IT companies/experts • Network service provider • Storage service provider *Informational Entities* • Universities • Libraries • Research institutes • Experts *Social Entities* • Public/Private organizations • Charities • Individuals	*Governmental Organizations* • Educational and scientific organizations • Intellectual property organizations • Telecommunication organizations *Private Sectors* • Knowledge intensive business services • Laboratories *NGOs* • Education charities • Advocacy NGOs *Interested Entities* • Businesses • Learning services • Consulting services • Training institutes • Supporters	*Potential Participants* ➢ Public entities: • Education centers • Social services • Libraries • Laboratories ➢ Business entities: • Companies • Enterprises • Corporations • Partners ➢ Private entities: • Individuals • Developers • Innovators • Designers
Interactions	*Customer Interactions* • Collaborating • Consulting *Competitor Interactions* • Knowledge exchanging • Partnering • Supporting *Supplier Interactions* • Joining	*Support/Service Acquisition* • Financial support • Technological support • Information service • Consulting service • Training service • Donation service *Agreement Establishment* • Dealing • Community affiliation	*Political Relations* • New/Wider relationships between people and organizations *Social Relations* • Public engagement • Participants practice how regard one another *Learning* • Public awareness • Democratized learning • New patterns of learning between organizations and social units *Seeking Support* • Knowledge sharing	*Member Searching* • Advertising • Participation is encouraged and supported • Invitation can be sent • Participants can bring in new faces • Current participants should be maintained *Joining Mechanism* ➢ Applicant: sends application for joining ➢ Community: evaluates the application, and: • Accepts the application, or • Rejects the application, or • Requests correction

As addressed in Table 3, three main groups of elements are considered for Exogenous Elements:

- *Network identity* – that defines the environment in which a MCL is positioned in, shows the position of MCL in the environment, and addresses the way in which a MCL presents itself in the environment.
- *Interaction parties* – identify the potential entities that MCL interacts with.
- *Interactions* – list the type of transactions that a MCL can develop with its interlocutors.

A MCL network and community needs to deal, among the others, with the issue of how to prove the value and quality of created and shared knowledge. The fact is that the key success factor for effective evaluation of collaboratively generated content is the trustworthiness and reliability of the involved participants [3]. "*As user-generated content is no more regarded as a second-class source of information, but rather a complex mine of valuable insights, it is critical to develop techniques to effectively filter and discern good and reliable content*" [20]. In order for the community participants to efficiently evaluate the reliability and quality of the created and shared contents/knowledge, there are several proposed strategies. In this regards we believe that the integration of human and computer support can help reaching an optimal balance between simplicity and speed on one hand, and validity of result on the other. In this suggested method, the human part consists of two phases namely, individual phase and community phase. In the individual phase, a participant initially checks the created and shared content/knowledge based on a proposed check list, considering some criteria such as authority, accuracy, currency, accessibility, relevancy, purpose, and bias. Once a certain percentage of assurance upon the reliability of content or knowledge and its source is achieved, the content will be next evaluated by the community and benefit of collective intelligence through again completing the same checklist (but this time through collaboration), evidence-based reasoning, formal argumentation, and collective decision making. By means of a computer part, detecting tools (e.g. fact check extension, fake news detector, and other novel tools) can be envisaged to help the human part [3].

5 Discussion

In this study, the proposed MCL-RM aims to provide a generic representation and conceptual model which can enhance the knowledge and understanding of the main contributing elements and practices around the environments of a MCL community. It attempts adding some inputs to this field of study for the purpose of discussion among those dealing with this issue (e.g. researchers, educators, decision makers, developers, innovators, and the community stakeholders). It is expected that once a reference model is established, it could drive the process of developing, organizing, implementing, simulating and evaluating real cases of such type of community.

However, it is important to note that MCL not only involves a multidisciplinary nature, but also it is a highly complex system. Thus, it should be considered, described, and modeled from multiple perspectives in order to truly cover and reflect its different

aspects and conditions. Thus, the findings of this study have to be seen in the light of some limitations. For example, there are lack of prior research studies on this topic, and neither CNs, nor learning areas have yet offered a suitable reference model for, or even developed considerable background around this particular topic. The complexity of MCL and the required reference model is another limiting factor that originally comes from, e.g. its nature, environment, multiple functions, stakeholders and applications.

Apart from these constraints, this study which relies on existing related models and also findings from reviewed literature, tries to propose a reference model for MCL to capture its complexity through identifying the core components that can directly or indirectly influence the internal environment and external interactions of MCL. It is our belief that this proposal can facilitate understanding the paradigm and provide the starting basis for future developments. However, we must take this fact into account that the proposed MCL-RM can only be considered as a first step towards defining a reference model for MCL, since this model is introduced for the first time. So that, it is quite clear that a complete model cannot be developed at this stage in time. On the other hand, this model, at the current stage, is proposed theoretically (although taking inputs from real cases) and undoubtedly it requires to be applied to a wider range of real cases (to determine its possible limits and weaknesses). Therefore, there is a need for further investigation, elaboration, development, dissemination actions, and feedback collection. In the next stage of development, this model should also be validated by some experts in this area.

6 Conclusion

Advances in knowledge discovery and management in the era of rapid expansion of collective activities has led to new emerging approaches for learning. MCL, as an example, is looking to solve a variety of complex problems by means of collective efforts and knowledge sharing. The developed communities from MCL will stand for collaborative knowledge construction and sharing through unlimited number of distributed but interested learners from around the world. Such communities, however, are still lacking a comprehensive refence model that can broadly and clearly elaborate the involved environment characteristics. This study, therefore, getting inspiration in the ARCON modeling framework, attempts to propose a general and appropriate reference model for MCL in order to develop a better understanding of related concepts, elements, and interactions. The preliminary findings of this work can be used for further investigation and development among interested and/or involved entities. Having reached this MCL-RM, we are then, as future work, going to apply it in furthers real case of learning communities.

Acknowledgements. This work has been funded in part by the Center of Technology and Systems and the Portuguese FCT program UID/EEA/00066/2019 and UIDB/00066/2020.

References

1. Camarinha-Matos, L.M., Afsarmanesh, H.: Collaborative networks: a new scientific descipline. J. Intell. Manuf. **16**(4–5), 439–452 (2005). https://doi.org/10.1007/s10845-005-1656-3
2. Zamiri, M., Camarinha-Matos, L.M.: Mass collaboration and learning: opportunities, challenges, and influential factors. Appl. Sci. **9**, 2620 (2019). https://doi.org/10.3390/app9132620
3. Zamiri, M., Camarinha-Matos, L.M.: Learning through mass collaboration - issues and challenges. In: Camarinha-Matos, L.M., Adu-Kankam, K.O., Julashokri, M. (eds.) DoCEIS 2018. IAICT, vol. 521, pp. 3–17. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-78574-5_1
4. Cress, U., Moskaliuk, J., Jeong, H. (eds.): Mass collaboration and education. CCLS, vol. 16. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-13536-6
5. Camarinha-Matos, L.M., Afsarmanesh, H. (eds.): Collaborative Networks: Reference Modeling. Springer, Cham (2016). https://doi.org/10.1007/978-0-387-79426-6
6. Eilks, I., Byers, B.: Innovative Methods of Teaching and Learning Chemistry in Higher Education, 1st edn, p. 258. Royal Society of Chemistry, London (2015)
7. Scardamalia, M., Bereiter, C.: Knowledge building: theory, pedagogy, and technology. In: Sawyer, K. (ed.) Cambridge Handbook of the Learning Sciences, pp. 97–118. Cambridge University Press, New York (2006). http://ikit.org/fulltext/2006_KBTheory.pdf
8. Lima, M., Zorrilla, M.: Social networks and the building of learning communities an experimental study of a social MOOC. J. Int. Rev. Res. Open Distrib. Learn. **18**(1), 40–64 (2017)
9. Lenning, O.T., Ebbers, L.H.: The powerful potential of learning communities. J. Improv. Educ. Future **26**(6) (1999)
10. Mitchell, C., Sackney, L.: Profound Improvement: Building Learning-Community Capacity on Living System Principles, 2nd edn. Routledge, London (2011). https://doi.org/10.4324/9780203826027
11. Kilpatrick, S., Barrett, M., Jones, T.: Defining learning communities. CRLRA Discussion Paper (2003). Series ISSN 1440-480X
12. Zamiri, M., Camarinha-Matos, L.M.: Organizational structure for mass collaboration and learning. In: Camarinha-Matos, L.M., Almeida, R., Oliveira, J. (eds.) DoCEIS 2019. IAICT, vol. 553, pp. 14–23. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-17771-3_2
13. Camarinha-Matos, L.M., Afsarmanesh, H.: A comprehensive modeling framework for collaborative networked organizations. J. Intell. Manuf. **18**(5), 527–615 (2007). https://doi.org/10.1007/s10845-007-0063-3
14. Camarinha-Matos, L.M., Afsarmanesh, H.: ARCON reference models for collaborative networks. In: Camarinha-Matos, L.M., Afsarmanesh, H. (eds.) Collaborative Networks: Reference Modeling, pp. 83–112. Springer, Boston (2008). https://doi.org/10.1007/978-0-387-79426-6_8
15. Macedo, P., Abreu, A., Camarinha-Matos, L.M.: Modelling a collaborative network in the agri-food sector using ARCON framework: the PROVE case study. In: Camarinha-Matos, L. M., Xu, L., Afsarmanesh, H. (eds.) PRO-VE 2012. IAICT, vol. 380, pp. 329–339. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-32775-9_34
16. Farooq, M.K.: Capability maturity model for ARCON implementation for e-government services. In: Proceedings of the 4th International Conference on Theory and Practice of Electronic Governance (ICEGOV), 25–28 October, Beijing, China (2010)

17. Beckett, R.C., Jone, M.: Collaborative network success and the variable nature of trust. Prod. Plan. Control **23**(4), 240–251 (2012). https://doi.org/10.1080/09537287.2011.62765
18. Nicola, S., Ferreira, E.P.: A novel framework for modeling value for the customer, an essay on negotiation. Int. J. Inf. Technol. Decis. Making **11**(3), 661–703 (2012). https://doi.org/10.1142/S0219622012500162
19. Beckett, R.C., Jones, M.: Active ageing: using an ARCON framework to study U3A (university of the third age) in Australia. In: Camarinha-Matos, L.M., Pereira-Klen, A., Afsarmanesh, H. (eds.) PRO-VE 2011. IAICT, vol. 362, pp. 189–196. Springer, Heidelberg (2011). https://doi.org/10.1007/978-3-642-23330-2_21
20. Dondio, P., Longo, L.: Trust-based techniques for collective intelligence in social search systems. In: Bessis, N., Xhafa, F. (eds.) Next Generation Data Technologies for Collective Computational Intelligence. Studies in Computational Intelligence, vol. 352, pp. 113–135. Springer, Berlin (2011). https://doi.org/10.1007/978-3-642-20344-2_5