Computers in Human Behavior 30 (2014) 574–582

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Assessing social construction of knowledge online: A critique of the interaction analysis model

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ARTICLE INFO

Article history:
Available online 30 August 2013

Keywords:
Human–computer interaction
Social knowledge construction
Asynchronous discussions
Interaction analysis model
Content analysis

ABSTRACT

The growing adoption of communication technologies to mediate teaching and learning processes fostered the study of asynchronous communication as an activity that can reveal students' behavior during learning processes. Much of the research conducted on this topic focuses on the application of interaction models to analyze the content of asynchronous discussions and assess their quality. Despite the existence of different models, the one developed by Gunawardena, Lowe, and Anderson (1997) remains as one of the most used in the study of online interaction. In this respect, the present work focuses on studies that mention the application of this model in its analysis and discusses the extension of its application as well as its limitations. Results reinforce the adequacy of the model to analyze knowledge construction in different types of communication tools, but they also suggest the need to look at how learning is orchestrated and the importance of re-defining some aspects of the model in question.

1. Introduction

The study of social knowledge construction in computer based learning environments has long been the object of detailed investigation. Asynchronous discussion groups are among the most preferred tools chosen to foster interaction and learning, but emerging technologies, namely the ones belonging to social software such as blogs or wikis, have been finding their way into education. Despite differences in the nature of the tools themselves and the types of learning they seem to promote (Anderson & Dron, 2011; Dalsgaard, 2006) they have an important aspect in common: they allow the automatic registration of discussions or messages, which can later be accessed, for instances, by students for purposes of reflection, by teachers for evaluation purposes or by researchers seeking a corpus of important data to analyze various research questions. In this context, asynchronous messages result in artifacts of learning that demonstrate students' behavior during learning processes and their analysis may help us to understand and optimize learning and the environments in which it occurs.

Much of the research on social knowledge construction focuses on the application of interaction analysis models to examine the content of online asynchronous message transcripts. One of such models is the Interaction Analysis Model (IAM), which was developed by Gunawardena, Lowe and Anderson (1997). The IAM is one of the most frequently used instrument in the study of knowledge construction and the extent of its use makes it one of the most coherent and empirically validated instruments in the research field. A review of recent studies (Lucas, 2012) returned 26 results on knowledge construction, but only 5 studies (4 of them reporting the use of the IAM) refer to emerging technologies as asynchronous communication spaces – blog (3), wiki (2) –, suggesting this is still a limited research field that needs further insights. As to results regarding the application of the IAM and evidences of knowledge construction, they are, in general, though with a few exceptions, low or almost non-existent, which may lead us to question its adequacy for assessing online interactions and knowledge construction.

For this reason, our research focused specifically on studies applying it in their analysis. The purpose of our work is two-fold. First it seeks to provide an overview of selected studies that apply the IAM in the examination of knowledge construction detailing studies that have used it to analyze blogs. Secondly, it attempts to discuss the adequacy of the IAM for assessing knowledge construction (with a special interest in emergent technologies) through the evaluation of the results reported by the retrieved studies.

The present paper is structured as follows: In Section 2 we discuss the study of asynchronous communication and the commonly adopted procedures to analyze it. In Section 3, we briefly describe the IAM which is the focus of this study. Then, in Section

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http://dx.doi.org/10.1016/j.chb.2013.07.050

4, we describe the method used to select the studies included in the present work. In Section 5, we present results found. Results are discussed in Section 6. In Section 7 we make some final considerations.

2. The study of asynchronous communication

Asynchronous communication has long been the most adopted way of interaction in computer based learning and continues to be, mainly due to the advantages different authors (Anderson & Dron, 2011; Hrastinski, 2008; Yap & Chia, 2010) associate with it: (i) the spatial and temporal flexibility afforded, which give participants more time to think, reflect and seek information before they contribute to the discussion; (ii) a more equitable communication, in the sense that opportunities for interaction, participation and self-expression are equal for all; (iii) the automatic registration of discussions or messages or (iv) the development of learning communities/networks, in which knowledge can be constructed as a result of discussion, shared practices or collaboration.

According to several authors (De Wever, Schellens, Valcke, & Van Keer, 2006), the first studies in the context of asynchronous communication, relied mainly on quantitative data, including the level of student participation, the number of logs made by each student, the number of messages belonging to each student, the number of posts in each thread, etc. However, the study of purely quantitative data was not sufficient to assess the quality of interactions or learning processes and as a result, research started adopting qualitative techniques such as content analysis of online asynchronous message transcripts.

Henri (1992) was the first author to develop a qualitative study of asynchronous communications through the development of an analysis model, which marked the beginning of the study of the dynamics present in the work of students, learning strategies adopted and the acquisition of knowledge and skills. Since then, different authors have proposed different interaction analysis models to study various aspects of learning, such as: (i) critical thinking (Garrison, Anderson, & Archer, 2000, 2001; Meyer, 2004); (ii) social and cognitive presence (Garrison, Anderson, and Archer, 2001; Tu & McIsaac, 2000); (iii) problem solving (Hou, Chang, & Sung, 2008); (iv) emotional expression (Quan & Ren, 2010) or (v) knowledge construction (Cobos & Pifarre, 2008; Gunawardena et al., 1997; Schrire, 2006).

In a literature review on content analysis, De Wever et al. (2006) report three essential aspects that must be taken into account when choosing a particular model and its application:

- Establishing the theoretical base of the model, so that it becomes possible "to identify empirical indicators that will form the basis of a coding instrument" (De Wever et al., p. 9) or contribute to ground the validity of analysis models.
- The choice of the unit of analysis, which may be dependent on some subjectivity, the context or the research question, should be well-considered, since it can affect the coding process and the subsequent comparison of results.
- The inter-rater reliability of the model, which should be established and mentioned to ensure the transparency of the coding process and the validity and replicability of the research. Authors mention some common indexes to establish the level of reliability, such as Krippendorff's alpha (α) and Cohen or Fleiss' kappa (κ). Usually, values equal to or greater than 0.75 reflect strong agreement in the coding process, values between 0.40 and 0.74 reflect moderate agreement, and values below 0.40 reflect a poor level of agreement.

In short, authors recommend that content analysis instruments should be accurate, precise, objective, reliable, replicable, and valid.

2.1. The study of asynchronous communication in emergent technologies

The study of knowledge construction in asynchronous communication tools like discussion forums or bulletin boards has become common in recent decades, but the introduction of social web tools in education has widened the scope for the study of this process to other environments, with different characteristics from the existing ones. As shown in a subsequent section, the analysis of this process is mainly based on discussions held in discussion forums, which usually belong to Learning Management Systems (LMS), and although this may not be a major factor in the quality of the discussions, it becomes important to study the construction of social knowledge in environments that are characterized by innovation and technological diversity.

There is an ongoing debate on the differences between the use of Learning Management Systems (LMS) and social software in education and the way they impact learning. Whereas an LMS is seen as "a high-level, strategic solution for planning, delivering, and managing all learning events within an organization, including *online*, virtual classroom, and instructor-led courses" (Greenberg, 2002), social software refers to a number of "networked tools that support and encourage individuals to learn together while retaining individual control over their time, space, presence, activity, identity and relationship" (Anderson, 2005, p. 4).

Over the last years, the LMS has been related to the administrative aspects of learning processes and not as a supporter for social-constructivist approaches, which emphasize self-governed learning activities of students (Arvan, 2009; Dalsgaard, 2006). Anderson and Dron (2011), for instances, associate these tools to different learning theories and pedagogies. While LMS are suggested to support structured learning environments in which students discuss, create and construct within a given restricted group, social software appears to foster learning through exploration, connection and artifact creation within a limitless learning environment. In this respect, Siemens (2004) believes that "as thinking skills move to higher levels, the artificial constructs of content and interaction imposed by an LMS are limiting to discovery/exploratory/constructivist learning." Still others believe impacts on learning are much more the result of appropriate interaction and pedagogical strategies than the choice of a specific communication tool (Gomes, 2008).

Despite being heralded by many authors as strong supporters of knowledge construction, the fact is that studies regarding the use of emergent technologies are still very scarce and the ones that exist do not report methodological procedures that allow us to compare results. Nevertheless, and in this respect, it is worth mentioning the research developed in wikis by Peters and Slotta (2009, 2010a, 2010b).

Their curriculum design is based on the Knowledge Community and Inquiry Model (KCI) developed by Slotta (2007), which combines collaborative knowledge construction with scripted inquiry activities to target specific curriculum learning objectives. As an attempt to provide a framework to examine students' knowledge contributions to a wiki Peters and Slotta proposed a new coding scheme. They established their unit of analysis as "individual transactions", i. e., actions that may include "the distinct changes to a wiki page that occur during authoring" (Peters & Slotta, 2010b). They coded all the students' transactions made to every version of the wiki according to: (i) the type of transaction: move, add, delete and/or format and (ii) the type of content: text, image, internal and/or external link. Within each type, categories were

applied as referred. Further coding was applied to text-based transactions. The ones performed on a classmate's text were coded as "peer" and transactions on one's own text were coded as "self". To study knowledge building activity in the wiki, authors wanted to find out how many transactions were coded as "peer" and "self", in order to establish levels of collaboration and contribution to the wiki. Though authors refer that their research is still ongoing they refer important aspects that need to be taken into account when examining and designing knowledge building activities. One refers to insecurity aspects manifested by students and their concern about how they were perceived by their colleagues when participating in discussions. Another relates to the overload phenomenon that was described by students "as a feeling of being overwhelmed by the number of messages in the online discussions" (Peters & Hewitt, 2010). According to authors, this seems to affect the way students read and perceive online messages, which may limit their engagement in the progression of discourse.

Other developments are related to the use of complementary procedures to analyze data. For instances, Yap and Chia (2010) put forward an attempt "to map the different stages of science knowledge construction as well as misconstruction in asynchronous discussion" (p. 1590). In their work, authors propose a combination of quantitative and qualitative measures, claiming that the study of knowledge construction in asynchronous discussions can only be studied "through analysis of both the content of messages and patterns of interaction" (p. 1593). Therefore, they propose a methodology that reveals the dynamics of asynchronous discussion through mapping and quantifying the electronic learning process, named Knowledge Construction Message Graph (KCMG).

Further studies assessing knowledge construction in recently developed tools use commonly adopted procedures, such as the application of the IAM, which we briefly describe in the next section.

3. The interaction analysis model

Gunawardena et al. (1997) created the Interaction Analysis Model (IAM) to examine knowledge construction in a collaborative learning environment mediated by computer communication. The model emerged when analyzing a debate that was conducted online as a professional development activity prior to the World Conference in distance education in 1995. The debate ran for a period of 1 week using a listserv, and the format of the debate influenced the structure of the model. Gunawardena et al. note that despite the debate leaders wanting to keep the participants away from negotiating meaning and coming to consensus in order to win the debate, negotiation and co-construction of knowledge occurred. The theoretical framework of this model is based on social constructivist principles and posits that the construction of knowledge is the result of interaction, meaning negotiation and building of a shared understanding.

In discussing IAM, the authors proposed a new definition of interaction that did not focus only on the links between messages, but rather conveyed an overview of the messages in the context of the debate referred to as "the entire gestalt formed by the online communications among the participants" (Gunawardena et al., p. 407). Following this idea, interaction is depicted as a "quilt block" which presents itself as a whole by joining and adding many parts, all of them unique and distinct. They argue that interaction is the process through which negotiation of meaning and co-creation of knowledge occurs, and should be viewed as the totality of interconnected and mutually-responsive messages, an entire gestalt formed by the online communications among participants. Given this definition of interaction, the authors argue for considering an entire message as a unit of analysis.

To analyze knowledge construction, Gunawardena et al. (1997) suggest a five-phase (Ph) model (Table 1), each phase containing a set of learning processes.

These processes include agreeing, sharing an opinion, identifying areas of disagreement, negotiating terms or concepts, and testing or applying ideas. When using IAM to analyze a computer transcript, a message is taken as unit of analysis and then coded for phase/s, observing the type of cognitive activity (questioning and synthesizing), types of arguments advanced, resources used to explore differences, and changes in understanding as result of group interaction.

When Gunawardena et al. applied IAM to analyze the debate from which it emerged, they were surprised that the debate exemplified all five Phases. The majority of postings and reference to resources occurred at Phases II and III. They noted that the debate format supported Phase I, sharing and comparing information, and Phase II, the discovery and exploration of dissonance. However, it hindered Phase III, the negotiation of meaning to reach a compromise. Yet, despite the constraints of the debate format, participants negotiated meaning, constructed new knowledge, and tried to apply and test this new construction. Further, they noted the progress of certain strands of argument from Phase I to V, moving from lower to higher mental functions, and evidence of more than one and sometimes three phases within a single message usually progressing from lower to higher mental functions.

These findings indicate that for this professional development collaboration, the majority of postings occurred at the lower phases of sharing and comparing information to discussing differences in ideas, and then a few moving on to proposing new ideas. However, levels of complex thinking in the higher phases of testing and applying the newly constructed meaning were rarely achieved. Possible explanations include the highly structured format of the debate, which may have influenced the participation and interaction established and hence the process of knowledge construction. In reality, when participants only have to agree or disagree with a given statement, their participation can simply be translated into a "yes" or "no". Therefore, the space for developing arguments or negotiating them becomes limited. Authors note that while there was an attempt on the part of some participants to reach compromise on new perspectives, the debate rarely allowed participants to evolve into more advanced phases of thought. Nevertheless and despite results achieved by the authors who proposed the model, the IAM continues to be applied in a considerable number of studies as Section 5 shows.

4. Method

In order to accomplish the overview that follows, we conducted a literature review in January 2011 in different international online databases: (i) ISI Web of Knowledge, (ii) ERIC, (iii) ScienceDirect, and (iv) CSCL, ICLS and ECTEL proceedings. Search terms were limited to publication dates ranging from 2006 and 2011 and to the topics Computer Science and Education and Educational Studies. Terms used in the search included the name of the authors plus the words content analysis OR interaction analysis AND knowledge construction OR knowledge building. Only studies describing the application of the IAM in the methodology section were downloaded for detailed reading. In order to further refine our review we established the following exclusion criteria: studies in which the IAM was significantly changed and that were not peer refereed were not included; studies referring to other educational contexts rather than Higher Education or to other communication type rather than asynchronous communication were not included as well. Our search resulted in 16 studies, which were the ones retrieved for inclusion in the present work.

Table 1
Phases of knowledge construction (Gunawardena et al., 1997).

PhI	Sharing and comparing of information	A. A statement of observation or opinion B. A statement of agreement from one or more participants C. Corroborating examples provided b one or more participants D. Asking and answering questions to clarify details of statements E. Definition, description, or identification of a problem
PhII	The discovery and exploration of dissonance or inconsistency among ideas, concepts or statements	A. Identifying and stating areas of disagreement B. Asking and answering questions to clarify the source and extent of disagreement C. Restating the participant's position and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view
PhIII	Negotiation of meaning/co-construction of knowledge	A. Negotiation or clarification of terms B. Negotiation of the relative weight to be assigned to types of argument C. Identification of areas of agreement or overlap among conflicting concepts D. Proposal and negotiation of new statements embodying compromise, co-construction E. Proposal of integrating or accommodating metaphors or analogies
PhIV	Testing and modification of proposed synthesis or co-construction	A. Testing proposed synthesis against "received fact" as shared by the participants or their culture B. Testing against cognitive schema C. Testing against personal experience D. Testing against formal data collected E. Testing against contradictory testimony in literature
PhV	Agreement statement(s)/applications of newly constructed meaning	A. Summarization of agreement(s) B. Applications of new knowledge C. Metacognitive statements by participants illustrating their understanding that their knowledge or way of thinking (cognitive schema) have changed as a result of the conference interaction

5. Results

Studies included in the present work are summarized in Table 2. It provides an overview of the participants that took part in the study, the asynchronous communication tool (CT) used and the percentage of coded messages in each phase proposed by the analysis model. Adding to this, and following what De Wever et al. (2006) reported as essential when choosing a particular model and its application, we also included the unit of analysis (UA), the type of reliability adopted and the level of reliability (TLR) reported.

As can be seen from the data listed in the table, all studies presented relate to the context of higher education or post-graduation. Levels of education range from undergraduate students to in-service teachers. The most preferred communication tool is the discussion forum (most likely belonging to an LMS) and the Knowledge Forum. The study by Heo, Lim, and Kim (2010) mentions the bulletin board and four studies report the use of tools belonging to social software – the blog and the wiki.

The units of analysis reported include the message, the sentence, the edition, the thematic unit, the meaning and the functional moves. This last unit is described by the author as similar to speech acts or as "the smallest unit of delivery, linked to a single theme, directed at the same interlocutor, identified by a single type, having a single function".

More than a half of the studies do not refer the type of reliability adopted, but only two fail to account for the level of inter-rater reliability achieved during the coding process. Four studies reflect strong agreement among coders, while the others reflect moderate agreement.

With the exception of studies by Kumar and Buraphadeja (2010), Heo et al. (2010) and Lucas and Moreira (2010) results reported are quite similar to the results obtained in the original study: there are low levels of complex thinking as the majority of operations coded remained in PhI. There is some evidence of operations in PhII and III, but they are almost non-existent in PhIV and V.

5.1. Studies analyzing knowledge construction in blogs

5.1.1. Hou, Chang, and Sung (2009)

The participants in the study by Hou et al. (2009) were 470 volunteer teachers in primary and secondary education in Taiwan. Authors created a "teacher blog environment" with "blogs dedicated to teachers [with] basic interaction functions" (Hou et al., p. 328). Each teacher was trained to use the environment and received permission to post "articles, make replies, upload photos, and use hyperlinks to share instructional knowledge" (Hou et al., p. 328). Blogs were closed to outside participants "to prevent compromised accuracy caused by accessing the blog visitors who [we]re not teachers" (Hou et al., p. 329). During 85 days, 110 teachers contributed with original posts, while the remaining ones confined themselves to participate in the form of answering and commenting.

From a total of 1455 messages, 88% were coded in PhI, showing that "most teachers focused on sharing instructional knowledge and making comparisons" (Hou et al., 2009, p. 331) and PhIII registered 4% of the total activity. Evidence of PhV was not found and the percentage of coded messages in PhII and IV was practically inexistent. Authors still report 7% of the messages coded as irrelevant to the discussion topics.

In their analysis, authors note that "it was rare to see in-depth analysis, discussion, and initiation of different comments and creative thoughts" (Hou et al., 2009, p. 331). Knowledge construction was very limited due to the way teachers explored the blog environment. Instead of using it for creating or discussing relevant topics related to their professional practice, teachers were limited to sharing feelings and experiences that neither incited controversy nor contributed to the advancement of knowledge. Authors also refer to the lack of a well defined strategy for exploring the blogs.

There are, however, other factors that may have contributed to the results achieved. One of them may be related to the fact that teachers did not know each other before they initiated the study. They were not used to working together, sharing or collaborating with people they did not know previously. As several authors have observed (Scardamalia & Bereiter, 2003; Wegerif, 1998), creating a friendly environment in which individuals feel welcomed and comfortable enough to express their ideas, is an important factor for the establishment of an online environment that aims to foster the construction of knowledge. In such an environment individuals feel that they can participate without the risk of being ignored or criticized by their colleagues and find the motivation needed to support and/or provide feedback to their colleagues. These characteristics may not have been imprinted in the environment created

Table 2
Overview of the studies employing the IAM.

Studies	Participants	CT	UA	TLR	PhI (%)	PhII (%)	PhIII (%)	PhIV (%)	PhV (%)
Sing and Khine (2009)	11 In-service teachers with different background in terms of the subjects and levels taught in a course on Integrating Information Technology into School Curriculum from the teacher training institute in Singapore	Knowledge Forum	Message	–	60	20	13	4	3
De Wever, Vankeer, Schellens, and Valcke (2007)	1st Year students taking the course Instructional Sciences at Ghent University	LMS	Message	α 0.52	63	20	13	3	1
Paulus (2007)	16 Students from an online graduate level educational psychology course at a large Midwestern university	Discussion Forum	Functional Moves	α 0.83	65	15	7	1	2[a]
Schellens, Van Keer, De Wever, and Valcke (2007)	1st Year students taking the course Instructional Sciences at Ghent University	Discussion Forum	Message	0.81–0.85	53	9	32	2	4[b]
De Wever, Van Winckel, and Valcke (2008)	49 Sixth-year medical students, interning at the pediatric ward of Ghent University Hospital	LMS	Thematic Units	α 0.74	69	9.7	14.8	0.8	5.8
Hou et al. (2008)	45 Senior college students from Taiwan majoring in Information Management	Discussion Forum	Message	0.72	88.6	11	0.4	0	0
Tan et al. (2008)	26 Practicing teachers in Singapore schools enrolled in a Master Course entitled "Engaged Learning in Knowledge Building Communities	Knowledge Forum	Message	0.70	92	5	3	0	0[c]
Chai and Tan (2009)	7 Singaporean teachers enrolled in an 18-month Advanced Diploma program	Knowledge Forum	Message	0.78	52	18	19	7	4
De Wever et al. (2009)	1st Year students taking the course Instructional Sciences at Ghent University	LMS	Message	α 0.52	–	–	–	–	–
Hou et al. (2009)	470 Voluntary teachers from locations around Taiwan teaching at the elementary and secondary school levels	Blog	Message	0.70	88	0.3	4	0.2	0[d]
Wang et al. (2009)	Second year students from Singapore pursuing Diplomas in Education	Blog	Sentence	–	67	30	3	0	0[e]
De Wever, Van Keer, Schellens, and Valcke (2010)	1st Year students taking the course Instructional Sciences at Ghent University	LMS	Message	α 0.83	–	–	–	–	–
Kumar and Buraphadeja (2010)	Twelve graduate students' contributions to a wiki in a 14-week on-campus course on Web 2.0 technologies in education are analyzed	Wiki	Edition	κ 0.62–0.70	54	–	–	–	15
Heo et al. (2010)[f]	49 Undergraduate students enrolled in an educational technology course at a woman's university in Korea	Bulletin boards	Meaning	0.86	10.7	28.6	39.3	0	21.4
					25.9	43.1	25.9	0	5.2
					28.3	28.3	4.3	0	39.1
					23.5	51.8	5.9	0	18.8
Lucas and Moreira (2010)	56 In-service teachers with different background in terms of the subjects and levels taught enrolled in a Master Course on multimedia in education from Portugal	Blog	Message	κ 0.78	41	16	15	13	15

[a] The remaining messages were coded into two categories that the authors added to the original model: drafts and resources.
[b] The percentage of messages coded in each phase was calculated based on the results shown for two distinct discussions.
[c] The percentage of messages coded in each phase was calculated based on the results shown for three groups and two distinct discussions.
[d] The remaining messages were coded into a category that the authors added to the model: Others.
[e] The percentage of messages coded in each phase was calculated based on the results shown for three discussions and one group work.
[f] Results refer to 4 different teams/groups.

and it may have led to inhibition on the part of some of the participants.

Another aspect may be related to the lack of necessary skills to control and manage the teacher blog environment, such as posting or commenting, though authors refer adequate training provided to participants. Finally, there is the fact that participation and interaction was dependent on voluntary action. The fact that there was not an "obligation" to participate, besides the personal interest and curiosity, and the fact that there was a lack of objectivity in the use of the environment created, may have originated some disinterest among participants.

5.1.2. Wang, Woo, and Zhao (2009)

Wang et al. (2009) describe a study with 17 students from a course on Education. In this course, only Multimedia Design was held online, with all the other subjects taking place face-to-face (f2f). Multimedia Design lasted for 12 weeks and included a series of pre-defined activities:

- The first activity involved interaction with the content provided by the teachers. Students were asked to read it and write individual weekly reflections on content read.
- The second activity involved interaction with a small group of students. Students had to share and discuss their final projects in groups of two.
- The third form of interaction referred to discussing different aspects with the whole class:
- the influence of media on learning;
- the final projects of at least two colleagues;
- the course itself.

At the end of the course, authors coded 122 posts. From these, 67% were coded in PhI, 30% in PhII and only 3% in PhIII. PhV and IV did not occur. The study found that knowledge construction remained at a low level, leading authors to conclude that the nature of discussions influenced the depth of opinions and the development of ideas. Authors state that, for instances, the first discussion asked students to debate the influence of media on learning. However, their responses were limited to opinions and common thoughts with little controversy, dissonance, counter-argument or reaffirmation of previously shared positions. When referring to the second discussion topic, authors considered that when commenting on the projects developed by their peers, students' interactions were limited to greeting/commenting. The third discussion topic referred only to students' opinions about the course. Authors point out the importance of the choice of the topics to be discussed: "should be meaningful and relevant to participants [as well as] challenging and controversial enough to trigger different opinions" (Wang et al., p. 102), which was not the case in the course under study.

They also report that most students did not know how to behave in the environment created. The fact that their writings and reflections were subject to review and could be read by others inhibited them to write what they really felt and deepen their opinions. Another important aspect mentioned by the authors is that the online collaboration requested was redundant for small groups of students who often met. Group members met each other constantly in f2f classes during the course period. Therefore and to a certain extent, sharing and negotiating information online became unnecessary, as students had the chance to do it in the presence of their peers.

5.1.3. Lucas and Moreira (2010)

This study refers to a postgraduate course on Multimedia in Education. The course comprised two face-to-face (f2f) sessions – one at the beginning of each subject and another one at the end – and distance work for the span of 4 weeks. The main objective of the course was to endow students with competences that empower them to integrate technologies into their professional tasks, develop activities or projects in educational fields that reflected and (re)created practices, along with the development of communication, collaboration, evaluation, assessment and research competences.

Activities included:

- participation in discussions/tools used;
- moderating blog posts/comments in the second blog of the course during 1 day;
- a hands-on experience planning and implementing an in-class activity with their students in their schools that explored web based communication tools to foster interaction.

There were 56 students (divided into 10 groups) participating in this study. Almost all students were in-service teachers. They were not required to post a minimum or maximum number of contributions in the discussions launched in the two blogs used in the course, but participation represented 15% of the course assessment.

Topics discussed in one of the blogs were launched by the course teachers and followed no previous schedule, i.e., blog posts and discussion emerged from the interaction that resulted from the first message. Topics explored in the second blog were launched and moderated by students themselves, who were free to choose what they wanted to share and discuss as long as it related to the issues being dealt with in the course, the projects being developed or to their professional activity.

Authors coded 752 messages. They found the highest number of activity in PhI suggesting that there was a high focus on sharing and comparing knowledge. However, they also found the number of occurrences in the other phases as very similar, suggesting "a balanced pattern of knowledge construction involving participant students as a whole" (Lucas & Moreira, 2010, p. 282), i.e., the majority of messages revealed explicit or implicit interaction to other participants' messages in a continuous degree of complexity. Messages coded in PhIII seem to illustrate the advancement of arguments obtained in PhII. This pattern is similar in the highest phases of knowledge construction and so authors conclude that students pursued the discussion by proposing alternative views, compromising with them and building on each other's ideas.

When discussing results authors advance a set of strategies explored during the course, which they believe may help explain the results reported: transfer of responsibility to students, autonomous, context situated, problem based learning and intra/inter-group collaborative work.

6. Discussion

Studies presented suggest that the IAM supports the lower phase of sharing and comparing (PhI) in all types of designs and in different communication tools. This is characteristic of many discussions where the members of the community have to get to know each other and understand the positions each is coming from. This is also a desirable characteristic in online learning environments as it is important that participants feel welcomed and comfortable enough in an environment in which they have to share their ideas and opinions (Scardamalia & Bereiter, 2003; Wegerif, 1998).

The fact that few discussions go beyond Phase I may be related to the learning design and/or the facilitation strategies employed by moderators. It is possible that moderators may not have the necessary skills or know-how to help individuals to build on each other's ideas and move a group into the higher levels of thinking. It

is also possible that participants themselves may not be prepared or motivated to engage in online discussions. The study by Hou et al. (2009) reflects these aspects: authors recognized the lack of an adequate exploration strategy and the fact that participants may not have been prepared to interact in the learning environment. The moderator did not challenge the learning environment very much and, in turn, the participants did not challenge the moderator or each other. Interaction remained at a surface level, with teachers sharing daily activities.

Moving into higher levels of thinking may also depend on the goals set for discussions. As we have seen before, if interaction is merely requested to discuss what participants have read on a given issue or to report daily activities, it will not go beyond the lower phase of knowledge construction. However, if discussion is needed to solve a problem, for instances, it might be more likely to move into higher phases. This is evident in the studies by Wang et al. (2009), Heo et al. (2010) and Lucas and Moreira (2010). On the one hand (Wang et al.) we have participants giving feedback on peers' work and the course itself; on the other (Heo et al.; Lucas & Moreira) we have participants engaging in a real-world learning problems and contexts. Although peer feedback is associated with knowledge construction (Ertmer et al., 2007; Liu & Lin, 2007), discussions launched in the study by Wang et al. did not challenge students and did not demand original participation as students met each other daily f2f. As to the other studies, most discussions launched challenged participants, not only because they were related with real problems experienced by them in their working places, but also because participants themselves were the ones responsible for choosing the discussion topics. Personal relevance of discussion topics may influence participants' motivation and engagement; motivated and engaged participants are more likely to employ deep, reflective strategies, to weigh and compare ideas or arguments and change their cognitive schema.

Compared to Phase I, it is of interest to note that Phase II, the discussion of dissonance, had few postings. This could be due to many reasons, one major reason being that the design of the online discussion did not specifically call for participants to post diverse or opposing views on the topic. However, on closer examination of the lowest percentages reported in Table 2 for Phase II, it is apparent that these two studies were conducted in Taiwan (Hou et al., 2009) showing 0.3%, and in Singapore (Tan, Ching, & Hong, 2008) indicating 5%. This finding makes us wonder if the discussion of dissonance or opposing ideas online may not be culturally appropriate in these two study contexts. This notion is supported by Biesenbach-Lucas (2003), in her survey of the differences between native and non-native students in their perceptions of asynchronous discussions. She found that both groups of students tended to avoid "challenge and explain cycles" where they had to do more than demonstrate knowledge by also agreeing and disagreeing in non-abrasive ways. She notes that non-native speakers, particularly students from Asian countries, consider it far less appropriate to challenge and criticize the ideas of others. Biesenbach-Lucas notes that this lack of challenge and disagreement of ideas is troubling as it is the resolution of such areas of agreement and disagreement that "results in higher forms of reasoning" because "cognitive development requires that individuals encounter others who contradict their own intuitively derived ideas" (p. 37).

Gunawardena (in press) observes that the point we need to consider is whether such challenges to ideas expressed by others, and discussion of disagreement at the level of ideas in online discussions is a necessary condition for higher forms of reasoning or knowledge construction, or whether it is merely an expectation from a western point of view, particularly American, where the learning philosophy underlying most emerging online course designs emphasizes the exchange of ideas, expressions of agreement and disagreement to construct meaning. Gunawardena questions whether higher cognitive reasoning and knowledge construction can happen without such open disagreement of ideas and cites two studies using the IAM conducted in Mexico (Lopez-Islas, 2001) and in Sri Lanka (Gunawardena et al., 2011) that show that knowledge construction or Phase III in IAM did occur even though there were hardly any postings in Phase II. The same is observed (in Table 2) in the studies by Schellens, Van Keer, De Wever, and Valcke (2007) and Hou et al. (2009). Lopez-Islas in discussing the study conducted at the Monterrey Tech-Virtual University in Mexico, observed that open disagreement with ideas expressed by others is not appropriate in the Mexican cultural context, and therefore participants moved to knowledge construction without moving through the cognitive dissonance phase as described in the IAM model. In Gunawardena et al. (2011) study that employed the IAM model to examine the impact of cross-cultural e-mentoring on social construction of knowledge in asynchronous discussion forums between American e-mentors and Sri Lankan protégés, they found a similar result. The Sri Lankan participants did not openly disagree at the level of ideas, but moved to negotiation of meaning and co-construction of new knowledge based on consensus building. Therefore, Gunawardena and colleagues point out the importance of re-defining 'dissonance' as specified in the IAM model in cultural terms.

Based on data found from the studies in Table 2, we suggest that the higher levels of thinking need to be reconsidered and maybe merged into one unique phase. For instances, Onrubia and Engel (2009) propose an analysis model that uses the IAM as a reference (among other analysis instruments) and shares many similarities in its knowledge construction phases: (I) phase of initiation, (II) phase of exploration, (III) phase of negotiation and (IV) phase of co-construction. Learning processes included in each phase are very similar to those proposed by the IAM, but in this case, the phase of co-construction merges processes from phases IV and V of the IAM. The process of testing and/or modifying proposed knowledge should be reconsidered as newly constructed meaning.

Results achieved in the highest phase of knowledge construction (PhV) are only significant in the studies by Kumar and Buraphadeja (2010), Heo et al. (2010) and Lucas and Moreira (2010). Two studies refer the use of social software (wiki and blog), the other relates to the use of a LMS. These results do not lead us to assume that the type of technology used in the design of the learning environment has a direct impact on knowledge construction. We can refer, however, that the model continues to be adaptable to a range of teaching and learning contexts, like suggested before by other authors (Lally, 2000). Nevertheless, now that emergent technologies have found their way in the field, it is important that research advances to help us understand whether such technologies provide the same benefits for learning and to gain insights into the ways students learn when interacting online.

The IAM has received some critiques in the past related to the discriminant capability of the model and the need for fewer and more explicit boundaries between phases (Kanuka & Anderson, 1998; Marra, Moore, & Klimczak, 2004). More recently, Lucas and Moreira (2010) advance that, despite focusing on interaction as the vehicle for knowledge construction, the IAM lacks the capability to demonstrate the social and interaction dynamics that go beyond the categorization proposed for the knowledge construction phases. Furthermore, they state that it does not provide an accurate picture of the progress and development of students' knowledge. Other authors (Heo et al., 2010; Yap & Chia, 2010) are already complementing content analysis with other procedures, such as Social Network Analysis, which enables the study of individual interactions in relation to the group, and provides a better understanding and accurate visualization of the contribution of such interactions to the group's collaborative knowledge construction process.

7. Final considerations

The analysis of asynchronous messages can provide important information to researchers on the knowledge construction processes of collaborative groups. Measuring these can be important in view of comparing different learning environments, tasks, supportive technologies and instructions. In addition, the retrieved information can also be important to "feed" the teacher, the tutor or instructor, who can better orchestrate learning and tailor learning activities towards the individuals' needs or towards a specific group of students.

This paper details a literature search conducted regarding the use of Gunawardena et al. (1997) IAM for knowledge construction and discusses the extent and adequacy of its application. Literature reviewed suggests that complex thinking and higher phases of knowledge construction are achievable in different types of communication tools, if activities are designed accordingly. For instances, Wang et al. (2009) refer the importance of choosing and determining discussion topics as they can influence the depth of online discussions and levels of knowledge construction; De Wever, Van Keer, Schellens, and Valcke (2009) find that assigning specific roles to students participating in asynchronous discussions leads to complex thinking; Lucas and Moreira (2010) suggest that the same happens when responsibility for the learning process is transferred to students and combined with autonomous learning, context situated problem based learning and intra and inter-group collaborative work.

Literature review also shows a lack of uniformity in the choice of the unit of analysis and a lack of information on the type/level of reliability in several studies. This may suggest lack of knowledge on the part of researchers regarding practical and detailed guidance about these aspects or even lack of tools available to calculate this aspect.

Future research should focus on emerging learning environments and fine-tuning the procedures, such as identifying units of analysis and reporting inter-rater reliability levels. Visualizing interactions can also be of interest, so that a more holistic view of discussions is provided. More detailed procedures will not only help researchers to compare results of different studies, but could also be used to enable automatic analysis tools. These tools could provide both students and teachers with ad hoc information on the collaborative processes and provide teachers and students with specific recommendations towards the development of knowledge construction.

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