*CALL-EJ, 20*(3), 2019, 62-76

# Understanding Online Learner Knowledge Building from Discussion Forum Analytics

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## Abstract

An advantage of online discussion and interaction for learning is that text-based communication allows time for reflection. Such text based communications and reflections provide a rich source of data for research. This research employed learning analytics to understand online learner knowledge building through discussion forums. The activity for such text-based communication is a global MOOC offering. The intention was to understand how the learners build their repertoire of knowledge through the online discussion forums. Online discussion forums are essential elements of MOOC and online learning. The transcripts of the discussion were compiled and the discourse analyzed. The research analyzed the contents of forum discussions using Atlas.ti, which is a qualitative data analysis software. This research revealed that knowledge building was mainly formed through the community knowledge that was generated by the learners. Knowledge building was also a result of posing authentic problems or questions that elicited real ideas connected to the actual situation that the learners were experiencing. It is recommended that relevant learning discussions should incorporate practices that encourage the development of meaningful learning dialogue. A study of this nature is significant to understand learner behaviors and to take actions to support and improve learning outcomes and retention.

**Keywords***:* knowledge building, learning analytics, discourse analysis, Massive Open Online Course (MOOC), online learning, discussion forums

## Introduction

Online learning relates both to online open educational resources as well as private online resources from individual institutions for their limited consumptions. In whatever forms of online materials and modes of offerings - the most recent development being massive open online courses, or MOOCs – the emphasis on establishing a robust online learning community that facilitates knowledge construction has been duly noted by many researchers (Garrison et al., 2000; Salmon, 2002; Akyol et al., 2009; Shea et al., 2009; Shea and Bidjerano, 2009; Garrison et al., 2010; Remesal & Columina, 2013; Kozan & Richardson, 2014). One significant factor of online learning success lies in how the presentation of the online materials and the environments enhance interaction and knowledge building among its community of online learners. Course developers are interested to know the most effective pedagogy for optimal online learning experience. One of the ways of investigating the effectiveness of online learning is via the analysis of digital textual discourse within the online learning platform. The consequent focus on offering effective online learning opens up a new facet of discourse analysis to examine the learning process that is different from the traditional classroom learning setting. This is due to the former's non face-to-face nature, cyber learning environment, and its synchronous/asynchronous flexibility. Learning analytics is viewed as important today to understand better how online learning can be optimally presented for successful learning and

retention. Such learning analytics may also provide insight into how online learners build their knowledge.

This is a retrospective research using learning analytics to understand online learner knowledge building while interacting in discussion forums. An advantage of online discussion and interaction for learning is that text-based communication allows time for reflection and planned communications. Garrison et al. (2000) suggested that text-based communication may be positively related to the achievement of higher-order learning objectives. In this research, the activity for such text-based communication was a global MOOC offering about action research. The course was offered over a two-month period by an open university in Malaysia. The intention was to investigate how students contribute and attend to the messages of others in online discussions forums and from that, understand how the learners build their repertoire of knowledge.

### Research Objective and Research Question

Since 2008, MOOCs have demonstrated its significant potential to dominate online learning environments. Nevertheless, research (Goh, 2016; Onah, Sinclair, and Boyatt, 2014; Crawford-Ferre & Wiest, 2012; Hamtini, 2008; Shelton & Saltsman, 2005) have reported issues related to motivation, sustainability and retention, online interactions and learner engagement. An analytics research mining student discourse can shed insight on desirable learning environments and anticipate retention issues. A better understanding of the discourses and its implication will provide pointers for better preparation and future facilitation of online courses. This is especially so in the case of full online courses where sustainability and full term attendance and participation is a problem. Learning analytics on textual discourse sheds light on knowledge building. It can provide recommendations for effective and meaningful learning discussions. The objective of this research was to explore the ways in which an online learning community engaged in knowledge building. The research sought to answer the research question: "How does the online learning community engage in knowledge building?"

## Review of Literature

### Knowledge building

According to Scardamalia & Bereiter (2003) knowledge building is a "collective cognitive responsibility" (Zhang, Scardamalia, Reeve, & Messina, 2009) of a community of learners to produce and continually improve on their ideas and became of value to the group. This process of creating new cognitive artifacts is a result of common goals, group discussions, and synthesis of ideas. The implication in this research is that the collective community's accomplishment will be "greater than the sum of individual contributions and part of broader cultural efforts" (Scardamalia & Bereiter, 2003).

A distinction is made between learning and knowledge building, where "learning is an internal, unobservable process that results in changes of belief, attitude, or skill; knowledge building, by contrast, results in the creation or modification of public knowledge." (Scardamalia & Bereiter, 2003). In the context of this research it becomes a coherent effort to initiate learners into a knowledge creating culture (Scardamalia & Bereiter, 2006) where the community of learners come together on a common platform to co-construct and rebuild ideas, knowledge and meanings related to a theme or topic in order to integrate new knowledge in one's existing knowledge base.

**Social constructivism and Knowledge building**

Social perspectives on learning see learning built from dialogue and social negotiation (Jonassen & Land, 2000). Knowledge construction is a fundamentally social activity (Littleton & Häkkinen, 1999) where participation is a condition for learning (Jaldemark, Lindberg, & Olofsson, 2006). In this context, individuals within a group, at a level beyond their initial knowledge level, should be directed towards advancing the understanding of what is known about that topic or idea. This is achieved through the discourse and the social interactions within this community of learners. They come together on a common platform to co-construct and rebuild ideas, knowledge and meanings related to a theme or topic in order to integrate new knowledge in one's existing knowledge base. In this research, it is essential to initiate the learners into such a knowledge creating culture (Scardamalia & Bereiter, 2006). Such knowledge creating culture allows the building of new knowledge that does not yet exist within the students. It also allows rebuilding existing knowledge whereby students may rediscover for themselves, and arrive at higher or new level of knowledge or understanding. In such instances, the teacher facilitator needs to be mindful of the conflicting intentions of wanting the students to learn the same thing and yet at the same time to build knowledge and make it their own (Laurilllard, 1993, p. 3).

**Principles of knowledge building**

Scardamalia (2002) identifies twelve principles of knowledge building as follows (Figure 1).

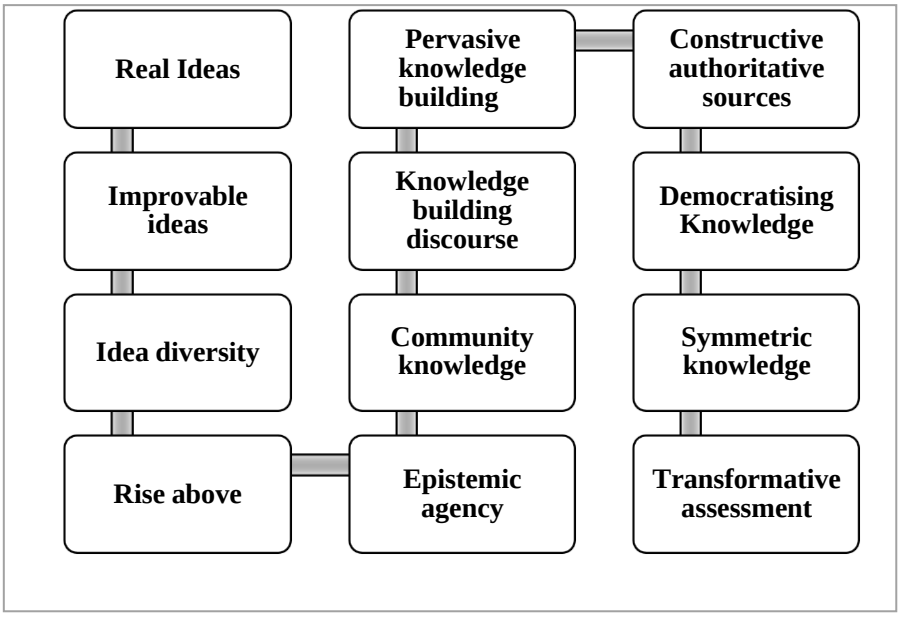


Figure 1: Knowledge Building Principles

*1. Real ideas and authentic problems. In the classroom as a knowledge building community, learners are concerned with understanding, based on their real problems in the real world.*
*2. Improvable ideas. Students' ideas are regarded as improvable objects.*
*3. Idea diversity. In the classroom, the diversity of ideas raised by students is necessary.*
*4. Rise above. Through a sustained improvement of ideas and understanding, students create higher level concepts.*

*5. Epistemic agency. Students themselves find their way in order to advance.*
*6. Community knowledge, collective responsibility. Students' contribution to improving their collective knowledge in the classroom is the primary purpose of the KB classroom.*
*7. Democratizing knowledge. All individuals are invited to contribute to the knowledge advancement in the classroom.*
*8. Symmetric knowledge advancement. A goal for Knowledge building communities is to have individuals and organizations actively working to provide a reciprocal advance of their knowledge.*
*9. Pervasive Knowledge building. Students contribute to collective KB.*
*10. Constructive uses of authoritative sources. All members, including the teacher, sustain inquiry as a natural approach to support their understanding.*
*11. Knowledge building discourse. Students are engaged in discourse to share with each other, and to improve the knowledge advancement in the classroom.*
*12. Concurrent, embedded, and transformative assessment. Students take a global view of their understanding, then decide how to approach their assessments. They create and engage in assessments in a variety of ways.*

This research employs the above principles as the framework for identifying the nature of knowledge building that happened.

**The Dynamics of Online Learning**

The digital revolution is a key force that innovates an emerging landscape for online learning, or eLearning within a virtual environment. Online learning can support teaching and learning, increase access to education and training; reduce the cost of education; and thus make possible the democratization of education (Gilbert, Morton, & Rowley, 2007). The creation of learning management systems provide classroom learning interfaces that spans the global reach and forever changes the concept from learning within four physical walls to learning without boundaries. "*New technologies clearly provide exciting opportunities for enhancement and innovation in learning opportunities*" (HEFCE, 2005). There is much to be learnt about how online courses can best be implemented to better facilitate the knowledge building of learners and enhance student learning. This research sought to glean such useful insight from the experiences of the community of online learners and the ways they interact with the contents of the learning resources and with other learners to build knowledge (Figure 2).

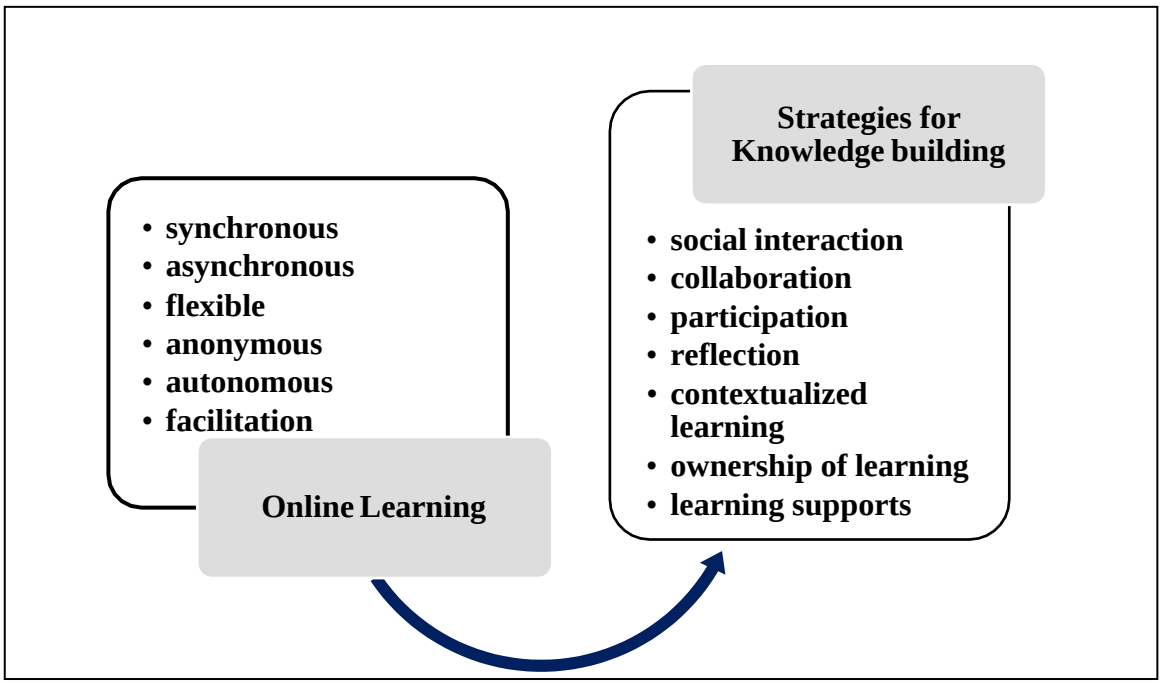


Figure 2: The Dynamics of Online Learning and Strategies for Knowledge Building

As discussed in the earlier section, one of the main strategies of collaborative knowledge building is through social interaction within the online learning community (Scardamalia & Bereiter, 2006). The synchronous and asynchronous nature of online learning provide opportunities to discuss, develop and revise ideas and questions. It is also noteworthy to reiterate that effective online learning is conditional upon learner collaboration and participation (Jaldemark, Lindberg & Olofsson, 2006). Such collaboration can be gleaned from the threaded discussions in the forms of reiterations, arguments, coaching, group presentations and reports.

Online learning generates reflection through discussion. The forums are flexible and provide time to reflect. Its relative anonymity allows both introverted and extroverted learners to be involved in discussions. In a well-structured and appropriately facilitated learning environment, learners can be guided to apply new information to their personal and professional schema and build upon their existing knowledge (Li, 2004).

Online learning is synonymous with learner autonomy. It allows the learners to contextualize their learning experiences in ways that is meaningful to them. Giving learners the choice of when and what to learn will capture their interest and give them a sense of ownership in learning. This intrinsically motivate their efforts towards participating in building knowledge for learning.

Central to the above characteristics of online learning is the importance of the instructor in facilitating learner knowledge building. Instructors of online learning communities play multiple roles - a guide, mentor, catalyst, coach, feedback-giver, and resource-provider (Prestera & Moller, 2001) – which are important in scaffolding learner knowledge building and providing a safe learning environment.

**Participation in online learning**

The online environment generally teems with the dynamics of learning patterns. Learners sharing the same inclinations congregate in the same virtual locale but may react and interact differently. Learners may collaborate and work together with each other. They may engage socially and emotionally in their online interaction to create a sense of community and cohesion.

There is an increasing reliance on online learning to acquire knowledge and skills in a broad range of domains. Online discussions are essential elements of online learning (Rodriguez, 2014). Changes in the boundaries of learning imply changes in pedagogy. Analysis of the learning patterns may reveal the nature of knowledge building and learning in the discussions. Online learning pedagogies view education as information transfer in many different ways that make it flexible at any time and in any place. In this respect, online learners are people who take responsibility for their own learning. There is a need to investigate the online learning dynamics in order to understand and determine the best strategies for optimum effectiveness.

## Methodology

This is a retrospective qualitative research employing the learning analytics method to understand online knowledge building. The activity used for the learning analytics is a full time massive open online course (MOOC) on action research created by an open university in Malaysia.

### Learning Analytics

The underlying assumptions of learning analytics (LA) are based on the understanding that Web-based proxies for behavior can be used as evidence of knowledge, competence and learning (O'Riordan et al., 2016). In LA, data about learners and their contexts is collected, processed, analyzed to reveal latent patterns of activities and behaviors. Such discoveries may be reported to increase the understanding of learner behaviors in online learning. Findings from LA may provide suggestions to optimize learning and the learning environments to support and improve student learning outcomes and retention. Shum and Ferguson (2012) argued that such learning analytics provide insights about the learning environment for organizational strategic planning and improved learner outcomes. Recent discourse analysis approaches provide new ways of understanding the large amounts of text generated in online courses and conferences (Shum & Ferguson, 2012). These discourses are collected to analyze and investigate how the learners "*interact with information, make sense of it in their context and co-construct meaning in shared contexts*" (Knight et al., 2014 p. 31). In this research the learning analytics method focuses on online discussion forums that include discourses in online activities sentiment analysis, and interaction between learners within forums (Ferguson, 2012). The generation of transcripts of interactions from discussion forums in online learning platforms provide authentic and valuable datasets for analysis based on Scardamalia's (2002) knowledge building principles framework. In a similar research, Wong et al. (2015) also viewed forums as information seeking datasets but they used a keyword taxonomy approach to analyze a large amount of MOOC forum data to identify the types of learning interactions taking place in forum conversations.

### Participants and Context

The discourses of 18 active online participants, including the facilitator, were examined to understand knowledge building within an online learning environment. Initiation of the learners into the knowledge creating culture (Scardamalia & Bereiter, 2006) was integrated implicitly into the facilitators' roles and actions. The facilitators were mindful to use support strategies to create conditions for social interaction, collaboration, participation, reflection, contextualized learning and ownership of learning that enable knowledge building.

The participants came from all over the globe. These participants made up the learning community within the forums. Reference to them in this research will be with pseudonyms, cited by the document and its line numbers.

**Data Collection and analysis**

Six separate threaded discussions were analyzed in a 3 weeks Module implementation of the MOOC "Action Research" course on the Moodle platform. The intention of the analysis was to understand how knowledge building occurred in online interactions. The researcher was one of the facilitators of this fully online course. The task was to record as much observations of the students' learning and attempts at knowledge building from the beginning of the course. More than 200 asynchronous contributions (both learners and facilitator) occurred within the discussion platforms during the 3 weeks of the course. As an example, activity 1.4 logged a total of 33 threaded contributions by 14 learners. In these forums, the facilitator initiated the discussion by posing questions or scenario or issues. For example, Learning Activity 1.2 started with the statement:

> *In the field of education, the practitioner in action research does not merely accept something at its face value. He/she participates actively in finding the reasons to take deliberate action consistent with his/her values and beliefs. How far do you agree with the above statement? Do share your views below.*

Learners were expected to contribute their personal knowledge and experiences and engage with other learners. The researcher as facilitator monitored and made observations of the students' learning progression right from the beginning of the course. The analysis of the online discourses occurred after the course was completed. The discourse data was downloaded from the learning management system. An example of the discussion threads is shown below (Figure 3).

*by O~ Action research is different to other forms of research in that is based in personal reflections and steeped in application to one's own setting. It is very much researched focused and outcomes benefit the consumer, who is typically the researcher. It is a very organic process that is researcher centered and is specific to their own needs. Action research is focused on improving one's own setting and practice.*

*by R~ Yes, reflection requires a lot of honesty because we have to observe our practice objectively. In Malaysia, I think this becomes a problem when teachers are "directed" to conduct an AR by top management as a continuing professional development activity/exercise. We should instead encourage teachers to 'embrace' AR. Any incremental change in their professional behavior is good enough for everyone, teachers and students alike.*

*by P~ Action research is self-reflective inquiry carried out to improve practices and to solve daily problems. Personal theories are formulated for self- reflective and further improvement.*

*by N~ Action research requires us to really reflect on our practice in order to be able to make necessary changes. I am relatively new to the idea of keeping a reflective journal. I have participated in reflections*

Figure 3: Transcript of Discussion Thread

The discourse transcripts were imported into Atlas.ti, a qualitative software program that was used to organize and code the discourse transcripts.

**Coding**

Prior to the coding exercise using Atlas.ti, the transcripts were scanned for recurring themes. The researcher prepared a list of initial codes for forum texts guided by the categories of descriptors of knowledge building based on the twelve principles which are: real ideas and authentic problems, improvable ideas, idea diversity, rise above, epistemic agency, community knowledge, collective responsibility, democratizing knowledge, symmetric knowledge advancement, pervasive knowledge building, constructive uses of authoritative sources, knowledge building discourse concurrent, embedded, and transformative assessment (Scardamalia, 2003). The initial scan, along with the initial list on the coding template, allowed the researcher to prepare a comprehensive content analysis scheme. Atlas.ti was used to process the forum texts into sensible chunks of data (Figure 4)

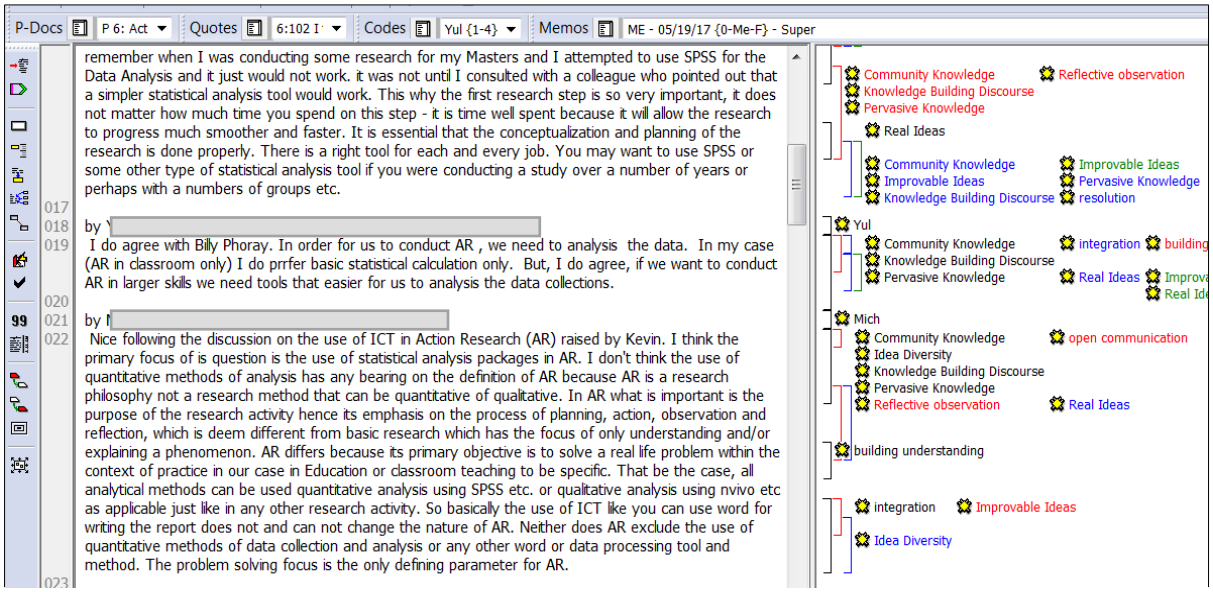

Figure 4: Coding and Data Analysis

During the coding process, the researcher went back and forth continuously to refer to Scadarmalia and Bereiter' s (2006) descriptions of the indicators for knowledge building in order to determine the most suitable category to insert the codes, or to create new codes for the category deemed most suited. More codes would be added to these templates as the analysis process got under way. This painstakingly meticulous and time consuming process reflected the rigor in data analysis. The researcher also engaged the aid of an independent coder to evaluate the data and carry out discussions to arrive at consistently similar conclusions. The effort to obtain inter-coder agreement is intended to establish the reliability of data analysis and interpretation. It is a known fact that inter-coder reliability is a critical component of content analysis.

## Discussion of Results

Figure 5 indicates how the group engaged with the facilitator and other members during the initial period of the course. The facilitator initiated the discussion for the activity, and was fairly frequently involved.

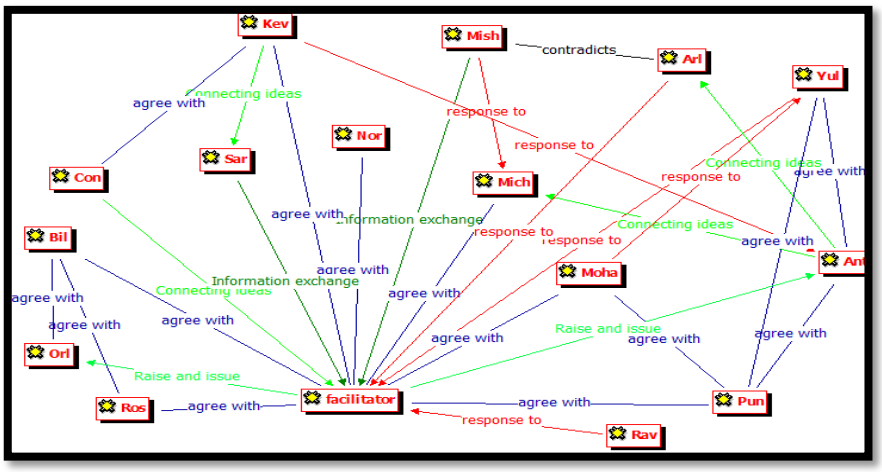

Figure 5: Initial Community Interactions

The figure above indicates a number of direct communication of members with the facilitator. The facilitator was involved fairly frequently, providing responses to the learners' communication. There were, however, two members (Ant and Yul) who seemed to dominate the discourse in which the other members contributed.

In later discussion forums, there were more complex and intricate communications within the community (Figure 6).

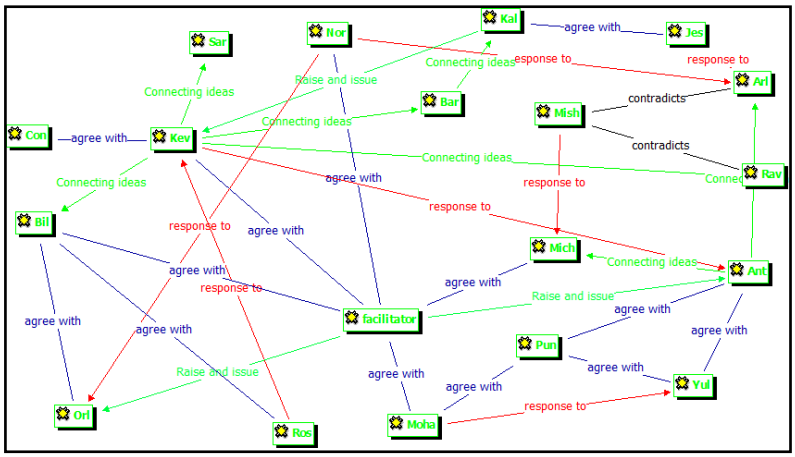


Figure 6: Later community interactions

In this instance, the facilitator presence receded, and the discussion took a life of its own, building on each contributed ideas that offered broader conclusions. Orl wrote, "*I think my initial answer was quite simple, in comparison to what I have now come up with!*" (P6:197).

## How Knowledge Building Occurs in an Online Learning Community

This section answers the research question "How does knowledge building occur in an online learning community?"

An interesting, albeit unsurprising observation is that the cognitive presence is a factor that contributes towards knowledge building (Table 1).

Table 1
Density of Knowledge Building Engagement

| Knowledge building principles | Density of engagement (%) |
|---|---|
| Real Ideas | 19% |
| Community knowledge building | 17% |
| Knowledge building discourse | 16% |
| Idea diversity | 13% |
| Pervasive knowledge building | 10% |
| Constructive authoritative sources | 9% |
| Improvable ideas | 8% |
| Democratizing Knowledge | 4% |
| Rise above | 3% |
| Epistemic agency | 1% |
| Symmetric knowledge | 0% |
| Transformative assessment | 0% |
| | 100% |

The main form of engagement in knowledge building was in the real ideas and community knowledge that was generated by the learners. This is visible in the iterative improvable ideas put forward (Figure 7).

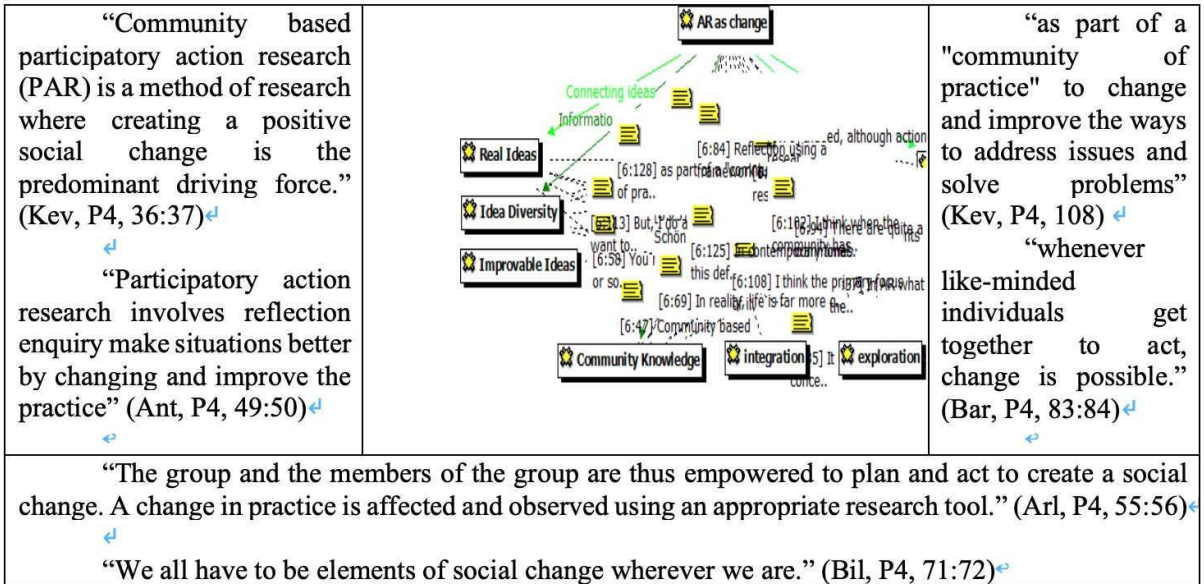


Figure 7: Knowledge building through reiteration

Knowledge building was also a result of posing authentic problems or questions that elicited real ideas connected to the actual situation that the learners were experiencing (Figure 8).

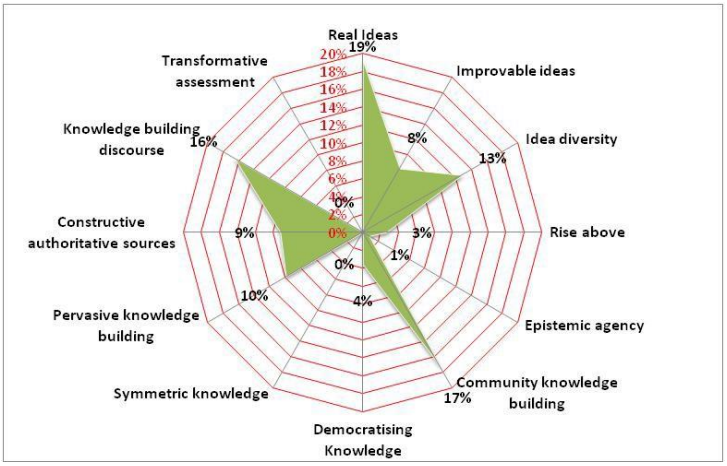


Figure 8: Engagement of Knowledge Building Principles

It is noted that there was a high volume real ideas and authentic problems generated on a given theme or topic. It was interesting that such ideas were reiterated by separate learners, but couched in different ways and perspectives, which indicated the knowledge building element of idea diversity (Figure 8). Idea diversity came into play when students linked notes, bringing different ideas in contact with each other. In a sense, the ideas became concretized knowledge that was "greater than the sum of individual contributions" (Scardamalia & Bereiter, 2003).

As mentioned earlier, online discussions encouraged reflection and meaningful information processing related to the achievement of higher-order learning objectives (Garrison et al., 2000). Zhang et al. (2009) noted such knowledge process as epistemic agency at high levels of cognitive complexity. Nevertheless, in this research, the knowledge building at the high level knowledge processes of epistemic agency was minimal. Coolidge (2013) noted that apparently some researchers have also encountered similar unsatisfactory results. She suggested that online instructional strategies such as authentic learning and problem solving would help learners achieve higher-order levels of thinking (Coolidge, 2013). However, it was not the case here. McLoughlin and Mynard (2009) suggested "*that the nature of the course, type of task, and wording of initial prompt have an effect on type of higher-ordering thinking processes that will emerge in an online discussion*" (p. 156). There is perhaps the need for the facilitator presence to direct learners towards high level discussions, like introducing theory building and conceptualizing frameworks.

## Conclusions and Learning Points

It was evident that the facilitator had a central role in the online learning community, engaging with most of the learners, directing the flow and quality of discussion and ensuring its sustainability. As the number of postings within the thread increased, it behooved the facilitator to reassert her presence and draw the focus back to the learning community.

The intention of the research was to understand how the learners built their repertoire of knowledge through the online discussion forums. It is shown that knowledge building occurs in online discussion forums, but its process does not necessarily take place in a logical and systematic manner; neither does it produce the exact desired result. More often, through the threaded discussion of shared interests, the conversation deviates from its original purpose and ends up with unexpected insights that are more complex, approaching but not reaching the level of "epistemic agency" (Scardamalia, 2002). Knowledge building is therefore a non-linear and complex process involving reiteration and presentation of new perspectives leading to more complex and complete understanding.

The research also indicated that although there was collaborative knowledge building, it was generated at a lower cognitive level. Kimmerle et al (2015) commented that if new information is fully congruent with the previous knowledge and beliefs of a system, there is no need for adaptation, and thus development will not occur. This research postulates that the level of knowledge generated in online learning is as high, or as low, as the collective level of discussion and knowledge of the learning community. In the context of knowledge building as a social activity, where the people contributed information that was affirmed or repeated by others instead of making contradicting rebuttals, knowledge building was thus retained at the cognitive level of knowledge and understanding. What might therefore be the condition to advance the cognitive level of knowledge building would be the opportunity to inject a cognitive conflict as an "irritation" (Luhmann, 1995) for argument, authentic learning and problem solving (Coolidge, 2013) leading towards development into newer ideas at epistemic level. Based on the findings of the research, it is recommended that relevant learning discussions should incorporate the following practices: there can be opportunities created for the move from teacher centric dialogue to community discussion, triggering different contributions from which the group may infer new knowledge beyond their initial cognitive level.

As mentioned in the methodology, this was a retrospective study of an intact group without any overt instruction regarding knowledge building. On hindsight, perhaps learners could have benefited from instruction about knowledge building prior to their commencement

of the course. Hyojeung-So et al. (2016) suggested that for learners new to the knowledge building pedagogy, providing explicit instruction and guided approaches to cultivate a knowledge-creating culture may help them improve their skills and level of knowledge building.

It was also suggested that low cognitive levels of knowledge building could be due to complex issues raised or inadequate facilitation (Meyer, 2003). Therefore, as group engagement in collective discourse contributes towards individual learning, discussion activities may also include higher level tasks and provision of relevant scaffolds to help develop epistemic agency and encourage the development of meaningful learning dialogue.

Finally, this research contributed to an understanding of how learning analytics information may be used to execute interventions, predictions, reflection, awareness, personalization, recommendation and benchmarking (Khalil & Ebner, 2016). The ways in which online learners engaged in educational dialogues among themselves provide indications of how knowledge building was generated. The research was also significant in raising awareness of an online facilitator with regards the nature of knowledge generated and the importance of the strategies that the facilitator should employ in moderating the forum discussion. This contributes towards the knowledge of effective pedagogy that may address retention issues in online learning. Future studies may approach knowledge building as an action research to improve the level of knowledge building among learners.

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