

Knowledge Communities and Formal Learning in Higher Education: A Blended-Learning Seminar with Learning Analytics Support

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Abstract. The use of online knowledge communities (OKCs) as learning environments, e.g., in higher education encounters two main issues: the learning guidance issue, and the newcomer integration issue. While the former can be solved by instructional design, the latter is still open and may be solved by Social Learning Analytics (SLA) support. This paper proposes a higher education seminar based on two instructional design components: a formal one as a face-to-face seminar, and an informal one as learning in OKCs. SLA tools are employed to select OKCs that are likely to integrate newcomers, and to provide participants with an overview over collaborative discussion partners. The seminar is being carried out at Ludwig-Maximilians-Universität München, Germany, with a group of $N=65$ undergraduate students. Early results show students' acceptance of the learning environment, and their compliance with the seminar script. Many learning groups could successfully initiate and sustain productive discussions with blogger OKCs focused on teaching mathematics in schools. The seminar will be completed mid-July 2016, soon after which evaluation results will be available.

Keywords: Social Learning Analytics; Higher Education; Informal Learning; Online Knowledge Communities

1 Introduction

Online communities have been successful for the last few decades, and new technologies support them in ways that are continuously improved. In particular, Online Knowledge Communities (OKC) supported by social web technologies prove benefic for knowledge sharing and knowledge building, mostly in informal learning

settings [1, 2, 3], as well as for academic help seeking [4, 5]. However, using OKCs as learning environments, e.g., in higher education is connected with two main issues.

First, the *learning guidance issue*: Open learning environments were sharply criticized for their minimal instructional guidance that may cause learners' cognitive overload [6, 7]. Indeed, OKCs are open informal learning environments and, per definition, no instructional guidance is provided. Research literature often reports on successful learning in OKCs, but it is reasonable to assume that there are unsuccessful learning attempts in OKCs, as well.

Second, the *newcomer integration issue*: Learning in OKCs is typically described as legitimate peripheral participation [8, 9], which implies that newcomers integrate in the socio-cognitive community structures. This, in turn, is a matter of long-term interaction with no guarantee for success. Integration failure would be a waste of resources, mostly unacceptable in learning practice, and especially in formal learning.

While the learning guidance issue can be easily solved by design, i.e., by the combination of informal learning in OKC with formal learning, the newcomer integration issue is still open. Keeping in mind these considerations, a higher education seminar has been developed. Its learning design reunites the traditional formal seminar in a face-to-face setting on the one hand, and informal learning in OKCs on the other. Social Learning Analytics (SLA) tools are used to analyze the OKC discourse and predict how likely the OKCs will integrate students as newcomers in their discourse. Thus, SLA is applied in an attempt to solve the newcomer integration issue.

This paper presents the theoretical and empirical foundations of the educational concept, the learning design, early results of the pilot seminar, and authors' conclusions. Full evaluation results will be available by August 2016.

2 Addressing the Minimal Guidance Issue: SCOLE and Inquiry Learning

Under a strong constructivist influence, Hannafin et al. [10] defined student-centered open learning environments (SCOLEs) as a synthesis of several instructional approaches, such as problem-based learning [11], anchored instruction [12], inquiry learning [13], or situated learning [8]. These approaches have in common the high degree of self-directedness, i.e., openness, meaning that the learners choose their own learning path in form of goals, resources and ways of using the resources. Furthermore, SCOLEs provide an authentic framework for students to engage in complex problem solving. A wide range of technologies has been used to build SCOLEs and make them "smart" [2]. From these, Web 2.0 technologies, and particularly blogs are already well established [3].

Kirschner, Sweller, and Clark [6, 7] point out a first prominent issue of SCOLEs: the aspect of minimal guidance, as opposed to fully guided instruction. The former is said to cognitively overload learners, thus failing to support learning; the latter is supposed to provide the necessary instructional support, and thus lead to significant learning.

A reasonably moderate position is recommended by Taber as optimally guided instruction [14][15], meaning an optimal balance between open-ended and teacher-

directed instruction, and between student-centered and teacher-centered learning. As a specific instructional approach, Taber recommends inquiry learning [13], an instructional design that is both minimally guided and, at the same time, scaffolded by teacher [11, 14, 16]. Slotta and colleagues [17] combine this with OKC. The resulting approach called Knowledge Community and Inquiry comprises self-directed exploration of complex immersive environments and guided reflection.

Reaching and maintaining the narrow guidance optimum can be best done by carefully scripting the learning process [18]. According to a recent meta-analysis, collaborative scripting leads to a small positive effect on domain-specific knowledge and to a large positive effect on collaboration skills, as compared to unstructured collaborative learning [19].

3 Addressing the Newcomer Integration Issue: The Contribution of Social Learning Analytics

Blogs, considered as collections of articles published in chronological order and with attached discussion forums, are dialogic environments woven around the blog owners. Several bloggers, i.e., blog owners together with their readers and commenters can join together and form a KC dedicated to a certain topic or practice. Similarly to Lave and Wenger's communities of practice [8], participation in OKCs and blogger communities is typically reflected in a socio-cognitive structure including central and peripheral members. Mainstream research [8, 9] describes central participants as more experienced and skilled, therefore assuming more responsibility and performing more difficult tasks than peripheral participants. In contrast, other studies (e.g., [5]) describe OKCs as help-seeking communities in which help seekers are the most active, thus most central, but not the most knowledgeable members.

As previously mentioned, learning in OKCs takes place as legitimate peripheral participation [8, 9]. Hence, learners must first be integrated as newcomers in these OKCs. Eberle et al. [20] describe strategies of newcomer integration in face-to-face communities, such as recruitment, positive or negative welcoming, encapsulation, consistent training, offering opportunities for peripheral participation, or accessibility of community knowledge. Nistor [21] finds similar strategies in online game player communities.

From their social-constructivist perspective, Lave and Wenger [8] stated that community practice – which includes newcomer integration – takes place in the community discourse. Accordingly, this research is based on the assumption that newcomer integration takes place in, and is part of, the OKC dialog. Moreover, we assume that various OKCs can be regarded as integrative if newcomer integration is easy and frequent, or as non-integrative if newcomer integration is difficult and seldom. Thus, integrativity, as well as the newcomer integration process, can be assessed by dialog analysis.

In recent work, automated OKC dialog analysis has been performed by crawling thematically preselected blog discussion forums and subsequently assessing dialog structures and properties, mainly collaboration and textual complexity.

Preselected blog discussion forums were crawled using BlogCrawl version 1.5 [22], an academic crawler specialized in content extraction from blogs, MOOCs, or

discussion forums. Its aim is to create clean data corpora that can be further used in educational research studies. BlogCrawl can extract content from specific segments of a digital environment, and from given periods of time, and it can also recrawl the same segments to check the evolution in time of the corresponding OKCs. BlogCrawl not only supports different data sources as input, it can also aggregate results in different formats. Content data are gathered in four stages: (1) URI discovery is performed using `crawler4j.jar`¹, an open source, multi-threaded web crawler in Java; (2) crawled data is normalized preserving semantics by extracting authors, corresponding dates and useful content, while adds, commercials, hidden texts, and cross-references are eliminated; (3) a standardized structure of dialogue consisting of turns and utterances is imposed, similar to the ConcertChat format [23], that enables the specification of explicit links between contributions (both posts and comments), participants, in tight correlation to the conversation timeline; (4) data is saved in an appropriate format, e.g. XML, plain text, CSV, XLS.

The crawled data were further processed using ReaderBench version 2.2 [24, 25, 26]. *Collaboration* was automatically evaluated based on two models – voice inter-animation [27] and cohesion network analysis (CNA) [26]. CNA makes use of the cohesion graph, the underlying multi-layered discourse structure centered on local and global cohesion, which reflects the semantic relatedness at inter- and intra-contribution levels [24]. From a computational perspective, cohesion is evaluated with respect to lexicalized ontologies (WordNet), Latent Semantic Analysis (LSA) vector spaces, and Latent Dirichlet Allocation (LDA) topic distributions [24]. After building the interaction graph, multiple participation and collaboration indices are derived by applying specific Social Network Analysis (SNA) centrality measures [26]. Individual collaboration scores are used in the described learning environment to find the most collaborative OKC members who are more likely to respond to inquiries.

Textual complexity relies on a multi-dimensional model that combines classic surface metrics derived from automatic essay grading techniques, syntax factors, as well as semantics and discourse indices of textual complexity [24]. In contrast to other automated essay grading systems [28], ReaderBench is centered on cohesion, derived from CNA, as semantic similarities govern the understanding of a text. Individual text complexity scores are used in the described learning environment to find experts in given OKCs, who are likely to possess sufficient knowledge to sustain a complex dialogue.

The tools and procedures described above were used in previous quasi-experimental studies to predict OKC integrativity. With respect to automatically assessed collaboration, Nistor et al. [29] reported that integrative OKCs were distinguishable by more intensive responses to newcomer inquiries in the previous OKC lifetime, and by social networks with a stronger peripheral layer. With respect to textual complexity, Nistor et al. [30] found integrative OKCs to produce more cohesive dialog. The highest accuracy of integrativity prediction (60-70%) was reached for non-integrative OKCs that can be thus excluded from a newcomer integration attempt, therefore reducing the risk of integration failure.

¹ <https://github.com/yasserg/crawler4j>

Examining the influence of the inquiry format on OKC response, a case study showed that more focused, on-topic questions, addressing a smaller number of blog-specific concepts were more likely to be responded [31]. A further experimental study [32] confirmed the role of inquiry format only in blogger OKCs with low topic complexity (cooking). In contrast, in OKCs with high complexity topics (economy and politics) the community response solely depended on the previously established dialogue quality.

These SLA findings imply several recommendations for the communication strategies applied by newcomers who attempt to be integrated in OKCs. The OKCs should be selected both by topic and by dialogic criteria predicting integrativity, i.e., proven responsiveness to newcomer inquiries along the OKC lifetime, socio-cognitive structures with a strong peripheral layer, and cohesive dialogue. As for the inquiry format, newcomers should ask focused, on-topic questions and, more general, observe the specific OKC netiquette that can be different from community to community. While posting inquiries, newcomer may specifically address the OKC members with higher individual collaborative scores.

4 Learning Environment Design

Based on the considerations presented above, a university seminar has been conceived and offered undergraduate students of Educational Sciences at Ludwig-Maximilians-Universität München, Germany. The seminar has been carried out in the summer term of 2016, i.e., from April to July, as an addition to the lecture “Teaching and Learning”. Its learning goal was to facilitate participants an overview on educational technology applications in teaching mathematics in US American schools.

The instructional design comprised a formal component (traditional higher education seminar, led by an assistant or associate professor), and an informal component. The latter was a SCOLE, in which the participants were assigned to several blogger OKCs dedicated to teaching mathematics in schools. This is where they asked questions on the given topic, thus attempting to integrate as newcomers in these math teacher communities. The formal and the informal components were synthesized in the form of inquiry learning, built up as a cycle: (1) formal seminar discussions aimed at goal setting and preparing inquiry, (2) performing inquiry in the chosen OKCs, (3) receiving inquiry results, (4) individual and group reflection on the inquiry results, and further again with step (1). During the 14 weeks of the summer term, the cycle was repeated for three times, after which the participants presented the achieved results, and the seminar was closed.

The $N = 65$ participating undergraduate students worked in 18 small groups of 2-5 persons. Collaboration was scripted, using an epistemic, i.e., content driven script within student groups, and a collaborative script in their collaboration with OKC members. The epistemic script comprised: lectures on recommended research literature and presentations of educational theories and empirical studies in the seminar sessions; observations of blogging activity with application of the reviewed literature; deducing an appropriate inquiry format so that the OKC most likely respond to the inquiry; and discussing causal explanations of the received responses, i.e. which were their success or failure factors in the employed inquiry format. The

collaborative script included three communication strategies, an individual, a collaborative, or a competitive communication strategy. This meant that an inquiry was either posted by an individual learner, or consecutively by two learners. In the collaborative strategy the second learner endorsed, while in the competitive strategy the second learner challenged the first learner's inquiry, and gave a partial answer to it based on own experiences. Thus, the inquiry remained open, and the OKC members were expected to perceive stronger newcomer interest, to which a cognitive conflict was added in the competitive inquiry.

The learning environment was designed for blended learning, such that the formal component took place in a face-to-face, and the informal component in an online setting. The former was provided as weekly seminar meetings, the latter as blog discussions. Additionally, thematically preselected blogs were crawled and automatically analyzed, thus excluding non-integrative blogger OKCs and providing the learners with individual participation, collaboration and textual complexity indices of all discussants.

The seminar schedule included the introduction and group building (week 1), literature review and presentation (weeks 2-3), observations in the blogger communities and preparing the first inquiry (weeks 4-6), posting the inquiry and subsequently discussion in the OKCs (weeks 7-8), reflecting on the results and preparing the second inquiry (weeks 9-10), reflecting on the results, preparing and posting the third inquiry (weeks 11-12), and the final results presentation and discussion (weeks 13-14).

5 Early Results

In order to assess the educational quality of the seminar and to identify potential improvements, the seminar has started to be evaluated. The evaluation comprised the following foci: (1) participants' perceptions, i.e., their acceptance towards the seminar, (2) participants' compliance with the seminar script, and (3) learning effects with respect to technical aspects, communication strategies, applications of theories and approaches of the Learning Sciences, and an insight in the Social Learning Analytics.

(1) The participants accepted to a high degree the blogs as technology-based learning environments for their studies. This was explicitly expressed in the seminar discussions; acceptance data were gathered as pretest, and the posttest data will be collected at the end of the term.

(2) The seminar participants complied to a high degree with both the epistemic and the collaborative scripts that were perceived as close to their everyday study activities. Minor delays were due to student schedule overload.

(3) Many participants were already familiar with the technical aspects of blog-based communication; no related problems were notified. Many participant groups could successfully initiate and sustain productive discussions with OKC members. The participants observed the communication in the blogger OKCs, thus pointing out essential requirements for their inquiries, such as on-topic comments, general netiquette compliance, explicitly addressing the central OKC members, using a limited number of concepts when phrasing their questions. Subsequently, they could

find plausible explanations for the OKC response, thus either identifying the success factors of their communication strategy, or hypothesizing why an OKC has not responded. As for theories and approaches of the Learning Sciences, at the beginning of the seminar the students made accurate presentations of theory, after which they could observe the same phenomenon in the blogger OKC environment. Many of them got a significant insight in the didactics of mathematics; however, in some blogs the mathematical contents exceeded the seminar participants' knowledge, so that they had to avoid discussions on purely mathematical topics and restrain to the instructional design. Finally, the seminar participants got an insight in the Social Learning Analytics, so that they could understand analysis results of the blogs they worked with, and use the dialogic indices to identify the central and peripheral OKC participants.

The seminar will be closed mid-July 2016. The final evaluation results, including survey responses, artifact analysis (presentations, seminar papers etc.) and grades will be entirely available by approximately mid-August.

6 Discussion and Conclusions

Altogether, the Social Learning Analytics based seminar of Educational Sciences is a definitely positive experience that suggests several conclusions. First, the seminar concept could reach a balance between minimally and fully guided instruction, reflected in the blended-learning media choice. The students followed the CSCL scripting – epistemic script for the formal, collaboration script for the informal component of the seminar – as expected, which successfully sustained the learning process.

Second, the Social Learning Analytics tools were helpful for directing the students to OKCs that not only addressed relevant topics, but that were also open to newcomers. Additionally, automatically extracted collaboration indices were used to better understand communication in OKCs, and to prepare successful inquiries, or to understand why some OKCs did not respond.

However, the full potential of Social Learning Analytics in general, and of the employed dialog analysis tools in particular, has not yet been entirely used. In the near future, research and development in the field of Instructional Design should refine both the analysis tools, and the communication strategies, i.e. the collaborative CSCL scripts that complement the analysis tools. Besides the further development of the presented seminar, it is planned to use the concrete results of this seminar, and especially the experimentally accumulated knowledge about the OKC integration of the seminar participants to enhance the current OKC integrativity models [29, 30, 31, 32].

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