Joining Informal Learning in Online Knowledge Communities and Formal Learning in Higher Education: Instructional Design and Evaluation of a Blended-Learning Seminar with Learning Analytics Support

Nicolae Nistor[1,2], Mihai Dascalu[3,4], Stefan Trausan-Matu[3,4]

[1] Ludwig-Maximilians-Universität, Leopoldstr. 13, D-80802 München, Germany
nic.nistor@uni-muenchen.de
[2] Walden University, 100 Washington Avenue South, Minneapolis, MN 55401, USA
[3] University Politehnica of Bucharest, 313 Splaiul Independenței, 60042, Bucharest, Romania
[4] Academy of Romanian Scientists, 54 Splaiul Independenţei, 050094, Bucharest, Romania
{mihai.dascalu, stefan.trausan}@upb.ro

Abstract. The use of online knowledge communities (OKCs) as informal learning environments in connection with formal learning 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). This paper proposes B-LABS (Blogs and Learning Analytics Based Seminar), a higher education seminar with a formal component as a face-to-face seminar, and an informal component comprising learning in OKCs. B-LABS was carried out with N = 65 undergraduate students. SLA tools were employed to select responsive OKCs that were likely to integrate newcomers. The students successfully followed the B-LABS script; learning outcomes included students' insight in mathematics didactics, and knowledge of OKC specific educational approaches. Student acceptance of the learning environment was predicted by performance expectancy and perceived social influence. Future development includes refining functions predicting the likeliness of OKC newcomer integration.

Keywords: improving classroom teaching; online knowledge building communities; media in education; pedagogical issues; post-secondary education.

1 Introduction

Creating new learning spaces with smart technologies is a current goal of the learning sciences [1, 2, 3]. Recently, several authors envision an integration of formal and informal learning as a way of renewing formal education [4, 5, 6, 7]. The same authors ascribe a central role to knowledge communities in this integration.

In this vein, Greenhow and Lewin [4] adapt a model by Malcolm, Hodkinson and Colley [8] to define formal and informal learning against the background of social media attributes. Accordingly, formal learning is intentional, externally determined and meant for closed audience; whereas informal learning is casual, self-determined (e.g., within knowledge communities), and the audience for learner-generated content may be open. The formal learning process is initiated, led and supported by authoritative teachers, the informal is supported by peers and based on democratized expertise. Formal learning is located in educational institutions, with explicit goals, curriculum and certification; whereas informal learning is focused on everyday practice with flexible or serendipitous outcomes. Although these attributes may seem to be opposites at first sight, Greenhow and Lewin [4] observe that they can actually coexist, and that social media (e.g., blog technologies) can support this coexistence by mediating the socio-cognitive interactions that are typical for knowledge communities.

Online knowledge communities (OKC) supported by social media prove beneficial for knowledge sharing and knowledge building, mostly in informal learning settings [9, 10], but in some cases also for academic help-seeking [11]. 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 such as OKCs were sharply criticized for their minimal instructional guidance that may cause learners' cognitive overload [12]. Indeed, OKCs are informal learning environments and, per definition, no instructional guidance is provided. Research literature (see overview by Hod, Bielaczyc and Ben-Zvi [9]) 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 [13], which implies that newcomers integrate in the socio-cognitive community structures [14, 15]. This, in turn, is a matter of long-term interaction with no guarantee for success. Integration failure would be a waste of resources, mostly inacceptable 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 [16], the newcomer integration issue is still open. Keeping in mind these considerations, a higher education seminar, B-LABS (Blog and Learning Analytics Based Seminar) was developed. Its instructional design unites 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 [17, 18] are used to analyze the OKC discourse and provide participants with an overview of participation and collaboration. Thus, SLA is applied in an attempt to solve the newcomer integration issue.

This paper has two main goals, both related to learning design. Firstly, it proposes the theoretical and empirical foundations of the B-LABS instructional design, and the design itself. Secondly, the paper provides B-LABS evaluation results with respect to the two issues addressed above: (1) how learners successfully deal with the challenges of the open learning environment, especially with reduced guidance, and (2) how far the newcomer integration issue could be solved using SLA tools. The innovation proposed here, in the sense of creating new learning spaces with smart technologies [1, 2, 3], consists of an SLA application in blended learning context. More specifically, SLA tools were part of the instructional design, but played no particular role in the evaluation of this design.

2. Addressing the Minimal Guidance Issue: SCOLE and Inquiry Learning

Under constructivist influence, Hannafin, Hill, Land, and Lee [19] defined student-centered open learning environments (SCOLEs) as a synthesis of several instructional approaches, such as problem-based learning [20], anchored instruction [21], inquiry learning [22], or situated learning [13]. 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. From these, Web 2.0 technologies, and particularly blogs are already well established (e.g., Hall [23]). Johnson [24] recommends Learning Analytics for identifying expert performers and mechanisms that mediate expert performance. In an OKC, for instance, the central participants may be the expert performers, and performance may be mediated by newcomer integration [14] and by legitimate peripheral participation [14].

Kirschner, Sweller and Clark [12] point out a first prominent issue of SCOLEs: their '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 substantial learning. A moderate position is recommended by Taber [16] as 'optimally guided instruction', 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 [22], an instructional design that is both minimally guided and, at the same time, scaffolded by the teacher [20]. Slotta, Tissenbaum, and Lui [25] combine this with OKCs. The resulting approach called 'Knowledge Community and Inquiry' comprises self-directed exploration of complex immersive environments, doubled by guided reflection.

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 [23]. Several bloggers can bring together and form a community dedicated to a certain topic or practice. Similarly to communities of practice [13], participation in OKCs and blogger communities is typically reflected in a socio-cognitive structure comprising central and peripheral members [26]. Mainstream research [13] 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., Karabenick and Puustinen [11]) describe OKCs as help-seeking communities in which help-seekers are the most active, thus most central, but not the most knowledgeable members.

Learning in OKCs takes place as legitimate peripheral participation [11]. Hence, learners must be first integrated as newcomers in these OKCs. Eberle, Stegmann, and Fischer [14] 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 and Serafin [15] find similar strategies in blogger communities.

From their social-constructivist perspective, Lave and Wenger [13] 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 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 blog discussion forums and assessing dialog characteristics, mainly collaboration and textual complexity [27]. Blog discussion forums had been crawled using BlogCrawl [28], a crawler specialized in content extraction from blogs, MOOCs, or discussion forums. BlogCrawl created data corpora to be further used in educational research studies. It extracted content from specified segments of a digital environment in four stages: (1) URI discovery was performed using a Java open-source, multi-threaded web crawler – crawler4j (https://github.com/yasserg/crawler4j); (2) crawled data were normalized by extracting authors, dates and useful content, and eliminating ads, commercials, hidden texts, and cross-references; (3) a standardized dialogue structure consisting of turns and utterances was imposed, enabling the identification of links between contributions (i.e., posts and comments), participants, and the conversation timeline; (4) data were saved in an appropriate format, e.g. XML.

The crawled data were further processed using ReaderBench [27]. Collaboration was automatically evaluated based on a polyphonic voice inter-animation model [29] and cohesion network analysis (CNA) [30]. CNA used the cohesion graph, the underlying multi-layered discourse structure reflective of both local and global cohesion, which considers the semantic relatedness at inter- and intra-contribution levels. From a computational perspective, cohesion was evaluated with respect to lexicalized ontologies (WordNet), Latent Semantic Analysis (LSA) vector spaces, and Latent Dirichlet Allocation (LDA) topic distributions [27]. After building the interaction graph, multiple participation and collaboration indices were computed by applying specific Social Network Analysis (SNA) [31] centrality measures. Individual collaboration scores were used to find the most collaborative OKC members – expert performers, as designated by Johnson [24] – who are more likely to respond to inquiries, thus mediating the acquisition of expertise and the expert performance.

Examining the influence of the newcomer 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 [32]. A further experimental study [33] confirmed the role of inquiry format only in blogger OKCs with low topic complexity. In contrast, in OKCs with high complexity topics, the community response solely depended on the previously established dialogue quality. In a larger perspective, topic complexity, socio-cognitive structure, and automatically assessed dialog characteristics were shown to predict newcomer integration at community level [26].

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 the dialog quantity and quality. As for the inquiry format, newcomers should ask focused, on-topic questions and, more generally, observe the specific OKC netiquette that can be different across communities. While posting inquiries, newcomers may specifically address the OKC members with higher individual collaborative scores.

4. Consequences for Instructional Design and Evaluation

Summarizing the considerations provided above, social media have the potential to renew traditional education [4] by creating smart learning spaces that integrate formal and informal learning, which in turn can be accomplished by joining formal higher education courses with informal learning in OKCs. However, such instructional design may imply the need for learning guidance [12] and issues with newcomer integration [14, 15]. We propose that the learning guidance necessity can be solved by design, in the sense of optimally guided instruction [16], while the newcomer integration issue can be addressed using SLA tools [26, 33].

Nevertheless, such smart learning spaces require evaluation studies to prove whether the two issues named above are indeed solved [34]. A basic, but ubiquitarian model formulated by D. and J. Kirkpatrick [35] establishes four evaluation levels: reaction, learning, behavior, and results. Accordingly, learners' positive reactions, such as their acceptance of a learning space [36], are prerequisites of their learning about relevant resources, requirements, and particularities of a specific learning environment. Learning produces improved behavior, particularly following a proposed learning scenario. Finally, the results will show how far the initially set learning goals have been reached. In our case, we assume that indicators of the learning guidance issue can be found at all four levels, whereas indicators of the newcomer integration issue are mainly present at the upper levels of Kirkpatrick's pyramid, i.e., at behavior and results levels. Positive evaluation outcome would indicate a well-functioning learning space, which in turn would confirm the appropriateness of the adopted instructional design.

5. Research Questions

Against the background of the evaluation model outlined above [35], the following study aims to assess the educational quality of the instructional design of a smart learning space joining informal learning in online knowledge communities and formal learning in higher education. The evaluation followed three overarching questions:

Research Question (RQ) 1: What are students' attitudes and perceptions of B-LABS? This RQ aims to detect possible learning guidance issues at Kirkpatrick's reaction level. In particular, RQ1 addressed (a) students' generic perceptions of the seminar, (b) the influence of demographic and contextual data, as well as (c) the influence of community response on these perceptions, (d) students' acceptance of blogs as learning environments, including its attitudinal predictors, and (e) the influence of B-LABS participation on students' acceptance.

RQ2: How far can students follow the recommended learning scenario? This RQ targets the detection of possible learning guidance issues at Kirkpatrick's learning and behavior levels, and newcomer integration issues at behavior level.

RQ3: What are the cognitive effects of the seminar? This RQ aims to detect possible learning guidance and newcomer integration issues at Kirkpatrick's results level. The RQ included (a) generic results, such as perceived learning effects and test results, (b) the influence of demographic and contextual data, as well as (c) the influence of community response on these results, (d) the predictors of the perceived seminar difficulty, and (e) the influence of B-LABS participation on the cognitive effects.

6. Methodology

Research Design. To keep the evaluation simple and easy for the students, it was conceived as a field study, mostly based on quantitative measurements, with qualitative additions. Besides assessing simple indicators such as test results, for this evaluation a pre-post design was chosen, complemented by a comparative and correlative design, and a qualitative record of instructor's notes. A causal comparison between treatment and reference groups, usually seen as the typical and most frequent evaluation design, was regarded as inadequate for a first evaluation, especially because of the academic setting, in which all seminar groups were supposed to receive the same treatment.

Participants. A number of $N = 65$ undergraduate students participated in the seminar, from which 57 (51 females and 6 males; all between 20 and 21 years old, and in the second study semester; 31 having Educational Sciences as a major, 26 as a minor) responded to the first evaluation survey, and 45 (42 females, 2 males, 1 missing data) to the second. The entire participant group was divided into three seminar groups; 13 survey respondents participated in the first, 19 in the second, and 25 in the third. Each of the three seminar groups was further divided in six workgroups of 2-5 persons.

Learning Environment Design. Based on the considerations presented in the introduction and theoretical sections, a higher education seminar called B-LABS (Blog and Learning Analytics-Based Seminar) was conceived and offered to undergraduate students of Educational Sciences at a large German university, accompanying the lecture "Teaching and Learning". The seminar provided an overview on educational technology applications in teaching mathematics in US American schools, to extend participants' knowledge of learning and communication approaches in OKCs. The seminar targeted the increase of students' acceptance of blogger OKCs as learning environments and to provide students with a first insight into Learning Analytics.

These goals were planned to be reached by participants, who were integrated as newcomers by participating in the discourse of adequate OKCs. More specifically, the instructional design comprised a formal component (traditional higher education seminar, led by an 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. They asked questions on the given topic in the targeted OKCs, thus attempting to be integrated as newcomers in these math teacher communities. The formal and the informal components were incorporated as 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 term weeks, the cycle was repeated for three times, after which the participants presented the achieved results, and the seminar was closed.

Students were requested to work in collaborative small groups. Collaboration within groups comprised:

- Reading recommended research literature;
- Presenting educational theories and empirical studies in the seminar sessions;
- Observing blogging activity while applying 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).

B-LABS was designed for blended learning, such that the formal component took place face-to-face, while the informal component occurred in an online setting. The former was provided as weekly seminar meetings, the latter as blog discussions. Additionally, approximately 100 thematically pre-selected blogs were crawled and automatically analyzed. Thus, 18 blogs with most intensive dialog were chosen, and data describing the individual participation, collaboration and textual complexity of all discussants were provided to learners.

The B-LABS schedule included: (1) introduction and group building (week 1); (2) literature review and presentation (weeks 2-3); (3) observations in the blogger communities and preparing the first inquiry (weeks 4-6); (4) posting the inquiry and subsequently discussion in the OKCs (weeks 7-8); (5) reflecting on the results and preparing the second inquiry (weeks 9-10); (6) reflecting on the results, preparing and posting the third inquiry (weeks 11-12); and (7) the final results presentation and discussion (weeks 13-14).

Variables. According to the RQs, independent variables (IVs) were Community Response (a categorical, dichotomous variable describing whether or not a working group had received answers from the inquired blogger OKC), participation in the seminar as a time-oriented variable (i.e., data points before and after the seminar), and demographic and contextual variables (sex, seminar group, study major). Dependent variables (DVs) were students' perceptions of the seminar, their acceptance of blogs as learning environments (attitudes, use intention and use behavior), and the cognitive seminar effects (self-reported learning effect, test results, and perceived degree of difficulty).

Instruments. To measure students' evaluative perceptions, they were asked how interesting (Ev1), well-done (Ev3) and pleasant (Ev4) they found the seminar; after removing Ev2 (degree of difficulty) for separate use, this ad-hoc developed scale was reliable (Cronbach's $\alpha = .84$). Acceptance variables were measured using the UTAUT instrument [37], translated and validated in German language by Nistor, Lerche, Weinberger, Ceobanu and Heymann [36]. Attitudinal variables were performance expectancy (PE), effort expectancy (EE), and social influence (SI); additionally, use intention (UI), use behavior (UB), perceived facilitating conditions (FC), and computer anxiety (CA) were measured. These variables were also reliable, with Cronbach's α values between .68 and .91. The complete questionnaire is provided in Appendix.

To measure the perceived learning effect, another scale was developed ad hoc, asking the participants how much they think they have learned in the seminar with respect to blogging-related technical skills (K1), adequate communication strategies (K2), knowledge about learning in OKCs (K3), and social and educational-psychological processes in OKCs (K4). This scale (K), reuniting K1 to K4, proved reliable with $\alpha = .87$ and .89 at the first and second data point, respectively. Finally, the participating students were asked how difficult they found the seminar. All survey questions could be answered on a seven-point Likert scale from 1 = strongly negative to 7 = strongly positive perceptions or cognitive effects.

The final test was part of the written examination, and included three tasks: State the learning theory of Lave and Wenger [13] about participation in communities (knowledge reproduction task); explain how this applies in the case of learning in blogger OKCs (knowledge application task); and describe a learning environment combining formal with informal learning in OKCs for learning goals and a target group of your choice (design task). The students could get a maximum of 10 points per question. The average number of points was used in the following as a scale of acceptable reliability ($\alpha = .65$).

On the qualitative side, a list of activities was used in the manner of a checklist for participant observation to observe how far the students were following the recommended learning scenario [38]. Participants' comments on the activities made during the formal B-LABS meetings were recorded. The checklist verified the activities in B-LABS participant took part:

- Reading about, and presenting theoretical aspects;
- Observing the same aspects in the OKC;
- Initiating and sustaining discussions with the assigned OKC by asking questions and eliciting information on given subjects;
- Observing and reflecting upon their own way of communicating with the OKC;
- Explaining which online behavior yielded OKC responses, or not;
- Acquiring knowledge related to the B-LABS topics.

Data Collection and Analysis. The first questionnaire (acceptance and cognitive effects) was administered after the literature review and presentation (weeks 2-3). Instructor's (i.e., author's) notes were recorded during the entire seminar. The second questionnaire (acceptance, cognitive effects, and seminar perceptions) was administered after seminar completion and written examination (week 14). Survey participation was voluntary and anonymous, based on students' informed consent. All quantitative data were processed using IBM SPSS Statistics version 24, using descriptive statistics, t-test for dependent samples, one-way ANOVA and multiple regression analysis as specified in Table 1. On the qualitative side, category occurrences were counted, and the related comments were summarized.

An overview of the research questions and methodology is provided in Table 1.

Table 1. Overview of the research questions and methodology of the evaluation study

Potential issues		Kirkpatrick's evaluation levels	Research questions	Variables	Data analysis
Learning guidance issues	Newcomer integration issues				
X		Reaction	RQ1: What are students' attitudes and perceptions of B-LABS?	IVs: Demographic data (sex), contextual data (seminar group, study major), participation in seminar (data point) DVs: B-LABS acceptance (effort expectancy EE, social influence SI, facilitating conditions FC, computer anxiety CA, use intention UI, use behavior UB), evaluative perceptions towards B-LABS Ev	RQ1a: Descriptive statistics RQ1b: One-way ANOVA RQ1c: t-test for dependent samples RQ1d: Multiple regression analysis
X		Learning	RQ2: How far can students follow the recommended learning scenario?	Executing recommended activities; students' comments on these activities	Counting participant percentage executing recommended activities, summarizing comments
X	X	Behavior			
X	X	Results	RQ3: What are the cognitive effects of the seminar?	IVs: Demographic data (sex), contextual data (seminar group, study major), participation in B-LABS (data point), community response DVs: Self-reported cognitive effects K1-4, test results (points for theory reproduction, theory application, and design task), perceived B-LABS difficulty	RQ3a: Descriptive statistics RQ3b: t-test for dependent samples RQ3c: One-way ANOVA RQ3d: One-way ANOVA, multiple regression analysis RQ3d: One-way ANOVA, multiple regression analysis RQ3e: t-test for dependent samples

7. Findings

RQ1: Student Attitudes and Perceptions

RQ1a: Student attitudes and perceptions of the seminar. At both data points, the students reported moderate expectations of performance and effort towards blogger OKCs as learning environments, and low to moderate social influence. They perceived moderate to good facilitating conditions, and moderate to low computer anxiety. Their use intention and use behavior towards blogger OKC were also moderate, and their evaluative perceptions of the seminar were good (see Table 2).

Table 2. Students' attitudes and perceptions of the seminar; differences were tested using the t-test for dependent samples

	Data point	*M*	*SD*	*T*	*df*	*p*
Performance expectancy (PE)	1	3.56	1.21			n.s.
	2	3.40	0.96			
Effort expectancy (EE)	1	3.91	1.27	4.723	44	<.001
	2	4.83	1.08			
Social influence (SI)	1	3.02	0.92			n.s.
	2	2.85	0.97			
Facilitating conditions (FC)	1	4.56	1.32	4.005	44	<.001
	2	5.46	1.16			
Computer anxiety (CA)	1	3.31	1.48	-3.485	44	.001
	2	2.73	1.33			
Use intention (UI)	1	3.79	1.26	-3.993	44	<.001
	2	2.93	1.24			
Use behavior (UB)	1	2.70	1.46			n.s.
	2	2.51	1.46			
Evaluative perceptions (Ev)	2	4.16	1.20	–	–	–

RQ1b: The influence of demographic and contextual data. A few differences in the acceptance variables were found between sexes. Social influence was generally perceived higher by male than by female students (data point 1: male $M = 3.96$, $SD = .89$; female $M = 2.91$, $SD = .86$; $df = 55$, $F = 7.834$, $p = .007$; data point 2: male $M = 4.08$, $SD = 1.01$; female: $M = 2.76$, $SD = .92$; $F = 5.715$, $df = 43$, $p = .02$). Similarly, at the beginning of the seminar, facilitating conditions were perceived higher by male than by female students (male: $M = 6.00$, $SD = .89$; female: $M = 4.39$, $SD = 1.26$; $F = 9.179$, $df = 55$, $p = .004$). Finally, at the end of the seminar male students reported higher use intention of blogger OKCs as learning environments than female students (male: $M = 4.33$, $SD = 1.51$; female $M = 2.83$, $SD = 1.17$; $F = 4.450$, $df = 43$, $p = .04$). There were no significant differences between seminar groups. As for differences across disciplines, participants studying Education as a minor reported higher initial computer anxiety (data point 1) than those studying Education as a major (minor: $M = 4.00$, $SD = 1.54$; major: $M = 3.06$, $SD = 1.32$; $F = 4.822$, $df = 43$, $p = .03$).

RQ1c: The influence of B-LABS participation. A few acceptance variables changed during students' participation in the seminar. As showed in Table , participants' effort expectancy and perceived facilitating conditions significantly increased, while the reported computer anxiety and use intention decreased with the seminar participation.

RQ1d: Predictors of B-LABS acceptance. The UTAUT model could be verified better at the first than at the second data point. At the beginning of the seminar, participants' use intention was predicted by PE ($\beta = .42, p = .002$) and SI ($\beta = .28, p = .02$), with no significant influence of EE. Thus, the model cleared adj. $R^2 = .40$ of the variance in use intention. Further, students' use behavior of blogger OKCs as learning environments was predicted by UI ($\beta = .40, p = .002$) and FC ($\beta = .26, p = .04$), with no significant influence of CA. The model explained adj. $R^2 = .29$ of variance in use behavior. At the end of the seminar, PE and SI predicted participants' use intention even better with adj. $R^2 = .53$ of the variance in use intention (PE: $\beta = .39, p = .002$; SI: $\beta = .46, p = .000$; EE n.s.). However, the model indicated no significant predictors of UB at data point 2.

RQ2: Instructor Perceptions of the Learning Process

The B-LABS participants complied to a high degree with the seminar scenario, which was perceived as close to their everyday study activities. 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. As a conclusion, they pointed out essential requirements for their inquiries, i.e., posting on-topic comments, complying with the netiquette, explicitly addressing the central OKC members, using a limited number of concepts when phrasing their questions.

Two thirds of the participant groups (12 of 18) could successfully initiate and sustain productive discussions with the assigned OKCs. Subsequently, the students could find plausible explanations for the OKC response, thus either identifying the success factors of their communication strategy, or hypothesizing why an OKC did not respond. The contact failure with 6 of 18 OKCs was mainly due to the sudden inactivity of the blog owners (e.g., for newborn babies or for religious reasons).

In the final discussion, many B-LABS participants reported having obtained a significant insight into the didactics of mathematics; however, in some blogs the mathematical contents exceeded the seminar participants' knowledge. Consequently, they sometimes had to avoid discussions on purely mathematical topics, and focus on the applications of educational technology used in the mathematics classes of the teacher who participated in the discussions. In the end, the B-LABS participants felt they have received an insight into Social Learning Analytics, so that they could understand analysis results of the blogs they worked with, and use the dialog's textual complexity indices to identify the central and peripheral OKC participants.

RQ3: Cognitive Effects

RQ3a: Generic cognitive effects. Students' self-reported knowledge on the seminar topics was moderate at the first data point and good to very good at the second, as shown in Table 2. **RQ3b**: The influence of demographic and contextual data. Significant differences in the cognitive effects could not be found between sexes or between seminar groups. As for disciplines, students studying Education as a major (M = 3.61, SD = 1.54) reported less initial knowledge on the seminar topics than students who studied Education as a minor (M = 4.46, SD = 1.56; F = 4.249, df = 55, p = .04). A similar difference was also found in the overall self-reported knowledge at data point 1 (major: M = 3.77, SD = 1.18; minor: M = 4.45, SD = 1,34; F = 4.145, df = 55, p = .047). However, significant differences in the self-reported knowledge were not found at the end of the seminar (data point 2), nor in the final test results.

Table 2. Self-reported B-LABS cognitive effects (K1 to K4 are survey items; K is the average of K1 to K4; differences were tested using the t-test for dependent samples)

Variables	Items	α	Data point	N	M	SD	T	df	p
K1	1	-	1	45	4.07	1.41	5.889	44	<.001
	1	-	2	45	5.51	1.39			
K2	1	-	1	45	4.13	1.47	7.962	44	<.001
	1	-	2	45	5.93	1.20			
K3	1	-	1	45	4.29	1.34	3.456	44	.001
	1	-	2	45	5.2	1.47			
K4	1	-	1	45	4.51	1.44	2.377	44	.022
	1	-	2	45	5.09	1.55			
K	4	0.87	1	45	4.25	1.12	6.360	44	<.001
	4	0.89	2	45	5.43	1.23			

RQ3c: The influence of community response. In the performance at the theory reproduction and theory application tasks there were no significant differences between student work groups who did, and those groups who did not, receive a response from the assigned OKCs. As for the design task, groups who did not receive any response performed better than groups who received OKC response, but this difference was only marginally significant (see Table 3).

RQ3d: Predictors of perceived seminar difficulty. The B-LABS participants perceived a moderate difficulty degree (M = 3.73, SD = 1.44), with a significant difference between students studying Education as a major (M = 3.17, SD = 1.24) and those studying Education as a minor (M = 4.38, SD = 1.40; F = 9.559, df = 44, p = .003). No significant differences by sex or seminar group were found. The perceived difficulty was predicted to R^2 = .17 by students' computer anxiety, such that the initial CA was a weak but significant (β = .33, p = .04), and CA at the end of the seminar a very weak and non-significant (β = .19, n.s.) predictor of the perceived difficulty.

RQ3e: The influence of B-LABS participation. Students' self-evaluation of knowledge changed in all its dimensions after the seminar, as compared to the initial self-report. At the end, students reported significantly higher knowledge than at the beginning of the seminar (see Table 2).

Table 3. Test results and differences by received community response (tested using one-way ANOVA)

Variables	Items	α	Received community response	*N*	*M*	*SD*	*F*	*df*	*p*
Points for theory reproduction	1	-	no	15	7.20	2.46			n.s.
			yes	37	7.86	2.21			
			entire sample	52	7.67	2.28			
Points for theory application	1	-	no	15	6.00	2.65			n.s.
			yes	37	6.92	2.77			
			entire sample	52	6.65	2.74			
Points for design task	1	-	no	15	8.07	2.28	25.747	51	.084
			yes	37	6.51	3.08			
			entire sample	52	6.96	2.94			
Points in total	3	0.65	no	15	21.27	5.56			n.s.
			yes	37	21.30	6.45			
			entire sample	52	21.29	6.15			

8. Summary of Findings and Discussion

This paper proposed the instructional design and first implementation of B-LABS, a higher education seminar uniting formal and informal learning in OKCs with SLA support. The instructional design aimed to address the minimal guidance issue [12] and the newcomer integration issue [14, 15] that might have occurred. The evaluation was performed using Kirkpatrick's [35] framework that assessed the instructional quality at students' reaction, learning, behavior, and results levels. Our evaluation also included the identification of possible guidance and newcomer integration issues. Positive evaluation results attest appropriate educational quality for B-LABS, showing students' positive attitudes and perceptions, their compliance with the seminar script, and positive, self-reported, as well as objectively measured learning effects. These results suggest that no guidance and newcomer integration issues had occurred; hence, B-LABS displayed high educational quality.

Students accepted B-LABS to a moderate degree, and this acceptance was mainly predicted by students' expectancies of increased performance, and by social influence [36, 37]. This factor structure was found at the end of the seminar, as well, however it no longer predicted students' self-reported usage of blogger OKCs as learning environments [39], probably because the mandatory use in the seminar led them to a more critical or realistic view of the personal needs and use of educational technologies. This may also explain the decreased use intention at the end of the seminar. On the one hand, this finding can be interpreted as the reflection of an increase in students' media literacy that, in turn, leads to more critical thinking towards the personal use of the blog technology [40]. On the other hand, the finding points at a limitation of the current acceptance models involving subjective data [39].

The B-LABS scenario was successful, meaning that the students could follow it without notable issues. Moreover, two thirds of the working groups could successfully integrate in blogger OKCs, and thus access the community knowledge. Failure to do so was due to sudden inactivity of the blog owner. In addition, the higher level of discussed mathematics was an issue for some Education students who could hardly follow.

A prominent outcome was the increase in students' self-reported and tested domain knowledge. Keeping in mind that initially, according to their academic curriculum, the students did not have any particular knowledge related to the seminar focus, the 75% performance at the final knowledge test can be regarded as very good. Surprisingly, the few work groups that received no community response performed better (although only marginally significant) at the design task. A possible interpretation of this finding may be that those students have spent more time on task, reflecting on the blog environment and trying to find a way to get in contact with the OKC.

The participation effects suggested by the findings noted above were complemented by several effects of individual traits and contextual variables. Male students reported more positive attitudes and higher acceptance than females. Students of Education reported less initial knowledge, and less computer anxiety than students of other disciplines. Computer anxiety increased the perceived difficulty, hence participants who studies Education as a minor found the seminar more difficult.

While the evaluation results suggest that B-LABS is a high-quality instructional design with potential for educational practice, the present findings are first and foremost limited by the pilot character of this evaluation. Larger scale implementations and evaluations are needed to confirm and extend this experience. Moreover, privacy and personal data protection did not allow testing relationships such as those between individual attitudes and community response. With regards to educational research, a notable limitation of this study is that it only uses a generic evaluation framework without trying to disentangle the effects of various design elements. Future research is needed to eliminate the related causal factor confounds, thus better understanding learner activity at the confluence of formal and informal learning.

9. Conclusions

Altogether, the Social Learning Analytics based seminar of Educational Sciences was a definitely positive experience that suggests several conclusions. From an instructional design perspective, the seminar concept reached a productive balance between minimally and fully guided instruction, possibly optimal guidance in the sense of Taber [16], thus avoiding learning guidance [12], and newcomer integration issues [14, 15].

From a Social Learning Analytics perspective [18, 24, 33], the LA tools were helpful for directing the students to OKCs that not only addressed relevant topics, but that also entertained lively discussions on these topics. Moreover, automatically extracted collaboration indices were used to better understand communication and to identify expert performers [24] in the targeted OKCs, and to prepare successful inquiries, or in some cases to understand why some OKCs did not respond. However, the full state-of-the-art potential of Social Learning Analytics in general [18, 33], and of the employed dialog analysis tools in particular, have not yet been entirely used. For instance, OKCs available on a certain topic could be more sharply selected, additionally including the prediction how likely the OKC will integrate newcomers [33]. Besides refining the tools with these functions, follow-up research and development should concentrate on the communication strategies the students employed to integrate in OKCs [14]. Further, 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 [33].

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Appendix: Evaluation Questionnaire

PE1	I would find blogger online knowledge communities (B-LABS) useful for my study.
PE2	Using B-LABS enables me to accomplish tasks more quickly.
PE3	Using B-LABS increases my productivity.
PE4	If I use B-LABS, I will increase my chances of getting good grades.
EE1	When I use B-LABS it is clear what I have to do.
EE2	It would be easy for me to become skillful at using B-LABS.
EE3	I would find B-LABS easy to use.
EE4	Learning to operate B-LABS is easy for me.
SI1	People who influence my behavior think that I should use B-LABS.
SI2	People who are important to me think that I should use B-LABS.
SI3	My university has been helpful in the use of B-LABS.
SI4	In general, my university has supported the use of B-LABS.
FC1	I have the resources necessary to use B-LABS.
FC2	I have the knowledge necessary to use B-LABS.
CA1	I feel apprehensive about using the computer as a learning tool.
CA2	It scares me to think that I could lose a lot of information using the system by hitting the wrong key.
CA3	I hesitate to use B-LABS for fear of making mistakes I cannot correct.
CA4	B-LABS are somewhat intimidating to me.
UI1	I intend to use B-LABS in the next months.
UI2	I predict I would use B-LABS in the next months.
UI3	I plan to use B-LABS in the next months.
UI4	I would recommend my friends and fellow students to use B-LABS.
UB1	I regularly use B-LABS.
UB2	I use B-LABS for my study.
Ev1	I found the contents of this seminar interesting.
Ev2	This seminar was difficult for me.
Ev3	This seminar was well-done.
Ev4	I liked to participate in this seminar.