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Cognitive presence in virtual collaborative learning
Assessing and improving critical thinking in online discussion forums

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Abstract

Purpose – The purpose of this study is to introduce a virtual collaborative learning setting called "Net Economy", which we established as part of an international learning network of currently six universities, and present our approach to continuously improve the course in each cycle.

Design/methodology/approach – Using the community of inquiry framework as guidance and canonical action research (CAR) as the chosen research design, the discussion forum of the online course is assessed regarding its critical thinking value. We thereby measure critical thinking with the help of the according model provided by Newman *et al.* (1995), which differentiates 40 indicators of critical thinking from 10 different categories.

Findings – The calculated critical thinking ratios for the analyzed two discussion threads indicate a strong use of outside knowledge, intensive justification and critical assessment of posts by the students. But at the same time, there are also weak spots, like manifold repetitions. Based on these results, we derive changes for the next course cycle to improve the critical thinking of the students.

Originality/value – A comparison of the results after the next course cycle will then allow us to assess the effects of the implemented changes, which would not be possible without a critical thinking diagnosis approach.

Keywords Higher education, e-Learning, Communication technologies, Critical thinking, Community of inquiry, Discussion forums

Paper type Research paper

Introduction

Learning with new media is becoming increasingly popular in times of Massive Open Online Courses (MOOCs) and a continuing growth in the use of mobile devices. Outside the traditional classroom, learning can spread to more diverse settings, contexts and locations. As at the same time, virtual collaboration is gaining significance in business; virtual collaborative learning (VCL) as a sophisticated type of e-Learning setting gains growing attention in both research and higher education practice. The accompanying pedagogical and technological innovations thereby create new challenges for the instructors and also redefine their roles.

Successful e-Learning requires learning environments that motivate the students and facilitate meaningful and worthwhile learning. A suitable design and a well-structured learning process need to consider social, technical and didactic challenges as interdependent dimensions of a good learning experience (Garrison, 2011). VCL settings thereby aim at the skills that are required and considered

indispensable for virtual collaboration, involving team members working from various international locations and with heterogeneous cultural and educational backgrounds.

This paper introduces our own VCL learning scenario "Net Economy" as part of a continuous build-and-evaluate loop, while our improvement efforts follow the iterative steps of canonical action research (CAR): diagnosis, action planning, intervention, evaluation and reflection (Davison *et al.*, 2004; Susman and Evered, 1978). Action research is committed to "[…] the production of new knowledge through the seeking of solutions or improvements to 'real-life' problem situations" (McKay and Marshall, 2001). It thus serves both research and practice by studying the real world while considering a particular theoretical framework.

For our e-Learning action research, the community of inquiry (CoI) – as introduced by Garrison *et al.* (2000) – serves as the required theoretical framework, consisting of the three interdependent elements of social presence, cognitive presence and teaching presence. While social presence is "the ability of participants to identify with a group, communicate purposefully in a trusting environment, and develop personal and affective relationships progressively by way of projecting their individual personalities" (Garrison, 2011, p. 23).

Cognitive presence is "the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry" (Garrison *et al.*, 2001). Teaching presence, finally, is "the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes" and thus merges all elements in a balanced and functional relationship.

While in previous papers we developed solutions mainly for various problems of teaching and social presence, like the use of a dedicated social network instead of a learning management system, we have so far not explicitly addressed the e-Learning elements of the setting with regard to the required cognitive presence. According to the CoI framework, students need to be:

> […] engaged in a collaborative and reflective process which includes understanding an issue or problem, searching for relevant information, connecting and integrating information, and actively confirming the understanding (Garrison, 2011, p. 94).

Through sustained communication (Gunawardena *et al.*, 1997). An obvious instrument to do so seems to be discussion forums, which are therefore commonly used in e-Learning (Meyer, 2003). Computer-mediated communication tools, like discussion forums, provide ways for learners to interact. Research suggests that asynchronous online discussions are even superior with regard to critical thinking and knowledge co-construction, when compared to synchronous face-to-face discussions, due to the available time for reflection (Wang *et al.*, 2009; Meyer, 2003) and a less-spontaneous discourse (Garrison, 2011) and more critical, constructive and explicit contributions (Wang *et al.*, 2009). Online discussion facilitates interrelated posts and responses, as these can be reviewed systematically by the participants (Lapadat, 2002). On the other hand, in practice, it usually stays unassessed and questionable whether the initiated discussions really provided for the intended critical and reflective interaction among the participants and thus for cognitive presence.

In the following, we therefore measure and analyze the critical thinking ratio of the discussion forum that we established in our "Net Economy" setting as part of a required discussion task. Based on this diagnosis step, we will then derive interventions that aim at improving the critical and reflective thinking and thus the cognitive presence. After a short introduction of our VCL setting in Section 2, we will outline the theoretical background and related work in Section 3. The diagnosis approach, as adapted from Newman *et al.* (1995), and the assessment of critical thinking in our implemented discussion forum can be found in Section 4. In Section 5, we will then derive interventions as improvement suggestions for the next course cycle before we conclude in Section 6.

The net economy VCL setting

"Net Economy" is an annual cross-location VCL setting in the framework of an international learning network which we established in 2008. The setting targets participants with heterogeneous educational backgrounds in the fields of business and economics, business informatics, international economy and hotel & tourism management, as well as different cultural backgrounds from Germany (Berlin, Mühlheim an der Ruhr, Soest), Indonesia (Jakarta), Crimea (Simferopol) and Sweden (Kristianstad). The course is taught in English and deals with entrepreneurship and business models in the net economy. Between 80 and 150 students took part in each course cycle so far and worked in virtual intercultural teams on exercises concerning eBusiness models and virtual collaboration. All partners agreed on the general learning scenario, leading to a stable VCL concept which we systematically improve using the previously mentioned CAR approach.

"Net Economy" is a complete online class with only three parallel classroom meetings at the various locations at the beginning of the different phases of the course, as depicted in Figure 1. A closed social network (established with Wordpress
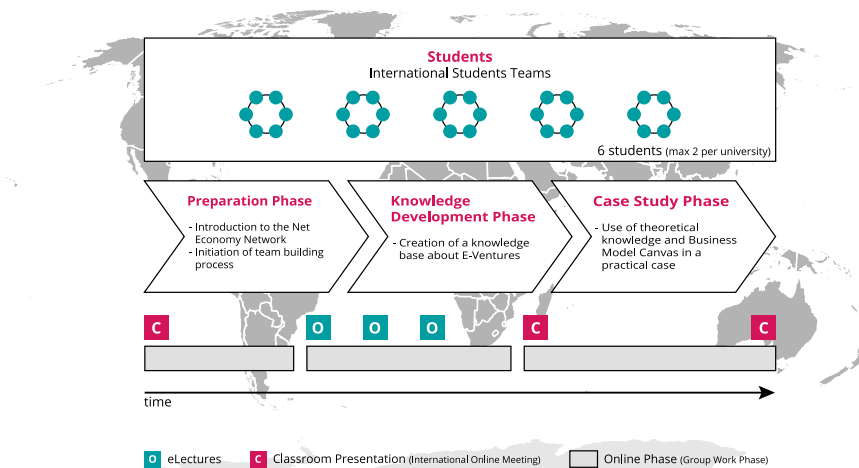

Figure 1.
The Net Economy learning scenario

and several plugins) serves as the major coordination platform for the course and facilitates social presence. Every student needs to set up a profile and join a team within the first weeks of the class, called preparation phase. During these weeks, the whole concept is introduced and the different tasks and roles within a team are described and assigned. The students team up to groups of five to six, in which every team member has a very specific role to fulfill. Only two members of the same university are allowed to be part of the same group so that a high diversity is given in each team. In the following knowledge development phase, the students are then introduced to some major characteristics, concepts and challenges of eCommerce and the Web 2.0 and to major types of business models on the Web. On each of the topics introduced by the instructors via eLecture, the individual students and the teams have to complete and submit assignments. Each participating location is responsible for one of these eLectures and an according online assignment. Knowledge development phase ends with a multiple-choice test on the topics covered in the eLectures. In the final case study phase, every team is then asked to apply the acquired knowledge and develop a business plan for an assigned business model type using the so-called business model canvas. This case study phase includes a peer-review process in which each team receives feedback from at least two other teams. The top-rated teams then present their business plan during a final live online meeting, in which all participants will vote for the top E-Venture of the class.

In the last course cycle accomplished between October 2014 and February 2015, students were asked to contribute to an online discussion individually as a first assignment. They could choose between two discussion threads on which they got a reading and had to write a first forum post pointing out their personal opinion and thoughts regarding the topics of the articles. In addition, they had to comment on at least two other posts and emphasize in their statements whether they support or rebut the post they are answering to, to facilitate critical and reflective thinking. Discussion Thread 1 discussed the online available WIRED article "The Web is dead. Long live the Internet" by Chris Anderson and Michael Wolff and initiated discussion with the question: "How does the article and the discussion around it reflect today's eCommerce trends and what consequences would you expect from the development for popular online businesses"? Discussion Thread 2 dealt with the online-available Fast Company article "Encyclopaedia Britannica (EB) is dead, long live Encyclopaedia Britannica", raising the question: "Why did the original business model have to change and how did the Encyclopedia Britannica adapt? Do you believe in the viability of the business model"? The not-any-further-moderated forum aimed to facilitate discourse and to make the students think critically about the provided articles.

In total, 80 members were registered on the "Net Economy" network in the last course cycle. Next to the lecturers, 13 teams of 5 active students, in total 65 students, were working on the platform. Fifty-six students (86 per cent) participated in this first individual assignment and 166 replies were posted, which are about three posts per participating student, indicating that the students fulfilled their task of writing one statement and two replies. To investigate the qualitative value of the forum posts, however, a closer look has to be taken at the posts themselves and a more qualitative analysis is required, as accomplished in the following chapters.

Theoretical background
Discussion forums in e-Learning
In comparison to face-to-face discussions, discussion forums in e-Learning differ in several key characteristics. The first and main difference is the separation of the instructor(s) and the learners in space and, due to the asynchronous format, also in time. Except in same cases by chance, usually no real-time interaction occurs between the discussants (Carswell and Venkatesh, 2002). At the same time, this means that the forum can be accessed and used at any time (Maurino, 2007; Salmon, 2011). One clear advantage of asynchronous discussion forums is that they provide time also for slow participation and that nobody is cut off from the interaction (Andresen, 2009) – students are able to participate at their own pace (Maurino, 2007). The participants are able to reflect the overall topic and the individual posts, as these stay visible all the time because of the developing transcript (Andresen, 2009; Salmon, 2011).

Based on a literature review, Andresen (2009) describes the following key components of successful asynchronous discussions:

- the instructor(s) need to engage the students in different ways, as emotion and passion are not directly visible;
- more precision and formality regarding the assignment are needed;
- the provided time for the discussion needs to be suitable;
- the nature of the discussion needs to be considered as decisive; and
- the chosen discussion topics need to be closely related to the learning material provided to the students.

In addition, the level of instructor intervention is also often discussed as central, as in Mazzolini and Maddison, (2003), who differentiate between the following roles that instructors can take:

- a prominent "sage on the stage" role;
- a more constructivist "guide on the side" role; or
- an ultra-low profile as "the ghost in the wings".

Online discussion forums also have well-known limitations, as summarized in Andresen (2009). For example, it is difficult to support problem-based learning (e.g. mathematical problems) with asynchronous discussion forums and different learning styles within the group of discussants (e.g. some prefer to work alone, others in groups; some tend to read more and stay invisible, others prefer writing and like to be in the spotlight, etc.) influence the discussion and the success of the forums. In addition, Maurino (2007) mentions the lack of facial expressions and of voice as guides for interpretation, what can cause misunderstanding and misinterpretation. Meyer (2003) argues that online discussions, in contrast to face-to-face discussions, may show a lack of speed, spark and energy.

In summary, asynchronous discussion forums can play an important role in online courses, as they provide a flexible way to let the students interact and discuss with each other. But to achieve a valuable discussion that fosters critical thinking and reflection, there are many challenges that need to be considered when deciding for the appropriate discussion setup.

Critical thinking
In the literature, many definitions of critical thinking can be found. According to the Foundation for Critical Thinking (2015), the word "critical" derives etymologically from two Greek roots: "kriticos" (meaning discerning judgment) and "kriterion" (meaning standards). Etymologically, then, the word implies the development of "discerning judgment based on standards". Ennis (1993) defines critical thinking as "reasonable reflective thinking focused on deciding what to believe or do". In his opinion, a person needs to, for example, judge the credibility of sources and the quality of arguments, identify conclusions, reasons and assumptions or develop and defend a position on an issue. Critical thinking therefore requires a wide set of information, generating processes and standards to base one's thinking on and relies on the person involved to have the intellectual commitment to make use of these skills and standards to guide his/her behavior.

Thus, critical thinking is a state of thinking that is beyond one's own, or even groups', interests and is dependent on the quality of standards and depth of experience the thinker has in respect to a particular problem or question. It also depends on different values and cultures, as differences in culture can have different effects and interpretations of being critical, as "in some cultures, being critical may be interpreted as 'argumentative' or 'being critical of others'" (Woo and Wang, 2009). Simplified, one can say that critical thinking involves seeking information, analyzing alternatives, evaluating the alternatives in relation to your aims and requirements and reaching a conclusion to the problem or answer.

In addition, critical thinking can also relate to other important areas in learning. Lai (2011), for example, says that "critical thinking skills relate to several other important student learning outcomes, such as metacognition, motivation, collaboration, and creativity". Being able to assess one's own arguments and reasoning is necessary for self-regulated learning. Tasks, which spark interest and are challenging the students, usually call for critical thinking and trigger motivation. Collaboration requires the students to think in diverse perspectives, and the more diverse they can think, the better collaborators they may become. Opportunities for collaboration may also encourage higher quality thinking itself. Finally, also creative thinking incorporates attributes of critical thinking, such as open-mindedness and flexibility. All these attributes enhance the learning experience for the students and stimulate intellectual and personal growth (Lai, 2011).

Related work
In their study, Mazzolini and Maddison (2003) examined the effect of instructor postings on student participation and perception of discussion forums. They found that frequent postings by instructors do usually not lead to more student postings. In addition, the more the instructors posted, the shorter the lengths of the overall discussion. Results of a following study in 2007 that focused on the quantity, the timing and the types of postings supported these initial findings. Analyzing a huge body of 40,000 postings in 400 discussion forums, Mazzolini and Maddison pointed out that the volume of postings cannot be interpreted as an indicator for the quality of a discussion. Quantity wise, like in the first study, they point out that instructor postings can influence the level of student participation in a negative way, with more instructor postings reducing the number of student postings. On the other hand, according to their study, frequent

postings from instructors influenced the students' evaluation of the according courses in a positive way. The students perceived a stronger enthusiasm and expertise of the instructor, the higher his/her level of participation in the online discussions. Students clearly liked frequent postings from their instructors, especially if they used follow-up, or socratic questions.

Arend (2009) explored in what way online discussions support critical thinking. In line with the findings of Mazzolini and Maddison (2007), she concluded that critical thinking turns out to be higher, when instructors contribute only infrequently to the forums and with rather objective postings. This is consistent with the literature on inquiry methods of teaching, known as the socratic method. Instructors should pursue a dialogue which supports the development of deeper understanding (Arend, 2009). They need to ensure that online discussions create a space and time for informal reflective thoughts, and they should not be focused on the frequency of their own posts but on provoking students with selectively spaced, neutral and probing questions. Garrison and Cleveland-Innes (2005), who state that instructors need to provide engaging questions and ensure that the discourse is progressive, support this and point out that the focus needs to be on the students rather than on the instructors. While there is a clear need for teaching presence that encourages participation, discussions should not end up being instructor centered. Cheng et al. (2011) address additional forms of participation in discussion forums. For example, they mention lurkers, as posting and replying to other postings are only a portion of the typical activities on discussion forums. Participants spend a lot of time reading the forum before contributing and reading replies to their own posts later on. Lurkers as "invisible students" only participate by reading, but not by posting (Beaudoin, 2002), which is of course not possible in compulsory forums. Considering this, Cheng et al. (2011) in their study focused only on voluntary forums and showed that students who participated actively in these performed better for the overall course.

Other studies focused on the written content in online discussion to assess deep learning and critical thinking. Bullen (1998) accomplished interviews with students to find factors that affect critical thinking and participation in discussion forums and found that the effectiveness of online discussion depends on the characteristics of the students, the facilitation of the discussion and the course design. A content analysis of discussion transcripts conducted by Hara et al. (2000) showed that the students contributed in cognitively deep and long posts with references to others but contributed only with the required number of posts. Heckman and Annabi (2003), who in addition report of at least equal, but in some cases even superior cognitive activity levels in online discussions, when compared to face-to-face discussions, published similar findings. Also, Newman et al. (1997) compared face-to-face with computer conferencing discussions and analyzed deep learning and critical thinking using content analysis. They found similar levels of critical thinking in both types but pointed out that the students provided more outside knowledge and personal experience in the online discussion. In contrast, the face-to-face discussion turned out to better support creativity and idea generation and was more spontaneous.

Methodology and application of method
Assessing critical thinking through content analysis
In literature, many instruments are described which focus on content analysis and aim at providing evidence of learning and the knowledge construction taking place. These

instruments represent a wide variety of approaches and differ in their level of detail, type of analysis categories and most importantly the diversity of their theoretical base (Wever *et al.*, 2006). Content analysis instruments need to be objective, reliable, replicable and systematic (Rourke *et al.*, 2001). Henri (1992) was one of the pioneers to introduce content analysis criteria (Wever *et al.*, 2006), defining five key dimensions (participation, interaction, social cues, cognitive skills and depth of processing, metacognitive skills and knowledge) to classify discussions. However, Howell-Richardson and Mellar (1996) argue that Henri's approach remains too superficial and unspecific to be considered systematic and robust. Newer instruments to measure critical thinking in terms of content analysis in a thematic unit of analysis were, for example, introduced by Newman *et al.* (1995) and Bullen (1998).

Whereas Bullen's framework is based on different conceptualizations of critical thinking and consists of four different categories of critical thinking skills, Newman *et al.*'s approach is based on Garrison's (1991) five stages of critical thinking and Henri's (1992; cited in: Wever *et al.*, 2006) cognitive skills. In his papers, Garrison describes critical thinking as a problem-solving process in which the critical thinker will move through five stages: problem identification, problem definition, problem exploration, problem applicability and problem integration. Marra *et al.* (2004) evaluate the Newman *et al.* protocol to be good for high-level descriptive data of what is happening in a discussion and clearly defined with numerous codes and coding rules. In our study we, therefore, used this approach to analyze the critical thinking of our students in the above-described discussion scenario.

A prerequisite for this method, however, is that critical thinking indicators are identifiable, or in other words "critical thinking should be defined in such a way that it is measurable" (Woo and Wang, 2009). To cover all possible types of posts in a discussion forum, Newman *et al.* (1995) expanded the five stages into the following ten categories of critical thinking indicators: relevance, importance, novelty, ambiguity, outside knowledge, linking ideas, justification, critical assessment, practical utility and width of understanding. Each of the indicators has a pair of opposites, one for in-depth processing and one for surface learning (Newman *et al.*, 1995). Newman *et al.* have developed a full set of 40 indicators within the 10 categories, as depicted in Table I.

While the categories are provided in the left column, the individual indicators and their pairs with the matching codes follow in the second and third column. A positive indicator for the novelty category could, for example, be new problem-related information (NP+) provided by a student or the welcoming of new ideas (NQ+). Negative indicators would, for instance, be repetitions (NP-), or even the dismissal of new ideas of a previous speaker (NQ-) and irrelevant statements (R-).

Along these provided categories with their various indicators, every post needs to be evaluated separately and codified accordingly. Statements may cover phrases, sentences, paragraphs or mere messages containing one unit of meaning and referring to at least one of the indicators. It may even happen that some indicators overlap with each other (see Figure 2). This is why the coding needs to be carried out in chronological order, evaluating the first post first and the later posts to the end of the evaluation sequence. Only in this manner the posts can be assessed properly, and new content or repetitions can be identified correctly. Furthermore, the links

Table I.
Coding indicators of the Newman *et al.* framework (Marra *et al.*, 2004)

Category		Positive indicator		Negative indicator
R±	Relevance	R+	Relevant statements	R−	Irrelevant statements, diversions
I±	Importance	I+	Important points/issues	I−	Unimportant, trivial points/issues
N±	Novelty; new info, ideas, solutions	NP+	New problem-related information	NP−	Repeating what has been said
		NI+	New ideas for discussion	NI−	False or trivial leads
		NS+	New solutions to problems	NS−	Accepting first offered solution
		NQ+	Welcoming new ideas	NQ−	Squashing, putting down new ideas
		NL+	Learner brings new things in	NL−	Dragged in by tutor
O±	Bringing outside knowledge or experience to bear on problem	OE+	Drawing on personal experience	OQ−	Squashing attempts to bring in outside knowledge
		OC+	Refer to course material	O−	Sticking to prejudice or assumptions
		OM+	Use relevant outside material		
		OK+	Using previous knowledge		
		OP+	Course related problems brought in (e.g., students identify problems from lectures and texts)		
		OQ+	Welcoming outside knowledge		
A±	Ambiguities: clarified or confused	AC+	Clear, unambiguous statements	AC−	Confused statements
		A+	Clear up ambiguities	A−	Continue to ignore ambiguities
L±	Linking ideas, interpretation	L+	Linking facts, ideas and notions	L−	Repeating information without making inferences or offering an interpretation
		L+	Generating new data from information collected	L−	Stating that one shares the ideas or opinions stated, without taking these further or adding any personal comments

(continued)

Category		Positive indicator		Negative indicator
J±	Justification			
		JP+ Providing proof or examples	JP−	Irrelevant or obscuring questions or examples
		JS+ Justifying solutions or judgments	JS−	Offering judgments or solutions without explanations or justification
		JS+ Discussing advantages and disadvantages of solution	JS−	Offering several solutions without suggesting which is the most appropriate
C±	Critical assessment			
		C+ Critical assessment or evaluation of own or others' contributions	C−	Uncritical acceptance or unreasoned rejection
		CT+ Tutor prompts for critical evaluation	CT−	Tutor uncritically accepts
P±	Practical utility (grounding)			
		P+ Relate possible solutions to familiar situations	P−	Discuss in a vacuum (treat as if on Mars)
		P+ Discuss practical utility of new ideas	P−	Suggest impractical solutions
W±	Width of understanding (complete picture)			
		W+ Widen discussion (problem within a larger perspective. Intervention strategies within a wider framework)	W−	Narrow discussion. (Address bits or fragments of situation. Suggest glib, p artial, interventions)

Table I.

between the different individual threads can be identified this way. But rather than classifying and coding every single word, it is reasonable and even suggested to mark and count the obvious examples and ignore the intermediate shades of gray (Newman *et al.*, 1995).

After assessing all posts this way, the approach allows for the calculation of a critical thinking ratio based on Formula 1 depicted below. The x ratio, with x identifying the category, is calculated by subtracting the sum of all negative indicator from the sum of all positive indicators, divided by the sum of all indicators. The resulting measure thereby expresses solely the quality of the text without depending on the quantity of participants. This way, ten critical thinking ratios are calculated, one for each category, and all of them in a range of -1 (all uncritical, all surface) to $+1$ (all critical, all surface) (Newman *et al.*, 1995).

$$x\ ratio = \frac{x^+ - x^-}{x^\pm}$$

Formula 1: calculation of critical thinking ratio (simplified according to Newman *et al.*, 1995).

In the context of such a qualitative analysis, inter-rater reliability would be the primary test of objectivity. It addresses the extent to which independent coders evaluate the same content in the same way and with the same results. For the Newman, Webb & Cochrane protocol, Marra *et al.* (2004) state that it is impossible to calculate such an inter-rater reliability, as the units of analysis vary among the coders. In our analysis, we therefore assume that the combination of the codings from a high number of coders compensates extrema in the codings and helps to reach realistic and reliable results.

Forum analysis
The following analysis of the above-explained discussion forum was conducted with the help of the students of the "Net Economy" course themselves. One student of each team was assigned the role of a research partner and as such had to mark the transcripts of the discussion thread that he did not participate in himself. The research partners were introduced to the job and the approach in a web conference, and, in addition, a short tutorial was provided on how the free coding software QDAminer Lite can be used to do
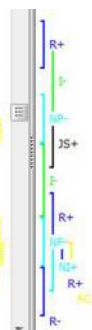

Figure 2.
Example coding of
forum posts

the job. The transcripts of the forums were provided to the students together with the indicators as a pre-defined project in QDAminer Lite. Out of the 13 research partners, 9 submitted complete and acceptable coding projects with 4 students covering Discussion Thread 1 and 5 students covering Thread 2.

The analysis to follow is a merger of these nine complete coding projects provided by the students. Figure 2 shows how the coding of a post looks like in QDAminer with the positive and the negative indicators being depicted in the right. Building on to these individual codings, we then proceeded by summing up all appearances of the different indicators and by calculating the critical thinking ratio for each category. While the two discussion threads were coded separately, we later also merged the results, as both threads were set up and managed in the exact same way. This way we were able to calculate critical thinking ratios also for the discussion forum as a whole.

Several problems accompanying the chosen analysis approach and research design need to be considered. Next to the apple-and-pear problem because of possible variances between the different codings of the students, also very small numbers of appearances of specific indicators lead to the risk of over-interpretation. We therefore do not consider the critical thinking ratios of the practical utility and the width of understanding category in our analysis, as these indicators were used too rarely. Another limitation to keep in mind is that the chosen critical thinking model does not answer any specific question or solve any specific problems, but rather develops an overall rating for the quality of the discussion behavior and the interactions between the students.

Results and action planning

After merging the coding projects, the results shown in Table II can be calculated for the ten categories. We were able to evaluate eight of the ten categories when considering the sample sizes. Only for the ambiguity category, a negative result was calculated, indicating that the coding students found many confusing statements. All other ratios are positive with mostly rather small differences between the ratios for the Discussion Threads 1 and 2. As Newman et al. do not provide a scheme for interpreting the results except for –1 indicating all uncritical and surface posts and +1 indicating all critical and deep contributions, there is a clear need to compare the

Category	Topic 1 Indicator			Topic 2 Indicator			Combined Indicator		
	+	−	Ratio	+	−	Ratio	+	−	Ratio
R± Relevance	118	46	0.44	125	85	0.19	243	131	0.3
I± Importance	58	53	0.05	34	11	0.51	92	64	0.18
N± Novelty	201	156	0.13	158	75	0.36	359	231	0.22
A± Ambiguity	35	72	−0.35	19	42	−0,38	54	114	−0.36
O± Outside knowledge	189	27	0.75	102	14	0.76	291	41	0.75
L± Linking ideas	62	41	0.2	29	31	−0,03	91	72	0.12
J± Justification	184	20	0.8	137	31	0.63	321	51	0.73
C± Critical assessment	55	12	0.64	74	6	0.85	129	18	0.76
P± Practical utility[a]	10	0	(1)[a]	5	5	0	15	5	(0.50)[a]
W± Width of understanding[a]	15	2	(0.76)[a]	12	7	0.26	27	9	(0.50)[a]

Note: [a] These categories are not considered any further due to too small samples

Table II.
Critical thinking
ratios in the Net
Economy forum
calculated after
Newman et al. (1995)

derived ratios with the ratios of comparable settings. This actually matches our CAR approach of a continuous build-and-develop loop, as we will derive interventions in the next step that aim at improving the critical thinking in the implemented discussion forum, with the critical thinking ratios allowing us to assess and evaluate any achieved improvement.

The high scores (CT $\geq$ 0.70) among the above results, nevertheless, point at several positive characteristics of the students' discussion behavior. Outside knowledge was used a lot (CT = 0.75), justifications were regularly provided (CT = 0.73) and the posts were mostly critically assessed by fellow students (CT = 0.76). A drill-down into one of the higher and one of the lower scores provides a clearer view of the assessed discussion. Table III adds an overview of the samples of single indicators from the two categories linking ideas and outside knowledge. Personal experience and previous knowledge, as well as additional course material and external resources, were introduced frequently by the students. Furthermore, they were also able to link facts and ideas, but thereby continuously repeated information and statements provided by other students before.

While these results indicate an overall positive discussion behavior from our point of view, the total number of posts points at a rather tightly focused fulfillment of the discussion task (one post + two replies). Students seem not to have participated in the discussion based on pure interest, curiosity or fun but rather because it was a required task. The chosen topics and the way of raising and structuring the discussion seem not to have managed to turn the students' extrinsic motivation into intrinsic motivation, which should have resulted in some sort of over-fulfillment of the discussion task. The identified numerous repetitions of information support this interpretation.

As it is our goal to foster critical and reflective thinking and thus cognitive presence, we aim at engaging the students in a more intrinsically motivated discussion in the future. Considering the above results, we derived the following interventions that we will accomplish and assess in the upcoming course cycle:

- Instead of only one discussion task during knowledge development phase, four discussions will be included as part of the three Assignments A, B, and C and as part of case study phase (Assignment D). This way, we can aim at a positive development of the student's discussion skills, and we can provide and analyze different discussion settings (see Interventions 4, 5 and 6).

- Next to the discussion task itself, we will explicitly point out the cognitive goal of the discussions (interactive debate and critical thinking). This intervention is meant to increase the students' motivation regarding more personally colored and meaningful discussion contributions.

- As another general improvement, we will use more polarizing discussion starters for all discussion forums and provide the students with examples of possible directions of interpretation. This intervention aims at a broader and livelier discussion.

- When providing the different discussion forums, we will assess the impact of teaching presence with regard to the critical thinking that can be observed in the according forums. We argue that a stronger teaching presence (in the sense of active contributions and comments from instructors) makes the students feel

Category	+ Indicator	Count		– Indicator	Count
O± Bringing outside knowledge/experience to bear on problem	OE+ Drawing on personal experience	129	OQ–	Squashing attempts to bring in outside knowledge	6
	OC+ Refer to course material	54	O–	Sticking to prejudice or assumptions	22
	OM+ Use relevant outside material	60			
	OK+ Using previous knowledge	41			
	OP+ Course-related problems brought in	19			
	OQ+ Welcoming outside knowledge	1			
L± linking ideas, interpretation	L+ Linking facts, ideas and notions	81	L–	Repeating information without making inferences or offering an interpretation	34
	L+ Generating new data from information collected	10	L–	Stating that one shares the ideas or opinions stated, without taking these further or adding any personal comments	38

Table III.
Closer look on the outside knowledge and linking ideas category and the according numbers

more actively perceived and thus more motivated, what we expect to result in a more valuable discussion. To be able to analyze the impact of the enhanced teaching presence, we will arrange two discussions as moderated discussions, while the other two remain without moderation.

- In addition, we will assess the impact of different types of media being allowed and used in the discussion forums. While two discussions will be purely text-based, the two other discussions will provide multimedia (text, audio and video) functionality and even promote, for example, video statements. We will then be able to see what forums resulted in the more active discussion and what discussion threads within the forums achieved the highest attention/participation. We expect multimedia to have a positive impact on the visibility of specific threats and thus on the participation level, but at least no positive impact (maybe instead even a negative impact) on the critical thinking value of the according forum, as the media usage will draw the students' attention and use part of their cognitive resources.

- Finally, we plan to analyze the role of the discussants themselves, which in our setting can be individual students or student groups. Therefore, two of the discussion tasks will be designed as "representative discussions", in which representatives of each group are provided for the discussion.

Table IV summarizes the resulting discussion setting.

After the next course cycle, we will assess the discussion forums regarding participation levels, critical thinking ratios, etc., to evaluate our interventions. This way, we hope to have started an improvement process for the discussion forums as a major instrument of cognitive presence in e-Learning. In addition, we will retrieve the students' learning styles according to the Felder-Silverman learning style model (Felder and Silverman, 1988) with the help of the Index of Learning Styles (Felder and Soloman, 2013). We thus plan to examine their relation with critical thinking, student participation and student reactions to the different discussion setups.

Conclusion, discussion and future work
In this paper, we introduced the VCL course "Net Economy" and our iterative CAR approach aiming at a systematic improvement of the setting. Using the CoI as guidance, we focused on cognitive presence as one major requirement of successful online learning, which we intended to provide for by implementing a discussion forum and an according discussion assignment among other tasks. We evaluated the discussion forum regarding its cognitive value by calculating the critical thinking ratios for all ten categories suggested by the Newman *et al.* (1995) critical thinking diagnosis model. Using this approach, we were able to diagnose some strength and weaknesses of our

Assignment/Discussion forum	A	B	C	D
Teaching presence	Without moderation	Without moderation	With moderation	With moderation
Media approach	Text	Multimedia	Text	Multimedia
Discussants	Individual	Individual	Group-based	Group-based

Table IV.
Planned interventions and discussion setting

discussion setting and derived interventions to be implemented in the upcoming course cycle.

The Newman *et al.* model was simple to use and user-friendly, as all categories and indicators are pre-defined. It provided for quality scores indicating the cognitive value of our discussion forum, while not depending on the number of participants. But despite this well-organized and user-friendly model, it turned out to be quite tedious and time-consuming to work through the assessed forum with regard to all 40 indicators contained in the model. A problematic aspect is also the interpretation of the derived results. While it is clear that the more the values tend towards -1 or $+1$, the worse or better discussion, respectively, behavior they indicate, there is no guidance as where a good value might start or a bad value might end.

Regarding the analyzed discussion forum, we found that the students frequently introduced outside knowledge to the discussion, that they argued intensely and that they thereby addressed posts critically. On the other hand, they often repeated information and posted a high number of rather confusing statements. However, the various cultural and educational backgrounds of the students might also play an important role in this matter, opening up the field for further research. From the calculated results, we finally derived interventions for the upcoming course cycle aiming at turning the students' initial extrinsic discussion motivation into a more intrinsic one. A comparison of the results after the next course cycle will then allow us to assess the effects of the implemented changes, which would not be possible without a critical thinking diagnosis approach like the one provided by Newman *et al.* (1995) and used in this paper. Also, the process of analyzing a forum in such detail helped us a lot to understand the effects of the chosen discussion task with its strengths and weaknesses better.

Another future direction of research could be the automatic assessment of discussion forums. As a first step, one could implement a function to let the students code their posting themselves to let them reflect on their own writings. Such an approach would require a shorter and simplified version of the Newman *et al.* protocol, like the one, used by Yang *et al.* (2005). In their study, the authors used a combination of Gunawardena *et al.*'s model and a simplified coding scheme based on the Newman *et al.* protocol, which resulted in a set of only four paired indicators and two groups of three related indicators. Another promising approach would be to use data mining and especially text mining techniques to assess discussion forums in a more efficient way. In this context, Dringus and Ellis (2005) used participation indicators to show how data and text mining can support the instructor's ability to evaluate threaded discussions. Another study by Corich and Kinshuk (2006) focused on a computerized tool to analyze discussion forum transcripts in comparison to manual codings.

References

Andresen, M.A. (2009), "Asynchronous discussion forums: success factors, outcomes, assessments, and limitations", *Journal of Educational Technology & Society*, Vol. 12 No. 1, pp. 249-257.

Arend, B. (2009), "Encouraging critical thinking in online threaded discussions", *Journal of Educators Online*, Vol. 6 No. 1, pp. 1-23.

Beaudoin, M.F. (2002), "Learning or lurking?: Tracking the 'invisible' online student", *The Internet and Higher Education*, Vol. 5 No. 2, pp. 147-155.

Bullen, M. (1998), "Participation and critical thinking in online university distance education", *International Journal of E-Learning & Distance Education*, Vol. 13 No. 2, pp. 1-32.

Carswell, A.D. and Venkatesh, V. (2002), "Learner outcomes in an asynchronous distance education environment", *International Journal of Human-Computer Studies*, Vol. 56 No. 5, pp. 475-494.

Cheng, C.K., Paréa, D.E., Collimoreb, L.-M. and Joordens, S. (2011), "Assessing the effectiveness of a voluntary online discussion forum on improving students' course performance", *Computers & Education*, Vol. 56 No. 1, pp. 253-261.

Corich, S. and Kinshuk, L.M. (2006), "Measuring critical thinking within discussion forums using a computerised content analysis tool", *Proceedings of Networked Learning Conference*, Lancaster.

Davison, R., Martinsons, M.G. and Kock, N. (2004), "Principles of canonical action research", *Information Systems Journal*, Vol. 14 No. 1, pp. 65-86.

Dringus, L.P. and Ellis, T. (2005), "Using data mining as a strategy for assessing asynchronous discussion forums", *Computers & Education*, Vol. 45 No. 1, pp. 141-160.

Ennis, R.H. (1993), "Critical thinking assessment", *Theory Into Practice*, Vol. 32 No. 3, pp. 179-186.

Felder, R.M. and Silverman, L.K. (1988), "Learning and teaching styles in engineering education", *Engineering Education*, Vol. 78 No. 7, pp. 674-681.

Felder, R.M. and Soloman, B.A. (2013), "Index of learning styles", available at: www.ncsu.edu/felder-public/ILSpage.html (accessed 1 September 2013)

Foundation for Critical Thinking (2015), "The critical thinking community: our concept and definition of critical thinking", available at: www.criticalthinking.org/pages/our-concept-of-critical-thinking/411 (accessed 5 June 2015).

Garrison, D.R. (1991), "Critical thinking and adult education: a conceptual model for developing critical thinking in adult learners", *International Journal of Lifelong Education*, Vol. 10 No. 4, pp. 287-303.

Garrison, D.R. (2011), *E-learning in the 21st century: A Framework for Research and Practice*, Routledge, New York, NY.

Garrison, D.R., Anderson, T. and Arche, W. (2000), "Critical inquiry in a text-based environment: computer conferencing in higher education", *The Internet and Higher Education*, Vol. 2 Nos 2/3, pp. 87-105.

Garrison, D.R., Anderson, T. and Arche, W. (2001), "Critical thinking, cognitive presence, and computer conferencing in distance education", *American Journal of Distance Education*, Vol. 15 No. 1, pp. 7-23.

Garrison, D.R. and Cleveland-Innes, M. (2005), "Facilitating cognitive presence in online learning: interaction is not enough", *The American Journal of Distance Education*, Vol. 19 No. 3, pp. 133-148.

Gunawardena, C.N., Lowe, C.M.A. and Anderson, T. (1997), "Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing", *Journal of Educational Computing Research*, Vol. 17 No. 4, pp. 397-431.

Hara, N., Bonk, C.J. and Angeli, C. (2000), "Content analysis of online discussion in an applied educational psychology course", *Instructional Science*, Vol. 28 No. 2, pp. 115-152.

Heckman, R. and Annabi, H. (2003), "A content analytic comparison of FTF and ALN case-study discussions", System Sciences, *Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS'03)-Track1-Volume 1*, pp. 3.1.

Henri, F. (1992), "Computer conferencing and content analysis", *Collaborative Learning Through Computer Conferencing*, Springer, London, pp. 117-136.

Howell-Richardson, C. and Mellar, H. (1996), "A methodology for the analysis of patterns of participation within computer mediated communication courses", *Instructional Science*, Vol. 24 No. 1, pp. 47-69.

Lai, E.R. (2011), "Critical thinking: a literature review", *Pearson's Research Reports*, Vol. 6, pp. 40-41.

Lapadat, J.C. (2002), "Written interaction: a key component in online learning", *Journal of Computer-Mediated Communication*, Vol. 7 No. 4.

McKay, J. and Marshall, P. (2001), "The dual imperatives of action research", *Information Technology & People*, Vol. 14 No. 1, pp. 46-59.

Marra, R.M., Moore, J.L. and Klimczak, A.K. (2004), "Content analysis of online discussion forums: a comparative analysis of protocols", *Educational Technology Research and Development*, Vol. 52 No. 2, pp. 23-40.

Maurino, P.S. (2007), "Looking for critical thinking in online threaded discussions", *Journal of Educational Technology Systems*, Vol. 35 No. 3, pp. 241-260.

Mazzolini, M. and Maddison, S. (2003), "Sage, guide or ghost? The effect of instructor intervention on student participation in online discussion forums", *Computers & Education*, Vol. 40 No. 3, pp. 237-253.

Mazzolini, M. and Maddison, S. (2007), "When to jump in: the role of the instructor in online discussion forums", *Computers & Education*, Vol. 49 No. 2, pp. 193-213.

Meyer, K.A. (2003), "Face-to-face versus threaded discussions: the role of time and higher-order thinking", *Journal of Asynchronous Learning Networks*, Vol. 7 No. 3, pp. 55-65.

Newman, D.R., Webb, B. and Cochrane, C. (1995), "A content analysis method to measure critical thinking in face-to-face and computer supported group learning", *Interpersonal Computing and Technology*, Vol. 3 No. 2, pp. 56-77.

Newman, D.R., Johnson, C., Webb, Brian and Cochrane, C. (1997), "Evaluating the quality of learning in computer supported co-operative learning", *Journal of the American Society for Information Science*, Vol. 48 No. 6, pp. 484-495.

Rourke, L., Anderson, T. and Garrison, D.R. (2001), "Methodological issues in the content analysis of computer conference transcripts", *International Journal of Artificial Intelligence in Education (IJAIED)*, Vol. 12, pp. 8-22.

Salmon, G. (2011), *E-moderating: The Key to Teaching and Learning Online*, 3rd ed., Routledge, New York, NY.

Susman, G.I. and Evered, R.D. (1978), "An assessment of the scientific merits of action research", *Administrative Science Quarterly*, Vol. 23 No. 4, pp. 582-603.

Wang, Q., Wooa, H.L. and Zhao, J. (2009), "Investigating critical thinking and knowledge construction in an interactive learning environment", *Interactive Learning Environments*, Vol. 17 No. 1, pp. 95-104.

Wever, B. de, Schellens, T., Valcke, M. and Van Keer, H. (2006), "Content analysis schemes to analyze transcripts of online asynchronous discussion groups: a review", *Computers & Education*, Vol. 46 No. 1, pp. 6-28.

Woo, H.L. and Wang, Q. (2009), "Using weblog to promote critical thinking-an exploratory study", *Proceedings of World Academy of Science: Engineering & Technology*, Vol. 37, pp. 431-439.

Yang, Y.C., Newby, T.J. and Bill, R.L. (2005), "Using Socratic questioning to promote critical thinking skills through asynchronous discussion forums in distance learning environments", *The American Journal of Distance Education*, Vol. 19 No. 3, pp. 163-181.

Further reading

Rourke, L., Terry, A., Randy, G.D. and Walte, A. (1999), "Assessing social presence in asynchronous text-based computer conferencing", *International Journal of E-Learning & Distance Education*, Vol. 14 No. 2, pp. 50-71.

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