

Making Classroom Response Systems More Social

Jonas Vetterick¹, Bastian Schwennigcke², Andreas Langfeld²,
Clemens H. Cap¹ and Wolfgang Sucharowski²

¹*Department of Computer Science, University of Rostock, Rostock, Germany*

²*Department of Humanities, University of Rostock, Rostock, Germany*

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Abstract: Classroom Response Systems (CRS) have been used in the last years to support teachers getting feedback from their students, especially in lessons with large audiences. Whereas CRS become more and more popular it is less known how students really use CRS for providing feedback and if social communication on CRS - and as a consequence in the classroom itself - can increase the benefit of CRS. Our research aims to open the discussion for more social communication on courses and lessons on CRS-usage by providing grounding of social communication with CRS. Moreover we outline conceptual and technical insights on an Social CRS implementation.

1 INTRODUCTION

It is a commonplace that learning success highly depends on the social embedding of learning processes. Beside motivational or emotional aspects we want to emphasize, that this embedment can be defined in terms of communicative interventions into learning processes. Social embedment of learning allows any learner to evaluate his or her understanding of given contents. It even allows to assess the appropriateness of this understanding through communication with other learners as well as with teachers and tutorial attendants in different learning contexts. Additionally it is another commonplace that academic teaching still often shows a lack of socially embedded learning this way. Even more, academic teaching misses significant strategies to develop this aspect of learning (Laurillard, 2002) (Laurillard, 2012). However, the issue of how to overcome this state and enable a significant social involvement of learning is far less trivial and still a serious challenge on quality and success of learning (Masschelein and Simons, 2013).

Classroom Response Systems (CRS) can be regarded as a technological reply to this issue. Whereas the original idea of CRS mainly implements a clicker functionality, where students answer multiple choice questions of the teachers (Fies and Marshall, 2006), they now become a wider platform to provide feed-

back and to elaborate it in direction to a higher social embedment of learning. Although teachers are still able to ask multiple choice questions, modern CRS provide students with the possibility to give more detailed feedback on demand (Feiten et al., 2012) (Kundisch et al., 2012).

Whilst modern CRS have been extended with many features, we think that CRS currently do not draw on their full potential to support the social embedment of learning. Until now, they are a helpful tool to link more explicitly the presentation and transmission of content on the teachers side with a specific range of receptive reactions on the learners side. In result CRS may support the addressing and solving of understanding problems.

Moreover, experience with CRS with features beyond mere multiple choice tests resulted in participants spontaneously inventing new forms of communication. For example, a public chat-like feedback channel intended originally to pose questions to the teacher was used for tutorial-style communication and for organizing study groups by the students. This demonstrates a demand for increased social interaction in the classroom.

But at this stage of evolution especially social interactions and communication are neither usefully enclosed by CRS learning concepts nor documented for students and teachers further usage on the CRS. In

previous work, we recognized a strong need of students to communicate with each other on CRS and to get durable access to the CRS content generated in a lesson (Vetterick et al., 2014).

Although the social evolution of CRS seems to be a vital demand as well as an exciting direction of development, the relation between social interaction and learning is widely unexplained, especially in the context of blended and e-learning interventions. This conceptual paper shall explore this gap in order to better estimate social phenomena in the evaluation of existing CRS and to provide significant constraints for technological advancements.

This publication describes our position on a current learning model, which covers latest and coming generations of CRS that are aware of social communication and interaction between students and teachers. Based on this discussion we will elaborate which aspects of socially embedded learning CRS currently enable and which aspects are still to be claimed. Furthermore this work outlines how coming CRS should look and act in order to contribute a serious intervention into the social challenge on learning.

The rest of the paper is organized as follows. Section 2 covers the related work in the field of learning and feedback and in the field of CRS. In section 3 we show that there are two different types of communication on providing feedback. Section 4 presents our approach for an Social CRS that is aware of and supports these types. At the end we conclude our work and outlook future research in section 5.

2 STATE OF THE ART

2.1 Learning and Communication/Feedback

To ground our investigation on the social embedment of learning, we want to adopt (this chapter) and partially develop (chapter 3) the learning model, Diana Laurillard introduced in the late 1990s and has refined up to her present contributions to the debate on academic teaching. It promotes our position in a three-fold way (Laurillard, 1999) (Laurillard, 2002) (Laurillard, 2008) (Laurillard, 2012).

- First, it comes from scientifically based efforts for reforms in academic education.
- Second, it uses an educational-driven approach to the use of digital technologies (Laurillard, 2008, p. 1).
- And third, it implements important aspects of the social nature of learning.

Her model essentially consists of three layers composed to an conversational framework of learning (Figure 1). These layers postulate the main functions teachers and learners have in educational settings. The first layer, the layer of conceptual discussion combines the function of content distribution on the basis of theoretical conceptions on the teachers side and the function of content documentation framed by an individual conception on the learners side. Learners even have to reply on distributed content and to control their individual understanding of content in the light of the teachers reactions on their replies.

The second layer, the layer of interaction, is determined by a learning environment constituted by the teacher. Within this environment learners are obligated to solve concrete tasks, such as working out exercises, solving questions or preparing talks or papers. Interaction even includes to observe how learners cope with those tasks on the teachers side. Additionally, learners will admit their processing of tasks while teachers attend to and react on their attempts at a solution.

The third layer establishes a connection between the first and the second one. It has a meta-cognitive function and its realization allows to adopt the operations on the interactive layer with respect to the interchange of content on the conceptual layer. Furthermore it enables to assess the reaches and limits of theoretical concepts in the light of task coping and outcomes as practical experiences on the interactive layer.

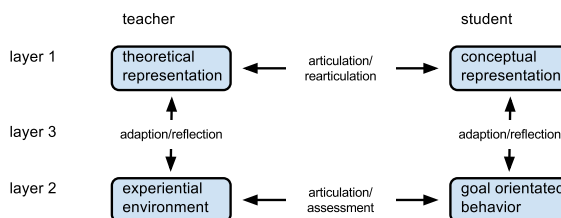


Figure 1: Conversational framework of learning (Laurillard, 1999) (Laurillard, 2002) (Laurillard, 2012).

Laurillard claims that learning processes based on these three layers go beyond simple instruction. Because any successful understanding of content depends on the ability of teachers and learners to apply a common ontological (object reference) and epistemic (direction of understanding) frame of reference. That means they have to anticipate a common identification of objects and their epistemic treatment in order to use transmitted content the same way. However, a central demand on teaching is not to presume this redundancy of orientation between teachers and learners, but to support its evolution. This evolutionary process has to

take into account an iterative progress of adjustment between the differing prerequisites of the participants in an educational process. The core instrument Laurillard suggests to make the outlined adjustment run is giving and handling feedback on each of the frameworks layers.

First of all, feedback is a way to interrupt the progress of content transmission and task instruction in order to claim a sequence of adjustment between transmission and reception of content. Normally this is the case when intentions behind content transmission on the teachers side and abilities to cope with content in the intended way on the learners side do not interlock. Any reaction on feedback has to respond to that imbalance between intended and performed understanding more or less extensively. The core issue to compensate this imbalance will be to explore the individual conditions learners apply to understand given educational content. This is a common sense affordance on modern teaching and it means to center teaching around the learner and provide as much occasions as possible to clear up and integrate the learners prerequisites within learning processes.

Enabling feedback belongs to a set of ideal solutions to integrate modern, learner centered teaching into academic education (Weimer, 2013). But there is a common risk behind those avant-garde demands on teaching. Admitting feedback contains the problem to include topics and issues into the learning setting that could endanger the viability of courses and lectures. Not only genuine spam but also content driven feedback is able to disturb a lesson significantly. It is an important challenge to distinguish between feedback assimilable to a lesson and feedback that cannot be integrated. Beside explicit rules or technical filtering, we assume that those decisions are normally processed by the use of communicative strategies.

2.2 Modern Classroom Response Systems

As Kay et al stated in (Kay and LeSage, 2009) CRS have been voting mechanism in the first place: Teachers ask a multiple choice question and students could answer by clicking the corresponding button on a special voting device. As these voting devices are very expensive and have to be maintained, modern CRS use the mobile devices students already have. Since mobile devices, as smartphones, pads or notebooks, provide a display that can draw more than just buttons for multiple choice questions, CRS evolve to comprehensive feedback systems that are able to implement more complex forms of feedback (Draper et al., 2002) (Feiten et al., 2012) (Jenkins, 2007) (Kundisch et al.,

2012) (Vetterick et al., 2013) such as:

- Multiple Choice questions asked by the teachers (TQ): Teachers can still use modern CRS as clickers, but without the limitations of a hardware device, so they may label their answers or use a flexible number of answers for example.
- Questions from students (SQ): Students ask specific questions. Other students may vote questions up or down, which can be an indicator for the importance of questions. Based on the number of votes the instructor can address the issues in his lecture. In a variant of this scheme, members of the audience may reply in writing using the system.
- Rating specific presentation parameters (SP): Students mark specific issues, for example when the instructor is moving ahead too fast or the talking volume is inadequate.

Moreover modern CRS are able to organize the given feedback to get a deeper understanding. The following methods present current methods for organizing live feedback.

- Durable Access (DA): Students and teachers can later access all the given feedback. Teachers are then able to provide additional material or examples and can improve the presentation. Students can use the feedback to identify important facts, topic or issues for a better preparation for their exams (Crouch and Mazur, 2001) (Vetterick et al., 2014).
- Identify students learning issues across lessons and terms (LA): By the use of identities (or even pseudonyms) teachers are able to track down how students learn. Interested readers are referred to the field of learning analytics (Ferguson, 2012).

Figure 2 demonstrates how the three forms of feedback TQ, SQ and SP are organized by DA and LA. Whilst the feedback generated in a lesson can be accessed afterwards (DA), LA allows to identify correlations between the students feedback over lessons or terms.

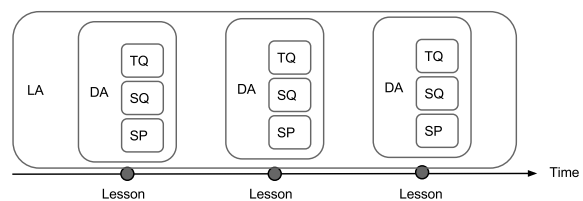


Figure 2: Interaction of access modes and CRS-features.

Regarding the previously presented interdependent layers of learning process organization (discussion layer, interaction layer, layer of adoption

and reflection), modern CRS only fit these layers in parts. The layer of discussion is covered by students questions (SQ) and the possibility to rate teachers speech parameters (SP). Students initiate the discussion about a certain issue or parameter, whereas teachers have to respond. The layer of interaction is covered by students questions (SQ), where students again initiate the feedback by asking questions. Additionally the layer of interaction is partly covered by teachers questions (TQ), because teachers demand feedback from their students, who then have to interact with their teachers. The layer of adaption and reflection is partly used by all modern CRS implementations of TQ, SQ and SP: Students may reflect their knowledge and understanding on teachers (TQ) or other students questions (SQ). Moreover teachers may reflect their teaching to identify facts, topics or illustrations that are hard to understand for students (issue repeat offender).

Regarding the methods to organize feedback, LA and DA cover the layer of adaption and reflection, too. DA provides persistent access to the content created by teachers and students during a lesson, so students are able to reflect their knowledge and understanding afterwards at any time. Furthermore teachers can do the same to reflect their teaching. LA allows teachers to get a deeper knowledge of how students proceed in their lessons over time (for a whole term for example), so teachers can reflect their teaching on a wider scope.

3 COMMUNICATIVE LEARNING

3.1 From Feedback to Communication

Chapter two showed that feedback is no add-on but a core element of learning. Here we want to add that feedback only works in connection with social, or rather communicative forms of intervention into the learning process. Therefore, any elaboration of feedback depends on the specific communicative strategies the participants of learning processes are able and allowed to realize in educational settings. What these strategies might be, how they work and to what extent they support learning processes are open questions within the learning research discussion we presented above. We consider answers to these questions to be a significant prerequisite for the evolution of feedback technologies like CRS.

Communication takes its special role within feedback processes, because its main function is not to discover the full potential of an individuals conditions applied to his or her engagement with transmitted content. That means, communication is more

than just talking about individual states or sensitivities within learning processes. Communication has to find a scope of selective topics and issues, which the communicative partners are able to connect with from their individual state while they are attending to and coping with feedback. To treat feedback by communication means to find a selective way of marking and negotiating feedback. Selective communicative treatment gives feedback a specific sense and determines its relevance. We now want to distinguish two major strategies conveying two basic forms of coping with feedback in the outlined way (for general introduction (Baecker, 2009)).

3.2 Systemic Feedback/Communicative Strategies within Lectures

Lectures normally work on the conceptual layer of learning. Lectures are successful when learners are able to anticipate an intended conceptual order of knowledge out of the way they document presented content (Figure 3). From a communication theory point of view, this setting could be regarded as systemic setting. Communicative Systems contain an affordance-competence balance (Baecker, 2010). And this is the case, when behavior on the one hand could be regarded as an accomplishment of an affordance setting on the other. The learners activities to document content and to anticipate underlying conceptual orders then are accomplishments to the intentions a teacher has in a specific learning process. Feedback framed by a systemic communication strategy will focus the partners on their knowledge about the structure of demands within that setting. They have to specify and reformulate what they determine to be the right understanding of underlying affordances.

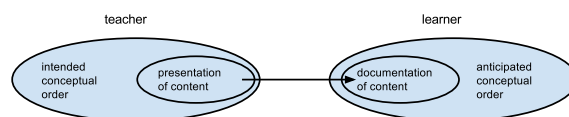


Figure 3: Conceptual basis of learning based on (Laurillard, 2002) (Laurillard, 2012).

In result the partners are able to decide whether their behavior is a deviation reclaimable by an accomplishment that fits to their understanding of given demands. Reaction on feedback within this framework will take feedback as a hint on deviation from ideal and it will reclaim this ideal by re-defining the affordance structure behavior should apply to. The problem is, such communicative framework only deals with feedback allowing to connect deviating behavior with redefinitions of given affordances. That means,

feedback already has to contain certain links to that affordance structure. In other words, it has to be consciously settled within a given affordance framework, which is shared between the communicative partners in the feedback process.

For example students ask for more explanation within a given topic area because they understand this topic area to be important for their exams and fear to overlook important issues without more explanation. However requesting more explanation could be a deviation from ideal learner performance within a lecture. But it could be handled within the systemic strategy, if the students request already contains knowledge about an intended affordance on the teachers side, e.g. exam preparation, and if this knowledge is shared between teacher and student. Replies to this feedback only have to redefine the affordance structure exam preparation in order to adjust performed and ideal behavior, that means to decide whether requesting more explanation is useful or not within the affordance set exam preparation.

We call feedback annotated in Figure 4 affordance competent or systemic feedback. We want to suggest that it only can be given by skilled students with enough experience within specific educational settings as university lectures or courses. It only works if feedback is applied to students assumptions on possible affordance structures or more general if feedback can be treated this way. Treating feedback within a systemic strategy needs communicative partners, who are able to find and assume comparable assumptions on a set of affordances in a learning process.

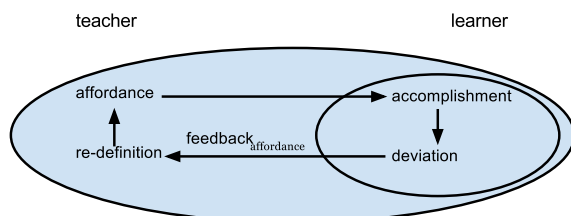


Figure 4: Systemic feedback process (integrated application of (Baecker, 2010) and (Laurillard, 2002)).

3.3 Concept Critical Interventions into Feedback

Feedback without a strong linkage to socially shared affordances is difficult to handle within a systemic framework. This is a significant problem for learning processes. Because this more open type of feedback contains the highest potential to enable and develop learning advancements (Bateson, 2000). Because deviation from pre-defined sets of learning affordances allows to go beyond affordance sets and to

understand their constitution and justification within broader conceptual considerations (Baecker, 2008) (Baecker, 2012) (White, 2012). If we go back to our little example of exam preparation it makes a significant difference whether students understand how to apply lecture contents to exam affordances or they understand, that exam affordances are constituted in the context of different and sometimes even competing standards within scientific paradigms or even other perhaps administrative and legal considerations. Feedback that deviates from pre-defined affordance sets contains the opportunity to investigate such contexts and to reclaim a deeper understanding of learning affordances and their range of variation .

The learning theory discussion above suggested to realize such demands by switching between different learning layers and to transfer experiences on one layer to the other. It has been emphasized that such transfer allows to insert experiences on one layer as a hint on the conceptual basis, that constitutes the other layer. For example the quizzes function of CRS can be used to go through a kind of exam like situation in order to help students anticipating the exam affordance set behind lectures. However the main issue here is, that this conclusion has to be worked out in a broader communicative setting. Within this setting communication has to ensure, that deviations are not rejected too soon as interferences into pre-defined systemic frameworks. Instead communication has to be aligned to find contexts which handle systemically deviating feedback as occasion to search for other affordance-accomplishment balances or as occasion to adapt pre-defined affordances.

On a communicative level it also means to find different partners or groups, who are able to pick up and investigate feedback in the outlined way. In effect, this type of communication leads to adaptive processes within given systemic frameworks as well as to distinction and differentiation between varieties of systemic settings. This type of communication additionally unfolds demands on the comparative competences amongst communicative partners. And this demand has to be implemented by parallel investigations into the conceptual basis different systemic settings are based on (Figure 5).

This type of communicative intervention allows to rebind deviations from single affordance settings back into academic lessons and to apply the content and the progress of lessons to different scopes of relevance and function. In effect, the communicative demands on such intervention are more complex. Because given feedback could not only be immediately applied or rejected, but even preserved for later treatment, transferred into other contexts of application

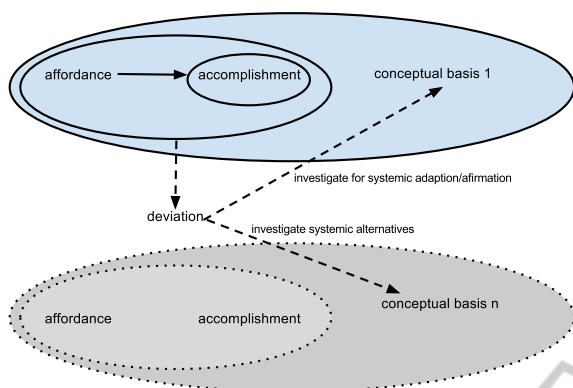


Figure 5: Concept critical intervention into feedback.

and integrated into social discourse about the range of conceptual diversity feedback fits to.

4 SOCIAL CLASSROOM RESPONSE SYSTEMS

Based on the critics and the suggestions for improvement from chapter 3, we will outline a new generation of CRS that is aware of and supports communicative intervention into feedback. The notion of classroom, however, has to be understood in the broader sense of a community of learners; their interaction may occur at the same time and same place (traditional CRS) or at different places (for remote learners) or times (carried over to different cohorts of learners).

This section describes our approach for a social CRS that is aware of social communication. At first we will present the conceptual design for this approach, then we address technical challenges and state feasible implementations for them.

4.1 Conceptual Design

On feedback-events (communicative interventions), when students struggle with an issue, discussions with others can arise. CRS should be aware of these events, because they are a part of students learning process. Similar to bubbles that rise to the surface, discussions can split off the lessons content. Whether or not discussions may not directly related to the lessons content, they are important for their members and can become interesting later on. Moreover, CRS should provide methods to initiate or create such discussion-bubbles. Because students often use their own medium, as social networks or online learning platforms, to discuss an issue, CRS should be able to export discussions. Thereby students are still able to use their known medium for discussion even if they

deal with something that has not been created on this medium (enabling concept critical feedback). Figure 6 illustrates this concept.

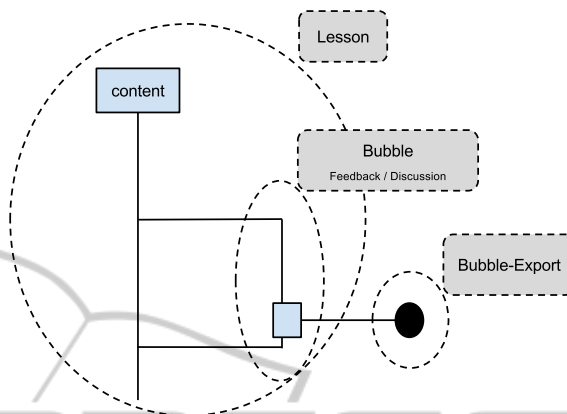


Figure 6: Discussion initiated during a lesson and their possibility for usage in external environments.

In addition to the ability to leave lessons to follow a discussion, CRS have to provide a mechanism to return to a lecture, so students on the one hand can adapt their knowledge generated from the discussion to the current teaching content and teachers on the other hand can react on issues aftereffects. CRS that support to leave to and return from a discussion to a lesson are then able to keep track of learning processes. This enables teachers and students to organize and analyze their own and others learning processes. Furthermore a lecture does now not only consist of teachers knowledge-materials, it also consists of the process how students identify and solve issues on lessons knowledge itself and on teachers learning-materials (adopt systemic affordances and investigate alternatives according to chapter 3.3, Figure 6).

Whereas traditional technical support in a classroom started with a blackboard and evolved via projector to an electronic presentation of learning material. The next logical step is interactive learning material, where the interaction can take place with a pre-programmed digital tutor (systemic intervention), or with a human docent or co-learner (systemic and concept critical intervention). This communication however must not have the usual digital form of interpersonal exchange (such as email, forum etc.) since in this form it is not centered on the topic to be learned or on the learner but rather on the usual human ritual of communication. Rather, new forms of dynamic lecture materials should be developed, where a Q&A session with a docent of a co-learner is directly connected with that place in the lecture material, where the problem arose.

Filtering of content, when a participant is able to

select the information he will see, and targeting of content, when a participant is able to designate recipients for his questions, remarks and answers, might be necessary to maintain a reasonable signal-to-noise ratio on a social CRS. This is especially important, when the collection and dissemination of contributions is not restricted to real time classroom activities and may span even courses.

4.2 Technical Design

Regarding the concepts previously described there are many technical challenges for implementations of Social CRS. Because modern CRS clients mostly run on mobile devices we assume that every potential user has a web browser and an internet connection, whether mobile or not. Based on this assumption we identify three main technical challenges. First of all there is the teaching content itself, which is the source of most feedback and the main part of interactive learning materials. Second the discussions, including their participants, references and verbalisations have to be implemented. Third the export of discussions is a functionality that highly depends on other technical frameworks, concepts and standards.

The teaching content mainly covers teachers presentation slides, scripts or any other digital documents. Current web technologies are able to present and distribute all of these documents, so the previous assumptions of an existing web browser enables Social CRS to display nearly every digital content teachers are currently using.

Providing a space for discussion or social communication is mainly covered by feedback type SQ (students questions). Even so discussions can arise from issues on other feedback types, so there has to be an implementation to switch to SQ or at least to initiate a discussion on a different medium. Furthermore discussions can include references to the teaching content, which can be implemented with references to digital objects (pictures, paragraphs, words, videos, etc.) of the digital teaching content. Moreover, social communication needs participants who can be addressable and identifiable. Modern CRS mostly have possibilities for users to use an existing identity, either from their university software system or their social networks. At least all users should be able to address new participants for a discussion and to resign the participation in a discussion. Social CRS can implement this requirement by using the existing identity management.

Exporting discussion or social communication highly depends on targets for an export and needs a specification for addressing. As stated above we rec-

ommend a strategy where digital fragments (or digital objects), as paragraphs, slides, pictures, etc, get unique identifiers. Additionally we assign each discussion and each point of discussion an unique id. Over the set of all digital objects and their identifiers Social CRS can span an Application Programming Interface (API), so identifiers are accessible with an unique URL. Thus Social CRS create the ability for an ecosystem around the given feedback. Applications of this ecosystem are able to access all the digital objects even if they were not created on them.

5 CONCLUSION

Our conclusion is that there is a strong need for CRS to allow and support social communication in learning environments. We showed that there are two basic types of communication on providing feedback. On the one hand the systemic intervention into feedback, when students need to deviate their accomplishment due to differences between their understanding and teachers knowledge. On the other hand the concept critical intervention onto feedback, which allows to rebind deviations from an affordance settings and to apply the teaching content and the progress of lessons to different scopes of relevance and function.

Moreover we presented conceptual and technical designs to create a Social CRS that is aware of these types of social communication (of feedback). This includes our approach to handle discussions (communicative interventions), which result from feedback, as important and necessary. CRS should allow to initiate or create discussions as a new part of a lesson that may be progressed in a different medium as well as CRS have to provide a way back to the teaching content. In addition we presented technical solutions for this concept which mainly base on a web application that provides discussion-objects.

In fact of the importance of discussions we are sensible of the distractions Social CRS will create. We see (Social) CRS as a tool for teachers and students that can support the learning process. For this reason one has to be aware that CRS are only able to see a portion of reality. This means that the benefit of feedback and its permanently availability highly depends on students motivation to document their feedback.

Beside this limitation Social CRS and CRS in general are able to become more than just feedback systems. In practice we observed students using CRS to criticize also the system around the lecturer: Some students claimed nuisances on the composition of students with different states of knowledge, which is

because the students come from different areas and which is enforced by the university administration. Even if the lecturer recognized this critics as spam at first, he identified it as this critic later on. Keeping this in mind makes it hard to decide if a discussion's level of distraction is worth it or not, even if this discussion might look like spam.

Further research should take up the discussion about social communication with CRS in general. Moreover there are several interesting questions on the discussion export. For example if it is possible to remove an existing export or all related connections. Furthermore it is possible that the ability to document all the social communication can lead to more unrelated information, such as spam, and that such information result in more expense of filtering them. In addition to this question further research can focus on the filtering itself. The filtering itself can be a part of the learning process and may be underestimated.

At least studies on CRS usage are highly important. On the one hand it has to be evaluated how teachers and students use Social CRS and if they get an benefit from them. On the other hand it should be evaluated when students use Social CRS or their documented content respectively. The latter may show that students use their documented social communication mostly for preparation for their exams. Of course this hypothesis is speculative at this point, but such an offline use, however, could require coining a new term, since it no longer is a Classroom Response System.

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