Comparing Tool-supported Lecture Readings and Exercise Tutorials in Classic University Settings

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Abstract: Teaching in classic courses offers too little interaction between docents and students and should be improved. Addressed approaches include a range from Simple Voting Systems to Clickers and Audience Response Systems, and interaction and Student motivation may be improved in them. However, different university course settings are affected in different ways by these systems. Therefore, this paper presents a comparison of a selected range of these systems (implemented as tool kits) within two course settings, namely readings and tutorials. These tools are Audience Response Systems, Question and Answer Systems (Q&A Systems), Discussion Systems (Panels), as well as Virtual Whiteboard Feedback Systems. A synopsis of feasibility for different settings is provided and concluded with important results on the distinguishability of Q&A Systems and Panels.

1 INTRODUCTION AND RELATED WORK

University courses at German universities aim to expand students' knowledge through the structured presentation of expertise by a docent, which goes beyond textbook knowledge, and by guiding students through the knowledge acquisition process. Teaching in classic courses has been criticised for offering too little interaction between docents and students. Learning as an active, constructive and highly individual process (Seel, 2003) is nearly impossible in huge readings and can be improved in most of the small course units, as well. As a consequence of missing interactivity and engagement, many students fail at learning - they do not manage to build adequate mental models of the domain taught.

There are several approaches to increase interactivity in classes. The spectrum ranges from simple voting systems (Duncan, 2006) to the method of Peer Instruction (Mazur, 1997). A large variety of systems are subsumed under the concept "Personal Response Systems" (Moss and Crowley, 2011), "Audience Response Systems" (ARS) (Caldwell, 2007) or "Clickers" (Brady et al., 2013). ARS provide feedback to the docent by giving the audience the possibility to participate during the course unit by voting on questions. By presenting questions during the course unit students get more involved in the lecture and the docent in turn gets some information about the audience's knowledge and attitude. Almost all of these systems work as follows: before starting the course unit, the docent defines one or more questions which are then presented on a screen during the course unit; the students are asked to answer via specialised technical devices (Clickers) or their smartphones. All answers are aggregated and immediately presented on the screen. The docent can include the audience's answers into the lecture, provide timely feedback, or adapt the lecture to special interests or needs. Some studies show that ARS are capable of increasing the interactivity in lectures (Mayer et al., 2009). A core instructional component of projects with ARS are learning questions (Mayer et al., 2009), (Weber and Becker, 2013) and live feedback features as in (Feiten et al., 2013).

Various studies have shown, that ARS lead to an increase of motivation (e.g., (Prather and Brissenden, 2009)) as well as to an increase of achievement (Duncan, 2006). According to (Caldwell, 2007) and (Beatty et al., 2006) ARS with questions can a) direct attention and raise awareness, b) stimulate cognitive processes, and c) help evaluating progress. When instructional designers have these underlying

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processes in mind when designing ARS questions, they can provide feedback to the students and can be used by the instructor as a source for feedback, as well (e.g. (Lantz, 2010)).

(Lantz, 2010) reviewed several studies about Clickers and concludes that providing questions within university lectures with the help of ARS has effects on attention, attendance, class preparation and depth of processing. Again, the questions provide immediate feedback to the students and can be used by the instructor as a source for feedback.

Existing Clicker Systems provide the possibility to increase the interactivity in university classes. In the following contribution we compare two systems which go beyond the classical Clicker System features with regard to their usefulness for the university readings and tutorials. The systems used in the existing literature vary with respect to their functions and the technical possibilities. We consider it useful to differentiate these functionalities into four categories: Audience Response Systems, Question and Answer Systems, Discussion Systems and Virtual Whiteboard Feedback Systems. The aim of the paper is twofold, as we aim to 1) present two systems developed in order to support students in university courses, and 2) emphasise that different content and course unit settings require tools to integrate distinct functions in order to help docents and students in successfully enhancing mastery of the learning process.

2 SETTING

As we intend to analyse a very focussed set of teaching and learning environments as well as situations, and draw conclusions on a comparison thereof, the considered settings shall be briefly outlined in this section.

The research conducted is based at a German university and topics are taught through readings, tutorials, practicals, as well as combinations thereof. All three types are based on units spanning 90 minutes. Purposed for knowledge presentation, readings present a learning environment in which an arbitrary number of a few to up to several hundred mostly passive students follow a docent presenting a subject. Tutorials and practicals are favourable means of knowledge consolidation. With respect to the knowledge presented in the readings, tutorials incorporate theoretical repetition and continued derivation, whereas practicals focus on the practical application of said knowledge. Typically, tutorials are designed to accommodate seven to up thirty students, whereas practicals often are designed for arbitrarily sized groups partitioned into units of three to eight students.

Due to a low utilisation degree of practicals at our alma mater, we want to focus on courses consisting of weekly readings accompanied by weekly or fortnightly tutorials. In this focus, both can be considered for tool-less and tool-supported realisation. The tool-less conduct shall be considered “classic”, signifying allowed presentation means are limited to voice, books, blackboard, pointer, demonstrators, as well as overhead and LCD projectors. Tool-supported realisations add to or replace parts of these means with interactive tools allowing two-way interactions between students and docents. The tools used are integrated into the curriculum and their primary objective is the enhancement of knowledge presentation and/or repetition.

Within the outlined focus, an intermediate realisation is of special interest for us, namely a course that can be conducted in a “classic” setting, but is amended by tool-support. I.e. these tools are **not** mandatory in order to achieve the course’s goal. – Hence, this realisation shall be defined as “pseudo-classic”.

Table 1: Test settings for the two systems AMCS and ETTK.

		Topic	**Dur.**	**n**
AMCS	Lecture 1	Psychology	90min	30
	Lecture 2	Cloud Computing	90min	18
	Lecture 3	Computer Networks	90min	$\sim$ 120
	Lecture 4	Economics	90min	$\sim$ 200
	Lecture 5	Economics	90min	197
ETTK	Exercise Tutorial 1	Computer Networks	10× 90min	13-26
	Exercise Tutorial 2	Computer Networks	7× 90min	7-14

In our investigation, we conducted tests in five readings with 15 to 180 students and seventeen tutorials with 7 to 26 students. An overview is provided in Table 1.

For the reading environment we utilised our system *Auditorium Mobile Classroom Service* (AMCS)[1] (Kapp et al., 2014b), (Kapp et al., 2014c), (Kapp et al., 2014a) with its integrated ARS and meta-cognitive activation features. The meta-cognitive prompts allow easy addressing of different target groups or even individual students within the audience.

[1]http://goo.gl/2UhsFn
– accessed 25 March 2015

Table 2: Synopsis of the technical comparison.

Tool/ Tool Kit	Lecture Reading	Exercise Tutorial
ARS	*feasible*, when slide-based, otherwise limited	*feasible*, when attached to line of thought and used with reset button, otherwise *infeasible*
Whiteboard	*infeasible*	*feasible*
Q&A System and Panel	*partially feasible*, for aggregation of questions and comments to be addressed at the end of or detached from unit	*feasible*

Within the environment of tutorials two prototypes were utilised, namely RNUW[2] with real time ARS and Q&A System, and ExerciseTool[3] with time decoupled ARS, Q&A System and Whiteboard. For both prototypes the Q&A System also served as a Panel as discussed later.

As for the applicability of the results and easier reading experience, we shall pool RNUW and ExerciseTool as one (virtually single) tutorial tool kit ("ETTK").

From a more technical perspective, the four enhancing tools elevating our classic setting to pseudo-classic tested and discussed within this paper are: Audience Response Systems, Virtual Whiteboard Feedback Systems, Question and Answer Systems, as well as Discussion Systems.

3 COMPARISON

Before outlining the comparison, we wish to forestall that our results are expectable; however, to our knowledge no original work has yet provided a diligent but routine piece of work on result provisioning.

The considered systems with their embedded tools naturally differ from each other due to their design and implementation, making a direct comparison difficult. However, on a conceptual level, suitable comparison conclusions can be drawn along the technical tools, or along classifications such as instant feedback, questions during the course (prepared lecturer's questions during the course), in-course collaboration (with Whiteboards), as well as questions asked by the students. The technical comparison suffers from partial indistinguishability of result allocation, whereas the classification comparison discriminates the technical aspects. – A synopsis of the technical comparisons is given in Table 2, and one of the classification-based comparisons in Table 3.

[3]http://exercisetool.inf.tu-dresden.de/ – accessed 2 September 2014

Table 3: Synopsis of the classification-based comparison.

Classification	Lecture Reading	Exercise Tutorial
Instant Feedback	*feasible*, when slide-based, otherwise limited	*feasible*, when attached to line of thought and used with reset button, otherwise *infeasible*
In-Course Questions	*feasible*	(not investigated for presence units) *feasible* for off-campus learning
Collaboration	out of scope	*feasible*
Student Questions	*feasible*	*feasible*

3.1 Audience Response System (ARS)

ARS present the audience of a course with the ability of providing direct and indirect feedback on the course's setting or its content. We considered two types of ARS, one providing presentation feedback (speech parameters) to the docent, and one for profiling of the audience and providing targeted hints to individual audience members. Both types are available concurrent to the course's presentation.

The first type allows students to provide *instant feedback* on parameters of the docent's presentation, i.e. speed and volume (in the tutorials we additionally tested explanation clarity). The university's semestral evaluation provides deferred feedback and is rarely finished and published before the end of the semester, hence the provided feedback does not benefit the evaluating students, but their successors in the next execution of the course. Therefore, motivation to provide qualitatively suitable feedback for the evaluation is low. Having the feedback available instantaneously allows docents to react in a timely manner.

The second type allows docents to prepare a set of timed questions and surveys linked to the presentation. These questions and surveys allow – when answered by the students – automated student profiling which in turn allows individualised system responses and learning experiences for each student. They also allow identification of learning demands, which in return helps the students focus on knowledge deficits when learning. Questions can range from a simple "Why are you attending this course", targeted at providing the docent with a gross overview of the composition of their audience, to individualised control questions like "Earlier you stated you were having difficulties to understand the DNS. Based on what has just been presented, [. . .]". Surveys present a distinct type of questions, i.e. linking the feedback of the entire audience, or a subset thereof, to form an opinion cross section which can be presented to the audience. E.g. the result of the before mentioned audience composition question could be presented to the audience in order of providing students a sense of cohesion or (intentional) rivalry amongst different degree programmes.

With respect to instant feedback, one of the main incentives is anonymity while providing feedback. The inhibition threshold to provide feedback – especially such that may reflect negatively on oneself – is considerably lowered when anonymity is introduced. This effect is considerably more noticeable in larger audiences, i.e. in readings compared to tutorials.

Another important aspect that could be verified in both environments is the immediacy of feedback and reaction. However, the extent of the immediacy varies between both environments. As the investigated readings' presentations were based on PowerPoint or Keynote, the ARS-based feedback was on a per-slide basis, meaning that students were able to provide feedback with the ARS at any time, but the feedback values were coupled to individual slides and reset after each change of slides. The docents as well as the students were able to see the ARS activity in real time, providing a topical audience report. The docents were at liberty to react to the feedback at their own discretion. However, processing of and reacting to the feedback proved to be most practical just before changing slides. This is vested in the available advertence of the docents who in general were occupied with the presentation, as well as the expected reaction time on the side of the students.

Ongoing availability of feedback was tested, as well. This however proved to make the correlation of feedback to presentation challenging. E.g. an "unable to follow" feedback could be submitted by the audience, but the docent's reactions could be delayed until moments later; i.e. in readings a few slides. This is important to note as within the tutorials per-slide basis was infeasible, as the investigated tutorials mainly used blackboards as their means of presentation. Hence, we investigated several different possibilities of feedback processing and reaction. An exemplary time decoupled ARS voting screen is depicted in Figure 1, where students could vote on the performance of the docent. The aggregated voting results are presented in Figure 2.

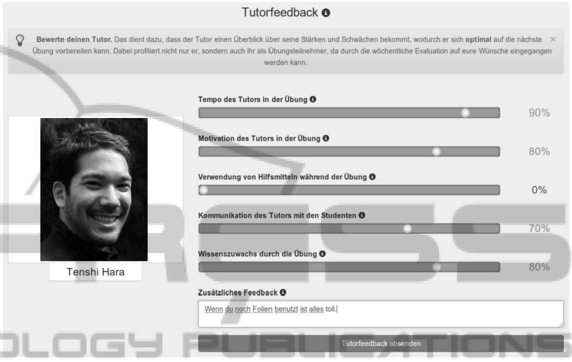

Figure 1: Students' voting screen allowing feedback on the docent's performance, as well as additional feedback.

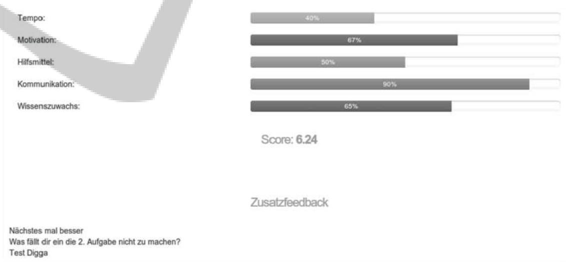

Figure 2: Docents' result screen allowing acknowledgement of their performance in the evaluated tutorial.

Hence, we investigated real time ARS feedback on the time bases of 5, 15 and 30 minutes in the tutorials. – An exemplary screenshot of the student view is provided in Figure 3. The Q&A System also depicted will be discussed further in Subsection 3.2 and Subsection 3.3.

Figure 3: Students can use ARS (top) and Q&A System (bottom) functions.

The time decoupled ARS proved to be impractical for the requirements of the audience. Students were able to provide feedback for the tutorial units on the unit-level, providing the opportunity of improvements in the next unit; but, motivation to participate was as low as with the paper-based semestral evaluations, if not even lower. We therefore changed the feedback to a docent evaluation where students could visually rate the docent's performance in each unit. Unfortunately, due to a small number of samples (3), the performance result are of limited significance.

For the time-based ARS feedback (as a reminder: bases 5, 15 and 30 minutes), our ETTK allowed an analysis of docent and student acceptance. However, strict obedience to the fixed time intervals proved impractical. Varying time consumption of different exercise tasks made a reasonable feedback correlation extremely challenging, especially when having the docent face the blackboard and forcing them to attend to the feedback by turning around, interrupting line of thought. Furthermore, it was hardly possible for the students to appreciate any feedback-based change in the presentation when the correlation to the original reason for the feedback was surpassed or lost. Therefore, we introduced a "reset button" which astonishingly proved to be very practical. It eliminated the time-constraints of the system while still allowing attributable reactions to the provided feedback. Nevertheless, the point in time of the reaction proved to be crucial. Having the docents react to feedback as soon as they realised there was feedback irritated the students as reactions in the midst of a line of though distracted both, the students and the docents. Next, having the docent react to feedback between different tasks was practical, but some students judged this referred response as being too slow; however, it generally improved acceptance. Lastly, we investigated having the docent react to the feedback as soon as a line of though was finished and positioning of the docent (as a person relative to the audience) allowed perception of the feedback. This compromise proved to be worthwhile to the students as irritations were limited since docents tend to emphasise changes of lines of thought by changes in intonation, speed, etc. anyway.

Back to the in-course learning questions, student participation and attentiveness can be improved by presenting students with those during a course unit. An example of such questions in combination with instant feedback features is shown in Figure 4.

In readings in-course questions can provide an individualised learning experience for students, even though the docent does neither actively, nor intentionally address individual students over the course

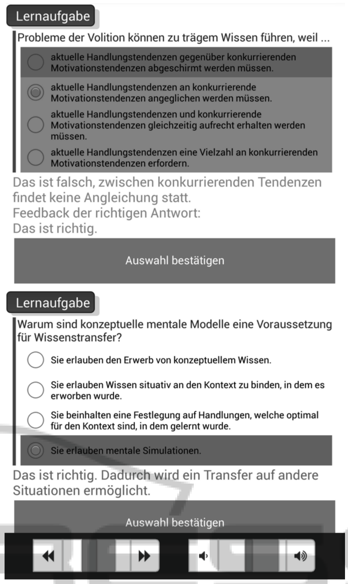

Figure 4: Individualised learning question arranged with single choice answers. The question on top has been answered incorrectly; an individualised prompt is given. In parallel, feedback on speed (bottom left) and volume (bottom right) of the presentation can be provided.

of a reading unit. The in-course questions must be prepared beforehand and currently cannot be generated out of the course material automatically. However, once questions are stored in the ARS alongside the course material – in our AMCS prototype they were stored within the PowerPoint and Keynote files as notes –, maintaining/revising them can be conducted alongside maintenance/revision of the actual course material. As mentioned earlier, AMCS allows meta-cognitive prompts. These are generated based on the answers submitted by students, and their profiles. A docent may prepare prompts for a selected subset of the audience, which is practical if the audience consists of students from different degree programmes, and individual prompts are not targeted at all programmes. Other targetable preconditions include whether students attend the course because of it being mandatory to their schedule or out of actual interest; such students are more likely susceptible for prompts on research proposals or available thesis topics.

In general, students reacted positively to the activating aspects of in-course questions and deemed them a valuable addition to readings. For example, students of the first reading (Psychology) were asked if they considered the functionalities (learning questions, messages and feedback to the lecturer) useful. They mostly agreed ($M = 4.19$, $SD = .68$, $n = 22$; scale from 1 "I do not agree" to 5 "I fully agree"). In line with that statement participants of the fourth reading (Economics) rated learning questions within the lecture as very useful (refer to Figure 5. Unfortunately, with a rising number of student attendance, server load exponentially grows, which yielded severe performance problems in the third reading (Computer Networks), but could be purged later on. Basic learning questions and direct feedback do not cause these problems, but frequent database or in-memory checks on complex model correlations (beyond "correct" or *incorrect* answers) for individual messages to be sent to all system users can be disadvantageous.

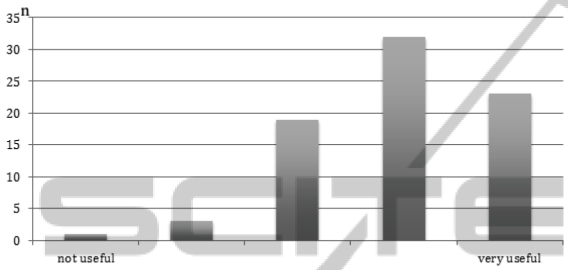

Figure 5: Students' usefulness assessment on Likert scale (1 "not useful" to 5 "very useful") of learning questions, messages and feedback to the lecturer. ($n = 78$).

For tutorials, utilisation of in-course questions is ambiguous. On one hand, they allow continued activation of fast/good students by presenting them additional learning questions as soon as they have finished topical tasks, hence reducing their idle times. On the other hand, this additional demand channel[4] endangers overall attentiveness as the docent continues asking verbal questions towards the general audience or individuals within the audience. No matter what psychology model one believes in, either multi tasking, or single tasking humans, the additional demand channel either takes from the shared attention pool and generates additional administrative effort in the multi tasking model, or it reduces the available attention spread in the single tasking model. This theoretical demur could be confirmed for in-course questions within a presence unit. However, stretching the definition of *in-course*, prepared questions for off-campus learning proved very useful. Especially the combination of before and after unit questions allows individualised identification of learning demands. Within our ETTK we presented students with confidence questions before each unit, simply asking them whether they felt confident in successfully finishing each single exercise tasks. For this, only the headings of the tasks were presented with a 5-step Likert scale (ranging "very uncertain" (1) to "very confident" (5)).

[4]In a psychological perception model, asking questions yield an answer demand. In the model, each means of question asking is a demand channel.

After each tutorial unit the students were then presented the same questionnaire, allowing the ETTK system an automated comparison of before and after unit confidence in a first step, and deriving individual learning demand for each student in a second step. Ultimately, a third step generated recess information on the course group's learning/understanding progress, providing repetition proposals to the docent. An exemplary individualised learning demand appraisal presented to a student is depicted in Figure 6.

Figure 6: Individualised learning demand appraisal pointing out deficits the student should focus on.

3.2 Virtual Whiteboard Feedback System (Whiteboard)

Whiteboards are a means of *collaborative* development and provisioning of sketch areas. In our setup we utilised a Whiteboard for student hand-ins during tutorials; utilisation in readings would not be feasible due to the size of the audience as well as their focus on passive presentation. The expectable amount of feedback would be more than challenging for the docent to comprehend. Of course, Whiteboards *can* be used as a scratch pad by reading attendants, but this scenario was not considered in our tests.

For a given task students would normally prepare hand-ins which in turn would be either selectively or in total put to discussion among the group, distributed among learning groups, effectively permuting a course's hand-ins within the course, or evaluated by the docent out of course units and have the results presented in the next unit. Loosening these constraints, Whiteboards allow a quasi-real time anonymous discussion of hand-ins without handling paper submissions. The docent can either share the evaluation process with the group, which would be equal to the prior mentioned discussion, or they could evaluate submitted hand-ins as they appear in the system and mark "noteworthy" submissions for later condensed discussion. This helps conserve valuable tutorial time.

Although Whiteboards allowing students to submit hand-ins are infeasible for readings, it can be argued that they can be utilised for other forms of feedback submissions. While this is true for students taking down notes and sharing them among each other, they could only be utilised for time-decoupled hand-ins from the docents' point of view. However, in our setting tutorials are the environment for hand-ins. In addition, having other feedback like questions submitted via Whiteboard inhibits automated handling in database archiving, etc., which is possible with ARS and Q&A Systems. Consequently, Whiteboards in readings are infeasible and their task can be satisfied by ARS and Q&A Systems.

With respect to tutorials Whiteboards can provide additional, valuable feedback possibilities. As discussions on topics are targeted, the ability to provide feedback and/or hand-ins that need not adhere to text-based restrictions (Q&A System) or pre-selection values (ARS) is a valuable amendment to tutorials. Students can swiftly hand-in tables, sequence and state diagrams, or other UML and sundry diagrams. As described in Section 2, the hand-ins are designed to be discussed in a timely manner, so the aspect of automated handling, etc. as discussed for readings is not as important. Generally, Whiteboard submissions would be erased after an tutorial unit and its associated discussions had concluded.

3.3 Question and Answer System (Q&A System) and Discussion System (Panel)

We assume the concepts of Q&A Systems and Panels are well known and do not require a definition here, so we can concentrate on the *student questions*.

Since 2011 we are utilising an advanced combination of Q&A System and Panel with Auditorium[5] (Beier et al., 2014), (Beier, 2014), which was originally developed as a student project. A simple Q&A System was tailored to tutorials by including it into an exercise tool kit with ARS as well as Whiteboard. This Q&A System allowed tutorial participants to anonymously ask questions, and up- or down-vote questions submitted by other students. The docent would – time permitting – answer the highest ranked questions at the end of an tutorial unit. However, actual deployment of the Q&A system lead to some modifications to this idea that shall be discussed here (and in Section 4), notably its "misuse" as a Panel.

Based in the design of readings, only a few questions can actually be addressed during a reading unit. Tacitly agreed upon, only imperative questions of utmost importance are asked during the reading, as this interrupts the docent. Students tend to note down questions and approach the lectern after a reading unit has concluded.

Deriving from the so described situation, Q&A Systems can only help to a certain extend. However, having a Q&A System serve the Q as well as the A aspect is surely infeasible for readings as the A aspect still contributes to interruptions of the reading. However, the Q aspect can serve well as it allows students to immediately note down questions they might have. These questions can then either be answered by the docent later (qualified answer), or they can be answered during the reading by other students who might have already understood the topic (or think they have) of the question or aspects thereof (solicited answer). Solicited answers can later still be revised or amended by qualified answers. Hence, Q&A Systems can augment readings, but only if the Q and A aspects are loosely coupled in terms of qualified answers in a timely manner. – Our Auditorium system addressed these aspects in the classic way a forum would, by also allowing vested discussions on topics.

Combining the aspects of system knowledge on individualised learning, our system was able to join assumed knowledge on individual learning progress with student question demand. AMCS fostered students to ask relevant questions by sending push notifications to their smartphones. Based on their individual profiles, AMCS sent messages, e.g. "You still had some problems with [topic]. You should ask the docent about [identified deficit]."

On the side of tutorials similar considerations as for readings can apply. Tutorials are designed for students to actively engage in the topic materials. As course contents are mandated by the predefined curriculum, time constraints mostly affect tutorials and limit the presentation/discussion ratio; some coverage of subject matter is mandatory, as all units are limited to the time frame of 90 minutes. So the basic problem is finding a solution to how many questions can be answered within 90 minutes without endangering the goal of covering all required topics. In classic tutorials students would raise their hands and the docent would either fairly apply FIFO[6] processing, or unfairly by arbitrarily (i.e. at their discretion) picking students. This can lead to stress and disappointment for the students as questions perceived as important might not be addressed or sufficiently answered.

Having introduced Q&A Systems into the described situations allowed maintaining a comprehensive list of submitted questions students either don't want to discuss openly because they are ashamed of exposing themselves, or deem important enough to ask, but not important enough to be addressed imme-

[5] https://auditorium.inf.tu-dresden.de – accessed 24 March 2015

[6] First In First Out — Students are processed in the order of them raising their hands

diately. Sometimes time constraints can force the docent to only allow a few questions at the end of the tutorial. Whether all questions can be answered is a secondary concern.

Introducing a fair rule for immediate and delayed answering of question might just do the magic. By allowing all questions – once again anonymously – to be seen and voted on by all students allows swift aggregation of issues important to the majority of students. In means of self-regulating communities as e.g. in stackoverflow[7] students are allowed to up- or down-vote questions, and therefore deciding themselves, which questions are "worthy" (important) and "non-sensical" (unimportant). Permitting time at the end of the tutorial unit, the docent can then immediately answer the top-X (e.g. 5) questions, while postponing answers to the other questions to an off-unit discussion. – Refer back to Figure 3 for an exemplary voting.

However, during our tests we observed that students would tend to not actually vote down questions, but use a comment feature designed for an utterly different purpose: our prototype allowed students to amend their questions with additional clarification of their problem. But, due to an implementation error all students were able to amend all posted questions, effectively transforming the feature into a commenting system. Making use of this error, students tended to negatively comment on "non-sensical" questions rather than voting them down. This could manifest into an extend close to mobbing the initial question poster to revoke[8] their question. On a more positive side, the "commenting system" was intensively utilised by idle students to try to explain and present their understanding of solutions and providing answers. This in turn lead to even higher grade up-vote results, as well discussed but still unresolved questions would tend to lead the ranks of "worthy" questions imperatively mandating answers by the docent. – For the idle students, who in general are the better among the group, this provided a stage to test themselves by attempting to help others without exposing themselves as strivers or nerds. Once again, the aspect of self-regulating communities supported the system as disturbers were swiftly engaged by the other students.

As seen, our investigations show that it is not advisable to strictly separate Q&A System aspects from Panel aspects.

[7]http://stackoverflow.com/
– accessed 25 March 2015

[8]Students were able to revoke their question at any time. Revoked questions were deleted from the system, making them also inaccessible to the docent.

4 RESULTS AND FUTURE WORK

Our comparison for the investigated tools show only few new noteworthy aspects findings when applied to a course curriculum consisting of readings *and* tutorials. However, when considering both settings separately with respect to the investigated tools and their combination, several remarkable aspects could be observed. – We wish to focus on two results here, namely "Panel*isation*" of Q&A Systems in tutorials, and readings and tutorials complementing eachother in their utilisation of tools.

The attendants of tutorials acting as a self-regulating (online) community within the tool kit prototypes was unexpected and needs to be investigated further. This implies that less "community management" effort is required from the docent, due to the students' situation awareness. Nevertheless, the extent of attentiveness for such "community tasks" in parallel to the actual tutorial activities needs to be fathomed.

Our design decision to utilise separate tools for readings and tutorials was founded in the well established Auditorium/AMCS for readings on one hand, and the desire for fast prototyping for the tutorials on the other hand, allowing week-to-week incorporation of subject (student) feedback. This decision proved to be poor, as this approach not only confused students and docents, but also discouraged both from using the tool kits. In future, we will research the effect of providing readings and tutorials using a single tool kit for both, readings and tutorials, by assimilating the best aspects of our ETTK prototype into AMCS. However, at the same time both application settings must be further investigated since their different contexts require different tool and/or system aspects. The usefulness of certain features remains dependant on the context of the application setting, so our system will need to adapt adequately. As our current systems can be utilised together with other e-learning tools or in combination with MOOCs, we wish to investigate the impact of our combined single system on those, as well. Especially as those e-learning tools and MOOCs often incorporate isolated applications specific to readings or other formats.

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APPENDIX

All tools and tool kits we utilised were web-based and operated from standard web servers at our alma mater in Dresden, SN, Germany and in Saint Louis, MO, USA. Access was made possible for web browsers as well as dedicated iPhone and Android apps for AMCS, and took advantage of socket-based bidirectional real time communication.