Aurora - Exploring Social Online Learning Tools Through Design

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***Abstract*—Teaching is an integral part of our work at university and we strive to achieve a high quality in teaching our students. Yet, we face classes with up to 800 students per semester and do not have the resources to ensure a close rapport with each and every one of them. For the last 6 years we have been working on an online solution for this problem, with the aim of letting students take responsibility of a large part of their own learning process. The e-learning system Aurora envelops a number of components ranging from organizational and informational tools to discussion systems and student portfolios. Students are invited to participate actively in this online learning environment and are presented with a variety of options they can choose from in order to accumulate enough credits to pass their courses. Over the years of developing Aurora, issues and inadequacies of the system became apparent and lead us to change our system design iteratively, learning from its shortcomings.**

Keywords-Asynchronous Interaction, E-Learning, E-Portfolio, Electronic Note Taking, Backchannel, Teaching, Design, Newsfeed

I. INTRODUCTION

The Web 2.0 as described in [1] changed online culture and shifted it from a passive consumer culture to a participatory culture. This development also influenced the process of teaching and learning, which is since referred to as E-Learning 2.0. The notion of E-Learning 2.0 is that Web 2.0 technologies are adapted and integrated in E-Learning systems [2]. Knowledge can be created, shared, remixed and repurposed by communities of practice. Students are part of this process, collect sources and participate in the communities, by sharing their own ideas and findings. Brown and Adler [3] describe a new age of education, in which lifelong learning is not only needed but also supported by the participatory architecture of the Web 2.0. They speak of a new learning approach, "...characterized by a demand-pull rather than the traditional supply-push mode..." of obtaining knowledge. They emphasize the importance of social learning in the new online learning environment, pointing out, that the traditional teacher-student relationship is exchanged by a peer-based learning relationship.

Siemens [4] took this change of learning culture and devised his theory of connectivism. He states that learning in the digital age is the self-driven process of building up networks of knowledge. Nodes in a network can be data sources, communities or people and are connected to the network with strong and weak links. Weak links are more interesting since they can open doors to new areas of knowledge, diversity and innovation. Siemens points out that the lifecycle of 'correct' facts is getting shorter, and new knowledge is created faster, so memorizing facts is not yielding desired results anymore. More important is the 'Know-where', which describes where knowledge can be found quickly rather than learning the knowledge itself.

In this paper, we present an E-Learning System with the aim of letting students take responsibility of their own learning process. The system is an attempt to create a holistic learning platform, valuing not only assigned course work, but also social and other additional content students create or discover over the course of a semester. What we wanted to avoid was to develop another system increasing the distance between teacher and students. Instead, our goal was to start from the rather difficult situation of very large classes, where contact between teacher and student is short and far between, and transform it so that students have a feeling of more immediate involvement, more contact and more personal mentoring. To achieve this, we put concepts like social interaction, participation, and exchange at the center of our design efforts.

Aurora is a learning platform consisting of three modules that can communicate with each other. The Dashboard is an administrative tool, containing an administrative Newsfeed as well as widgets to enhance communication between all participants of the course and maintain an overview of the course progress and interesting developments around the course topics. The Slides module is used during and after lectures as backchannel and basis for upcoming discussions around course topics. Students are provided with a pool of activities they can choose from in the Portfolio. We chose the word activity rather than exercise for work assignments, since we want to motivate students to actively pursue their work for this course and we wanted to avoid the vocabulary usually associated with course work to try to increase motivation. The name Aurora is not an acronym, nor has it any deeper meaning. We used the name because it refers to something beautiful, and because it sounds good. Also, pictures of auroras give awesome visuals to be used in the layout.

The remainder of this paper is structured as follows: The next section 'Overall Goal' will give an idea of our motivation and process to create a new e-learning system and explain why we chose to develop the system ourselves instead of taking existing tools. Subsequently, in the section 'Components', each module of Aurora is described and compared with existing solutions from literature. The description is followed by a preliminary evaluation, 'Evaluation', and finally a conclusive section, 'Conclusion and Future plans', in which we describe how the evaluated data influences future designs.

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II. Overall Goal

At the Vienna University of Technology, lecture participants are sometimes in the high three-digit numbers. Traditionally, this would mean that lectures have to be endured with a passive and consuming stance. Around 2005, we set out to explore new ways to make lectures more interactive. We started by appropriating existing systems like IRC and Twitter to facilitate backchannel communication and interaction for students visiting large lectures. Early on, we were fascinated by the idea that we could time-sync this information to the slides. This would enable students to understand the backchannel as a means of taking (collaborative) course notes that became attached to the individual slides of the lecture.

We also started to replace the then prevailing passive html web pages for course information with blogs, which seemed an ideal fit for some years. Later, we started to supplant blogs with a custom-made newsfeed solution that was heavily inspired by the structures and aesthetics of social media systems like Facebook or Twitter.

By replacing all the passive elements of large scale courses with interactive components, we also set out to change the way we evaluate student performance in order to come to a final grade. This led to a somewhat idiosyncratic redefinition of a portfolio system that we implemented.

All these systems are currently being actively developed and refined in an effort to explore new ways of teaching and learning for a generation that grew up with ever-present internet access and for the most part played a lot of games [5]. We redesign our systems year after year after understanding what works and what doesn't. We pursuit this research in the spirit of design as research, or explorative design. One core idea is that with each version, new concepts become evident that were impossible to see last year, be it from use, from formal or informal evaluation, or because we reflect on our progress from the feedback we get from students.

Following this path for some years now, we have come to a place where individual components have been published about, but we never set out to describe the system as a whole. This is what this paper sets out to do.

III. Components

A. Dashboard

Dashboards are often used in complex system to provide participants with an overview of activity on these platforms. The role of a dashboard is variable, depending on the context of its application. Dashboards have been used to track activity from different applications in a complex system [6]; to create peripheral awareness, provide navigation and a system-wide inbox [7]; to create awareness of group members' actions and to convey the status of shared artifacts [8]; and to provide multiple views of a large dataset in a system [9]. More specifically, in an e-learning context, they have been used for self-monitoring for students and to improve teachers' awareness [10]; and to help students to relate their learning experience to that of their peers or other actors in the system [11].

In Aurora, the Dashboard is the first page every student is presented with when logging into the system. It is a collection of widgets, containing the Newsfeed, an individual course status overview, showing colleagues, groups, current links and additional contact information. The page draws together course-relevant information related to the content from other websites, as well as information from other components of Aurora.

In former versions of Aurora, we included a statistics page to enhance students' peripheral awareness. The page provided a statistical overview of the large amount of data that is distributed over the whole system. Students could for example look up who of their peers was involved in a lot of discussions, or who got a lot of stars, which could be awarded for good comments by other students and members of the staff. This view has not made it into current versions of the system, mostly because of a lack of time and resources for the development.

1) Newsfeed: The Newsfeed is a largely organizational message board, but can also be used for content related postings. The lecture staff can use the Newsfeed to publish course updates and other relevant news for the students. Questions, annotations, complaints and praise can also be posted here, and can be answered by other actors in the system. Students post content related comments as well, but are asked to first look for a suitable slide in the Slides section to provide context for the content, before blindly posting it in the Newsfeed.

Information from other components is collected and posted via sticky notes at the top of the Newsfeed. Students are informed if someone answered to one of their postings in the Slides section and can jump directly to the posting via link. If students get points for a good comment in the Slides section or for a newly marked activity in the Portfolio, they are notified here. Direct messages show up on top of the Newsfeed section, and can be sent by either colleagues or team members.

The Newsfeed enhances direct communication between students and staff and also provides a forum for discussions about the course design. It can be searched or filtered to see either only staff postings, only organizational postings, or only content related postings. Students can subscribe to Newsfeed postings via RSS to integrate them into their everyday online environment.

2) Additional widgets: The Progress Bar widget is a tool students can use to get an overview of their progress in each of their classes. Each lecture has an overview of the student's activity status. It shows the amount of points received in the lecture through activities and through comments, as well as the total amount of points. Additionally, it shows the amount of points that the student has handed in but which have not yet been graded and the amount of points the student can still hand in until the end of the semester.

In the Colleagues widget, users can add other students to their course network and, on accept, see their avatars and further information. They can write direct messages to their colleagues as well as see all their colleagues' comments in the Newsfeed and the Slides highlighted. This can create a feeling of connectedness within the course and motivate to interact with others regularly.

Some activities in the Portfolio can be worked on in teams. The Teams widget shows a list of all existing teams the student is a part off. Each entry contains the name of the project the team is working on, the possibility to send a message to all team members, and a list of the other team members.

The Current Links widget displays a list of recent articles and interesting websites - supplementary reading material of topics covered in the course. The collection of links is compiled in a blog using soup.io and integrated into the Dashboard via RSS.

Lastly, the Dashboard lists contact information to correspond with the staff directly. Students are invited to ask all

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course relevant questions directly in the Newsfeed so that other students can profit from the answers as well, but some issues need to be taken up with the staff directly.

B. Slides

There is some research on how to offer interactivity in large lectures. One approach are the Audience Response Systems, also called Clickers. Kumar and Rogers pioneered such systems in their 1976 Olin Experimental Classroom [12] that featured a feedback channel for students in the form of 12 buttons. Today, clickers are commercially developed products, offering a number of potential benefits to large lectures. Caldwell [13] summarized the literature on using clickers in lectures. Recently, software clickers based on the fact that most students bring a network-connected device, most prominently mobile phones, to lectures have begun to appear, but this approach is still mostly experimental [14] [15].

Of course, more elaborate backchannel communication systems have been tried as well, such as ActiveClass [16], Fragmented Social Mirror [17] or ClassCommons [18]. The development and evaluation of these systems overlaps with the development of the approaches presented here, first published in 2008 [19].

It can be argued that backchannel communication during lectures is potentially distracting, diverting the attention from the speaker to unrelated things. On the other hand, students regularly bring their laptops to class in the hope of finding productive use, but often end up doing other stuff that is available on the computer. We have observed that supplying students with a backchannel that is centered around the lecture itself brings some of that attention back, and while it creates bubbles of divertion from the lecture itself, at least these bubbles are focussed on the content of the lecture.

Slides consist of two major components, Livecasting and Studio. Livecasting lets participants add notes to individual slides of a lecture, either in the style of a backchannel conversation, or privately. Once the lecture is finished, slides and comments are available in a combined view in the Studio. Participants can keep adding comments, links etc. in the Studio, so that the lecture slides become the focal point of discussion and exchange for participants and lecturers alike.

1) The Livecasting component (Figure 1): During a lecture, the lecturer runs a script on her computer. By pressing the next slide button on the remote, she triggers a script that sends the number and title of the newly displayed slide to the slidecasting server. Additionally, the script retrieves the lecture notes of this slide in the presentation document and scans them for a custom-made meta-syntax signifying information that is meant to be posted with the same slide. These text-lines include explanations, enhanced quotes, references and other links, activities and discussion starters.

Participants load a web page that changes with each slide the lecturer shows, so that information entered into either the public comment or private note fields on this page ends up being attached to the slide that was visible when the participant started typing. All participants can see the public comments entered by other participants, and they can reply to these comments, creating ad-hoc discussions of the lecture content. To ease the cognitive load, a participant's own comments are colored yellow. Additionally, students have the opportunity to mark slides as liked, important or unclear with a single click.

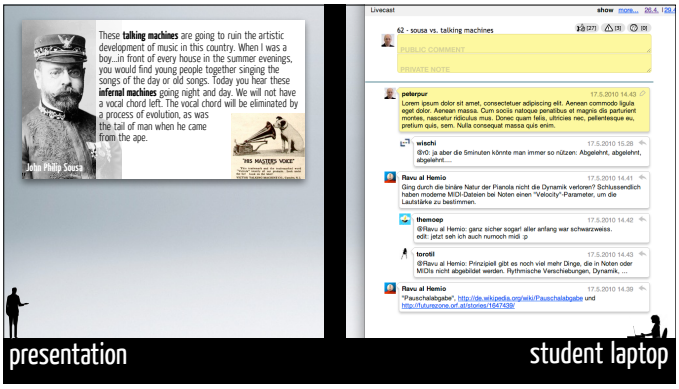

Figure 1: Livecasting setup of the Slidecasting system

2) The Slidecasting Studio (Figure 2): Once the lecture is over, the lecturer makes slide-by-slide pictures of his presentation available to the slidecasting system. While this can also be done before the lecture, we decided not to show the slides because of the obvious spikes in network traffic this would generate whenever a new slide is shown. The slides, all the participants' comments as well as the lecturers automatically posted comments are then made available in the Studio.

Here, participants and lecturers can post comments even after the lecture is finished. In the Studio, the slides are arranged horizontally, sorted by their time of appearance in the lecture. The comments attached to each slide are laid out vertically, with the earliest comments up on top (usually the comments posted by the script on the lecturers computer), with reply threads sorted in the same way.

Participants can give praise to good comments by clicking the star next to the avatar of the author, in which case the star turns yellow and shows the number of clicks it has accumulated. Lecturer can use this same mechanism to award points to outstanding comments. In this case, the star is distinguished with a green glowing outline, making its commendation visible to everybody.

While lecturer's comments are generally displayed in the same way as student comments, there are two lecturer-posted types that stand out from the rest: discussion starters and activities. Comments of both these types are arranged between the slide and the private notes delineator, thus standing out even when scrolling through the slides quickly.

Discussion starter comments typically contain a questions and an invitation to discuss this question in the comments of the slide. We use this mechanism to post slides in between lectures, asking participants to discuss upcoming content. Activities contain a brief explanation of an activity, linking into the Portfolio system where an elaborate description of this activity can be found. This gives the lecturer an opportunity to announce new activities that derive from the content on a slide.

Activities take student to the Portfolio of Aurora, where they hand in their work for review and evaluation.

C. Portfolio

In areas like HCI or Informatics and society, it is hard to make written exams, and once you have more than a couple of hundred students, it becomes impractical to the point of impossible to conduct oral exams. We started to abandon tests

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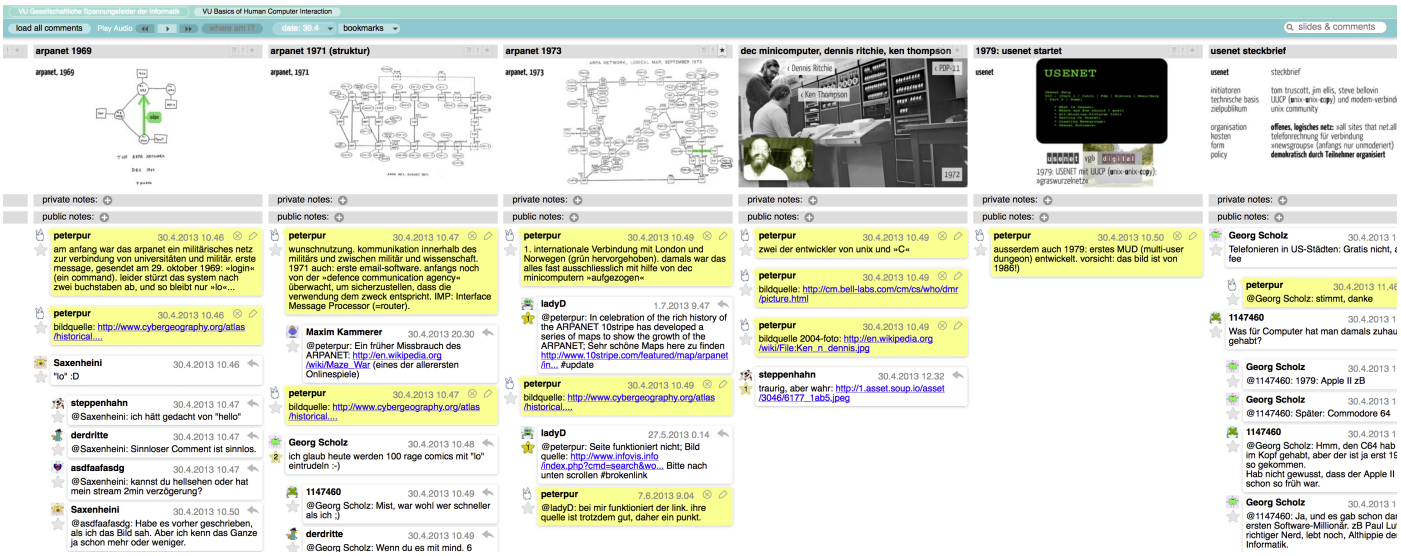

Figure 2: Slidecasting Studio, where all slides and comments become accessible to participants and lecturers alike

and exams at some point when we had the distinct impression that the fact that we had to make a written exam changed what we taught. This compromises the whole idea of teaching, especially at the university level.

For a couple of years now, research papers have been explaining the theoretical sense the adoption of ePortfolios would make. Advantages implied are, among others, improved reflection, increased student engagement, improved learning outcomes, and increased integration of knowledge [20]. The paper quoted gives a comprehensive overview over ePortfolio research, and points out the lack of empirical support for many of the asserted advantages.

The module we call Portfolio is not really an ePortfolio in the strict sense of the word. While we explicitly ask the students put upload artefacts that shows what they have learned, we offer a large catalog of predefined activities that can be handed in here. These activities include a broad range of tasks, from simple applications of theoretical content, to actions reflecting their own prior projects, to complex design exercises. Many of those activities would make viable exercises in a traditional deadline-based context, while others would be quite unsuitable for such an environment. The catalog also contains meta-activities such as finding new sources, suggesting new activities, and organizing round table discussions with experts in the field. No activity should yield substantially more than 10% of the final grade, so that students will be exposed to a broad range of topics.

Participants hand in their work using the portfolio system of Aurora. We do not set any deadlines other than the end of the semester, and we do not expect them to follow a specific order. The only requirement they have to meet is to make sure that their work is distributed throughout the semester, instead of congested at the end.

The Portfolio includes an easy review component for the course admins to review and evaluate the participant's work, with the notable addition of enabling for the students repeated submission of work that failed to meet the standards. It also includes a double blind peer review component that makes part of the assessment process into an activity by itself on the premise that if you do an honest review of somebody else's work, you will learn a lot.

This approach tries to abandon the usual scattering of deadlines through the semester, giving the students a lot of autonomy in their work, which self-determination theory deems essential for intrinsic motivation [21].

IV. Evaluation

Our focus in evaluating these components is in better understanding how we can advance the system. We do not have an ultimate goal, but we use both the design process and the evaluation to understand how the system should be enhanced, refined and changed in order to satisfy our needs as teachers as well as the needs of the students as learners.

TABLE I: The table shows how many people were involved in the evaluated courses, staff as well as students. Additionally, it shows how many certificates were handed out for each course at the end of the semester.

	Profs	Predoc	Tutors	Students	Certificates
BHCI	3	1	6	733	442
IST	1	1	4	521	337
Total	3	1	10	1254	779

This preliminary evaluation is based on data from two courses, Basics of Human Computer Interaction (BHCI) and Interactions of Society and Technology (IST), which took place in the summer semester of 2013. A total of 11.793 activities was handed in over the course of the semester, 7126 in BHCI and 4667 in IST. The staff of both courses combined consisted of 3 professors, 1 predoctoral fellow and 10 tutors, exact numbers can be found in Table I. Students only got a certificate if they handed in at least one activity. Every student who ultimately received a certificate handed in 15 activities on average. In the Slides section, 1283 slides were posted distributed over two courses with 23 lectures in total, and 3975 comments were written during and after these lectures.

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Figure 3: Time it took to grade an exercise, calculated in weeks

A. *Portfolio evaluation*

Figure 3 shows a pie chart of the time it took to grade activities. One third of the activities were graded after a week, which would be an acceptable amount of time for students to wait for feedback. Given the student-staff ratio, we tried to achieve a maximum waiting time of three weeks until every activity is graded. As can be seen in Figure 3, we were not able to reach that goal, as only two thirds of handed in work was evaluated within the given time frame. The final third of the pie chart consists of activities that took 4 and more weeks to be graded. Considering the importance of feedback in order to keep students motivated and continuously working [22], 4+ weeks seems too long a time to hear back on one's work.

We suspect that this fluctuation in delay can actually be explained by queue modeling in game theory. Activities tend to be handed in unequally distributed in time, leading to an overload what causes congestions that are then almost impossible to resolve within the given resources until the end of the semester.

B. *Slides evaluation*

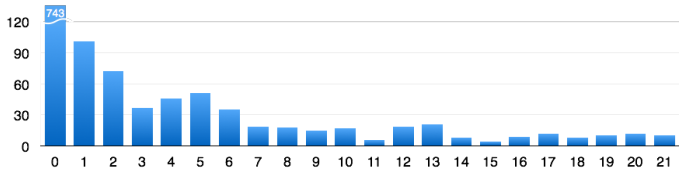

Figure 4: How long after a slide was posted (Day 0) are students interacting with it via the comment stream.

In Figure 4, the comment data was analyzed to find out if and how long after the lecture students engage with the content by writing comments and discussing it in the Studio. The graph shows that most comments are written during the lecture, but there is a long tail (going up to 75 days) after the original slide was presented. Approximately 120 comments were posted even after the semester was over.

Also interesting for us is the second peak a couple of days later, as well as the 'long tail' of posted content after the lecture that can be seen in Figure 4. A cursory evaluation of these 'late' postings show that students come back to post things they find relevant, like news coverage, examples, references, etc. or to partake in discussions they have started with another postings. We see this as a successful feature of the system, as it induces reflection of and occupation with the content of a lecture quite some time after the lecture is over.

V. Conclusion and Future plans

The main goal of our work is to explore the design space of online teaching and learning support systems. Our approach is best described as explorative design, with the main goal to better understand the situation, the players, and their needs. In building and using systems that implement novel approaches to the context of teaching and learning, we in turn have a chance to understand the change such systems bring into the situation, and react accordingly. This approach shifts the focus of evaluation from understanding how and why the approach worked (or not), to finding new approaches to try. In the end, we are not interested in proving that our approach is right, e.g., by showing effectiveness by some abstract learning measurements. Instead, we want to find new and better ways to teach and learn that use the potentials of new technologies, and tap student's self-motivational capabilities.

The next version of Aurora is already in development. We redesigned Portfolio in order to address previously identified problems, and to explore new ways of organizing evaluation and grading. Our main goal was to reduce the students' waiting time for graded activities by introducing double blind peer reviews into the grading process. Also, activities will be organized by topic and will be structured in 'levels' that build on each other. Only top level activities are considered grade relevant and will thus be graded by a staff member. All other activities will just be reviewed by two or more peers with an emphasis on constructive feedback, not marks, given by the reviewers. For every activity a student hands in, they have to review three activities of the same type handed in by colleagues. To maintain a certain level of quality, activities as well as reviews will randomly be checked by members of the staff. We will also implement an easy way for students to report extremely poor elaborations, plagiarized work, or, on the other side, if they did not get meaningful feedback from a reviewer.

The second component that is undergoing major changes is the Newsfeed. We are putting more emphasis on ways to filter and reorder the comment stream in order to make information better accessible. This redesign is based on the way reddit [23] works, e.g., using up- and downvoting to incentivize collaborative content filtering. We also designed a feature to extract good (student) questions and corresponding (student or staff) answers from the Newsfeed for display in a separate FAQ section.

Another step in Aurora's development will be to include our discussion component Discourse into the system. Discourse is a threaded asynchronous discussion forum that differs from traditional systems in the way discussions are represented. It vertically displays new thoughts, arguments and ideas in the discussion, and horizontally the answers and exchanges to said arguments. Students can gain points towards their final grade when participating in discussions and composing clear arguments supported by references.

Handling more than 500 students in university courses is a rare situation. Often, such a challenge is tackled by introducing distance between teachers and learners, and by relying on examination and tests. This removes autonomy from the learning process, which we see as a central property. Thus, we tried to go the opposite way, and designed Aurora with the

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explicit goal to give students as much autonomy as possible in such a setting. In our experience, such a challenge requires explorative approaches, learning not only from evaluation, but also from the design process itself.

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REFERENCES

[1] T. O'Reilly, "What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software," Design, vol. 65, 2007, pp. 17–37.

[2] S. Downes, "Feature: E-learning 2.0," Elearn magazine, vol. 2005, no. 10, Oct. 2005, pp. 1—, [Accessed Jan. 24, 2014]. [Online]. Available: http://doi.acm.org/10.1145/1104966.1104968

[3] J. S. Brown and R. P. Adler, "Minds on Fire: Open Education, the Long Tail, and Learning 2.0," Educause Review, vol. 43 (1), 2008, pp. 16–32, [Accessed Jan. 24, 2014]. [Online]. Available: http://www.educause.edu/ir/library/pdf/ERM0811.pdf

[4] G. Siemens, "Connectivism: A Learning Theory for the Digital Age," 2004, [Accessed Jan. 24, 2014]. [Online]. Available: http://www.elearnspace.org/Articles/connectivism.htm

[5] M. Irvine, "Survey: 97 Percent Of Children Play Video Games," 2008, [Accessed Jan. 24, 2014]. [Online]. Available: http://www.huffingtonpost.com/2008/09/16/survey-97-percent-of-chil_n_126948.html

[6] J. L. Santos, S. Govaerts, K. Verbert, and E. Duval, "Goal-oriented Visualizations of Activity Tracking: A Case Study with Engineering Students," in Proceedings of the 2Nd International Conference on Learning Analytics and Knowledge, ser. LAK '12. New York, NY, USA: ACM, 2012, pp. 143–152, [Accessed Jan. 24, 2014]. [Online]. Available: http://doi.acm.org/10.1145/2330601.2330639

[7] C. Treude and M.-A. Storey, "Awareness 2.0: Staying Aware of Projects, Developers and Tasks Using Dashboards and Feeds," in Proceedings of the 32Nd ACM/IEEE International Conference on Software Engineering - Volume 1, ser. ICSE '10. New York, NY, USA: ACM, 2010, pp. 365–374, [Accessed Jan. 24, 2014]. [Online]. Available: http://doi.acm.org/10.1145/1806799.1806854

[8] J. T. Biehl, M. Czerwinski, G. Smith, and G. G. Robertson, "FASTDash: A Visual Dashboard for Fostering Awareness in Software Teams," in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ser. CHI '07. New York, NY, USA: ACM, 2007, pp. 1313–1322, [Accessed Jan. 24, 2014]. [Online]. Available: http://doi.acm.org/10.1145/1240624.1240823

[9] M. McKeon, "Harnessing the web information ecosystem with wiki-based visualization dashboards." IEEE transactions on visualization and computer graphics, vol. 15, no. 6, 2009, pp. 1081–8, [Accessed Jan. 24, 2014]. [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/19834175

[10] S. Govaerts, K. Verbert, J. Klerkx, and E. Duval, "Visualizing activities for self-reflection and awareness," Advances in Web-Based Learning â ICWL 2010, vol. 6483, 2010, pp. 1–10, [Accessed Jan. 24, 2014]. [Online]. Available: http://link.springer.com/chapter/10.1007/978-3-642-17407-0_10

[11] E. Duval, "Attention Please!: Learning Analytics for Visualization and Recommendation," in Proceedings of the 1st International Conference on Learning Analytics and Knowledge, ser. LAK '11. New York, NY, USA: ACM, 2011, pp. 9–17, [Accessed Jan. 24, 2014]. [Online]. Available: http://doi.acm.org/10.1145/2090116.2090118

[12] V. K. Kumar and J. L. Rogers, "Student Response Behaviors in an Instrumented Feedback Environment," SIGCUE Outlook, vol. Special, Dec. 1978, pp. 34–54, [Accessed Jan. 24, 2014]. [Online]. Available: http://doi.acm.org/10.1145/1318457.1318461

[13] J. E. Caldwell, "Clickers in the Large Classroom: Current Research and Best-Practice Tips," CBE-Life Sciences Education, vol. 6, no. 1, 2007, pp. 9–20, [Accessed Jan. 24, 2014]. [Online]. Available: http://www.lifescied.org/content/6/1/9.abstract

[14] D. Lindquist, T. Denning, M. Kelly, R. Malani, W. G. Griswold, and B. Simon, "Exploring the Potential of Mobile Phones for Active Learning in the Classroom," SIGCSE Bull., vol. 39, no. 1, Mar. 2007, pp. 384–388, [Accessed Jan. 24, 2014]. [Online]. Available: http://doi.acm.org/10.1145/1227504.1227445

[15] S. Teel, D. Schweitzer, and S. Fulton, "Braingame: A Web-based Student Response System," J. Comput. Sci. Coll., vol. 28, no. 2, Dec. 2012, pp. 40–47, [Accessed Jan. 24, 2014]. [Online]. Available: http://dl.acm.org/citation.cfm?id=2382887.2382895

[16] M. Ratto, R. Shapiro, T. M. Truong, and G. W. Griswold, "The Activeclass Project: Experiments in Encouraging Classroom Participation," in Designing for Change in Networked Learning Environments, 2003, vol. 2, pp. 477–486.

[17] T. Bergstrom and K. Karahalios, "Social Mirrors as Social Signals: Transforming Audio into Graphics," Computer Graphics and Applications, IEEE, vol. 29, no. 5, 2009, pp. 22–32, [Accessed Jan. 24, 2014].

[18] H. Du, M. B. Rosson, and J. M. Carroll, "Augmenting Classroom Participation Through Public Digital Backchannels," in Proceedings of the 17th ACM International Conference on Supporting Group Work, ser. GROUP '12. New York, NY, USA: ACM, 2012, pp. 155–164, [Accessed Jan. 24, 2014]. [Online]. Available: http://doi.acm.org/10.1145/2389176.2389201

[19] W. Purgathofer, Peter Reinthaler, "Exploring the Massive Multiplayer E-Learning Concept," Ed-Media Invited Talk, 2008, pp. 1–9, [Accessed Jan. 24, 2014]. [Online]. Available: https://igw.tuwien.ac.at/designlehren/exploring_for_edmedia.pdf

[20] L. H. Bryant and J. R. Chittum, "ePortfolio Effectiveness: A(n Ill-Fated) Search for Empirical Support," International Journal of ePortfolio, vol. 3, no. 2, 2013, pp. 189–198, [Accessed Jan. 24, 2014]. [Online]. Available: http://www.theijep.com

[21] E. L. Deci and R. M. Ryan, "Motivation, personality, and development within embedded social contexts: an overview of self-determination theory," in The oxford handbook of human motivation, R. M. Ryan, Ed. Oxford, 2012, pp. 85–107.

[22] A. P. Rovai, "A constructivist approach to online college learning," The Internet and Higher Education, vol. 7, no. 2, 2004, pp. 79 – 93, [Accessed Jan. 24, 2014]. [Online]. Available: http://www.sciencedirect.com/science/article/pii/S1096751604000144

[23] "reddit.com," [Accessed Jan. 24, 2014]. [Online]. Available: http://www.reddit.com/

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