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**Autor:** Kortemeyer, Gerd  
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# That's one giant step for a university, one small leap for digitization

Gerd Kortemeyer\*

## 1. Introduction

Talk about “disruption”: between February 27 and March 12, 2020, ETH Zurich went from beginning to make various contingency plans to a complete shut-down of all face-to-face instruction; starting March 16, 2020, all instructional activities for 1060 courses (95% of all courses) were online for the remainder of the semester. The remaining 5% of the courses, which were mostly laboratory courses, had to be postponed into smaller sessions during the summer. Eventually, on June 17, the last of the end-of-semester examinations (“final exams”) was completed – online.

Across several surveys, students and instructors gave the highest marks for various aspects of this transition – for example, students rated 1043 of the 1060 courses as working well for them. Written comments oftentimes reflected wonderment over how well everything worked in spite of extraordinary challenges – that was one giant step for the university, thanks to the enormous efforts and commitment of instructors, support staff, administrators, and students! Talking to colleagues at other institutions of higher education in Switzerland and internationally, many of them reported equally successful transitions. But was the forced giant step to a digital format also a giant leap for the digitization of learning, as heralded in various media? Do we even want a giant leap?

## 2. Values and realities

Like many universities, ETH Zurich traditionally prides itself in its academic climate on campus. Besides subject-specific knowledge, there are hidden curricula, employability skills, identity development, and cross-disciplinary competencies that are valued and traditionally believed to best flourish in a face-to-face community. This mindset explains one of the initially most puzzling outcomes of the instructor survey about experiences during Corona: while the majority of instructors stated that they were able to successfully cover most if not all materials, they also stated that they did not truly reach all their learning goals. This value system with an emphasis on face-to-face interaction is reflected in the teaching scenarios of a normal semester, illustrated in Figure 1.

Under normal circumstances, by far the most common scenario is face-to-face classroom instruction, indicated by the purple branch in Figure 1 – generally, students would listen to a prepared presentation, oftentimes using a blackboard or PowerPoint slides. Several of the

lecture halls have camera equipment to synchronously transmit the lecture to overflow lecture halls, lecture halls on another campus, or individual student computers – this live stream is indicated as the green branch. In addition, several lectures are recorded, so students can asynchronously and individually watch them at a later point in time (upper beige branch). Before Corona hit, a commonly expressed desire by students was to expand usage of video recording; reasons given were flexibility, avoidance of long commutes, possibility to watch lectures again before exams, but also the possibility to replay crucial segments of lectures while browsing other segments at double playback speed.

The green and beige branches are one-way, instructor to student, and one may ask how these technologies are compatible with the ideal of an interactive, academic learning community. As it turns out, during the Corona semester, when instructors had to lecture from their offices at home or in empty lecture halls on campus, a frequent notion in instructor surveys was that the green and beige branches really do not work satisfactorily without the purple one: the face-to-face students in the lectures were needed as proxies for the remote audience; a large number of instructors expressed the lack of verbal and non-verbal feedback from the audience, “like talking to a wall.” This lack of feedback was not necessarily helped by video conference technology (blue branch); instructors bemoaned that most students had their cameras and microphones turned off – besides the obvious privacy reasons, this was also due to bandwidth constraints. Moving into future semesters with continued restrictions, several instructors already plan to have at least a handful of students face-to-face in the room when using the green and beige technologies.

\* ETH Zürich, Educational Development and Technology, 8092 Zürich, Switzerland, and Michigan State University, East Lansing, MI 48825, USA.

E-mail: [gerd.kortemeyer@let.ethz.ch](mailto:gerd.kortemeyer@let.ethz.ch)  
<http://gerdkortemeyer.com/>



**Gerd Kortemeyer**, Ph.D. (Physics), Director of Educational Development and Technology, ETH Zurich, since 2019, and Associate Professor of Physics, Michigan State University, since 2010. Guest professor at FernUniversität Hagen, Ostfalia University of Applied Science, and Massachusetts Institute of Technology. Research foci on technology in STEM (Science, Technology, Engineering and Mathematics) education, in particular formative assessment, and learning content management, in particular learning analytics and recommender systems.



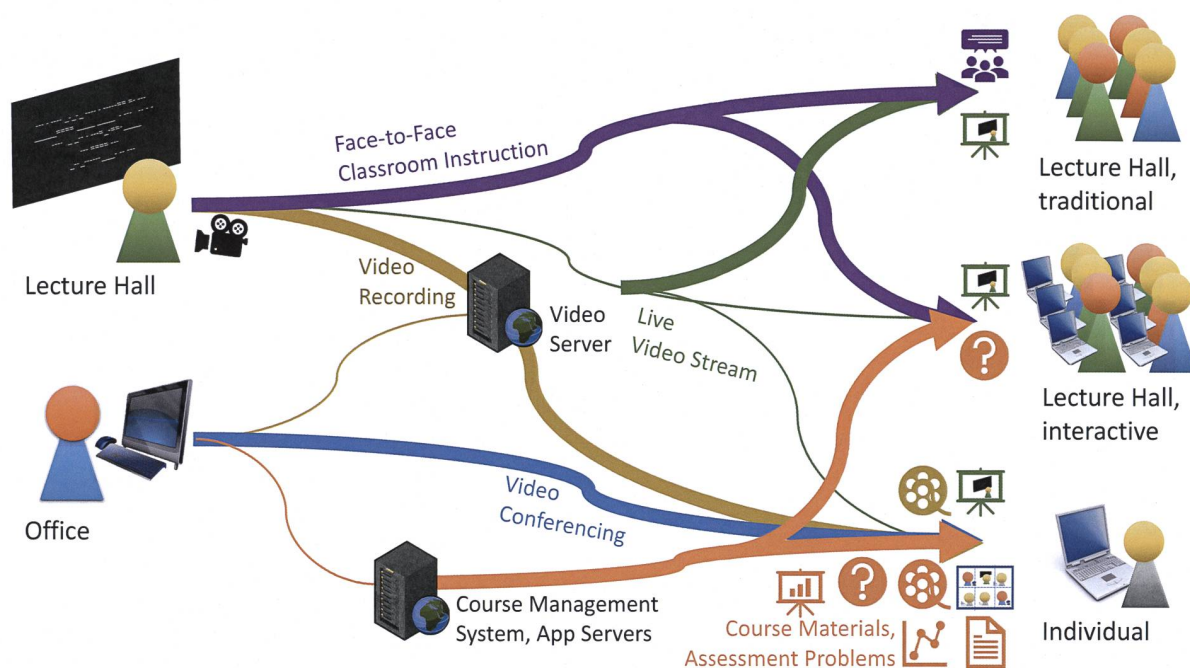


Figure 1. Modes of instruction

There are also technological ways to get synchronous feedback from the audience, both inside and beyond the lecture hall. The most common way, even before Corona, are audience response systems, commonly known as “clickers,” even though nowadays mostly implemented in the form of smartphone or web apps. Instructors can ask questions during lecture and have students answer them interactively (orange branch), which can provide highly meaningful feedback.<sup>1</sup> Educational research has shown that this instructional technique is particularly effective if the lecture is adjusted according to the responses, that is, if the lecturer moves on from or elaborates on certain topics depending on the feedback – and even more so, if these interactive questions are combined with peer-instruction<sup>2</sup> (alas, hardly possible in times of Corona).

Far less commonly used modes of instruction at ETH Zurich make use of completely asynchronous tools, for example online course materials and online homework. These are typically mediated by course management systems with integrated document repositories and assessment functionality (included in the orange branch in Figure 1) – the relatively small usage of these systems is probably one of the most striking differences to higher education in for example the United States, where the availability of asynchronous learning resources is frequently simply expected to go along

with lectures.<sup>3</sup> While students might work “backwards” into these resources from the online homework,<sup>4</sup> reading up only on what they need to solve the problems (similar to how they work with online lecture recordings), nevertheless both instructors and students can receive highly meaningful feedback from these learning resources.<sup>5</sup> Somewhat surprisingly and tellingly, usage of course management systems and document repositories only minimally increased after the shutdown of face-to-face instruction – up until the final exams, that was.

### 3. Exams in times of Corona

While many universities around the world moved to a pass-fail mode for the Spring semester,<sup>6</sup> the decision at ETH Zurich was to generally maintain course grades and exams, but annul failed attempts; usually, there is a limit on the number of attempts to pass a course or an exam, but a failed attempt during Spring would not count. Here, ETH Zurich had to deal with two distinct classes of exams: those embedded into courses (midterm assessments and end-of-semester exams), and high-stakes comprehensive exams (ses-

<sup>1</sup> Kortemeyer, G. (2016). The psychometric properties of classroom response system data: a case study. *Journal of Science Education and Technology*, 25(4), 561–574.

<sup>2</sup> Crouch, C. H., & Mazur, E. (2001). Peer instruction: Ten years of experience and results. *American Journal of Physics*, 69(9), 970–977.

<sup>3</sup> Dziuban, C. D., Moskal, P., & Hartman, J. (2005). Higher education, blended learning, and the generations: Knowledge is power-No more. *Elements of quality online education: Engaging communities*. Needham, MA: Sloan Center for Online Education, 88–89.

<sup>4</sup> Seaton, D. T., Kortemeyer, G., Bergner, Y., Rayyan, S., & Pritchard, D. E. (2014). Analyzing the impact of course structure on electronic textbook use in blended introductory physics courses. *American Journal of Physics*, 82(12), 1186–1197.

<sup>5</sup> Kortemeyer, G. (2014). Extending item response theory to online homework. *Physical Review Special Topics-Physics Education Research*, 10(1), 010118.

<sup>6</sup> Basken, P. US Colleges Adopt Pass-Fail Rules, Stirring Wider Reform. *Times Higher Education*, April 6, 2020.



sion exams) that are not connected to one particular course.

The immediate challenge during the Corona semester was enabling the various forms of course-embedded exams and assessments – and there was no one-size-fits-all. Some assessments which needed special setups or equipment could not be moved online and had to be postponed to a future time in the fall where they hopefully will be possible. Ironically, several of the exams that at ETH Zurich are traditionally called “online” belong into this category: computer-based exams that demand specialized setups, including licensed software packages mirroring authentic science and engineering challenges.<sup>7</sup>

For smaller courses, instructors were encouraged to morph their written exams into oral exams which could be conducted via Zoom – with limited response, most likely due to the time demands imposed by “processing” exams in series rather than parallel. For the remaining “written” exams, means of ensuring integrity had to be found. While in the United States, a common practice is to use commercial online proctoring services, after initial exploration, this option was discarded at ETH Zurich for various reasons.

A straightforward yet frequently overlooked way to avoid “cheating” is to simply allow looking up facts and background materials, that is, to make the exams open-book, open-notes, open-web, and open-ended; this puts various demands on the design of the exams, including – of course – the avoidance of pure knowledge questions, but this mode also in many ways creates more authentic scenarios. While open-ended responses are harder to grade, they are also easier to check for plagiarism.

Course management systems saw increased use during exams as a means to administer and grade “closed-format” questions, such as multiple-choice. Instructors were strongly encouraged to randomize these questions, so that the exchange of solutions would be hindered. Finally, a scenario was supported where students would write on paper under Zoom supervision by regular course staff; students would then scan and email their solution sheets.

In all written scenarios, instructors were encouraged to keep the timeframes for their exams “sportive,” again to curb possible collaborations and usage of unauthorized resources. Feedback from students at

the end of the semester showed that exams generally went extremely smoothly – the almost only criticism was that students stated that they ran out of time, so “sportive” timing seems to have been more than achieved in some of the exams. Grades for these course-associated assessments showed the usual distribution, so the initial worry about grade inflation turned out to be unwarranted.

On the other hand, for the high-stakes comprehensive exams, the decision was to carry them out face-to-face – while it is believed that the vast majority of students is honest, and while remote exams appear to have worked well, in these high-stakes scenarios even the unsubstantiated suspicion of misconduct would be detrimental.

#### 4. Outlook for fall

Planning for the fall semester is aiming for a moving target:<sup>8</sup> at the time of this writing, nobody knows how the Corona situation will develop. The extremes of the spectrum of possibilities are “easy:” business-as-usual could always be implemented, but it is highly improbable for fall. Going completely online is something that could happen again – we now have some experience on how to do this in an emergency, and another shutdown will have to be part of any “Plan B” currently conceived.

More likely than the “easy” solutions are mixed or so-called “hybrid” models, which take place in more challenging, uncharted territory: having some courses, or some students, on campus, while having other courses or students online could, if done undifferentiated, indiscriminately and across-the-board, be the worst of both worlds.<sup>9</sup> The goodwill of students and faculty reflected in the Spring semester surveys may be exhausted by the time the Fall semester rolls around, due to some expectation that university administrators should have figured out workable solutions by then. In a widely-distributed tweet, maintaining face-to-face instruction while concurrently offering adequate online instruction, all the while being able to revert to fully online at the drop of a hat, has been compared to teaching on a moving train in a burning building while juggling and riding a unicorn.<sup>10</sup>

Thus, ETH Zurich tries to take a measured approach to the Fall semester, evaluating pragmatic online solutions in terms of pedagogical loss. This loss would be

<sup>7</sup> Halbherr, T., Reuter, K., Schneider, D., Schlienger, C., & Piendl, T. (2014). Making examinations more valid, meaningful and motivating: The online exams service at ETH Zurich. *EUNIS Journal of Higher Education*, 1.

<sup>8</sup> Gardner, L. (2020). Why Colleges' Plans for Fall Are Like 'Nailing Jell-O to the Wall'. *The Chronicle of Higher Education*, June 07, 2020 Issue.

<sup>9</sup> McMurtrie, B. (2020). Colleges say Hybrid Courses will make the Fall a Success. But will Students get the Worst of Both Worlds? *The Chronicle of Higher Education*, July 24, 2020 Issue.

<sup>10</sup> Finley, A. (2020), *Twitter*, June 23, 2020.



greatest for interactive scenarios like exercise sessions and hands-on scenarios like labs – these have priority in the allocation of space and on-site staff. In addition, advanced students carry out laboratory-based research studies, and there are field trips, construction projects, even courses which require sports equipment (e.g., trampolines) – all of which cannot be “virtualized.”

Finally, first-year students would experience the greatest loss from the lack of the academic environment, so ETH Zurich will ensure that they can benefit from prioritized allocation of on-site teaching space. Since during the first semester, most students in a major still take mostly the same courses, forming “bubbles” of students moving through courses as a cohort will hopefully enable contact tracing.

On the other hand, the loss of going online was generally deemed the lowest for large-lecture teaching scenarios; this notion was also reflected in a faculty survey of teaching preferences for the fall – thus, as a guideline, lectures with more than 100 students should take place online using the green or blue branches in Figure 1, bolstered by increased usage of electronic feedback tools (orange branch). In addition, lecture recordings will be strongly encouraged (beige branch), as students’ schedules may demand more flexibility than in “normal” semesters.

Finally, instead of mandatorily deciding across-the-board, the policy and decision timeline leave room for faculty and departments to adjust the allocation of the limited face-to-face venues, according to specific curricular needs. Through this differentiated approach, the hope is to create a robust environment where a complete shutdown is unlikely. In any case, all face-to-face teaching scenarios will need to maintain an adequate online presence to enable students in unusual circumstances (quarantine or sickness) to keep following the course; the university is currently building up support resources to hopefully mitigate the faculty challenge of “riding a unicorn.”

In contrast, if we were to treat the Fall semester as the “new normal” rather than a continued anomaly, frustration over “hybrid” models might easily lead to a giant leap *backwards* for the digitization of learning. Going forward, if we allowed ourselves to confuse pragmatic emergency solutions and cutting our losses (as well as the associated emotional rollercoaster of enthusiasm and frustration) with sustainable strategies for the digitization of learning, we risk losing any support for real strategies.

## 5. Emergency versus strategy

Looking back, the single-most important ingredient for ETH Zurich’s success in transitioning to “online” was Zoom, that is synchronous video conferencing technology (blue branch in Figure 1); the very same observation was reported at many other universities around the world, where video conferencing “saved the day.” This should give us pause in several respects:

Had Corona happened even a decade earlier, lack of bandwidth and computing power would have made this approach prohibitive (and still makes it challenging today for the economically less fortunate, who cannot afford the required technology and bandwidth).

Essentially, the transition was merely a brute force continuation of face-to-face teaching – one could provocatively turn this argument around: if teaching worked so well at a distance as the various surveys make believe, just how “distant” was the face-to-face instruction?

Finally, if media are celebrating the Corona response as a giant leap toward the digitization of higher education, this demonstrates a very limited view of what digitization of learning could mean. Video is only one medium in the portfolio of multimedia support of teaching and learning.

Pragmatic solutions were highly successful in this emergency situation, and these indeed can rightfully be celebrated as a giant step. What the emergency situation created was possibly openness, curiosity, courage, and the willingness to abandon previously unquestioned traditions – unless the Fall semester erases all of that. In addition, one of the main lessons from the Spring semester is a new appreciation of the value of face-to-face time; while seeing opportunities in online venues, at the same time, some faculty members never knew what they were missing by not meeting face-to-face.

Now instructors, administrators, and support staff need to fill this opportunity with substance. A digitization strategy under preservation of the traditional values of the Swiss system of higher education is still a giant leap, with the possible reward of leap-frogging longstanding developments in other higher education systems.

## 6. Leap-frogging

The landing patch of a truly giant leap should not necessarily be fully online courses. While these are extremely desirable and valuable for non-traditional learners, the goal for traditional learners should be a synergetic interplay between online and face-to-face



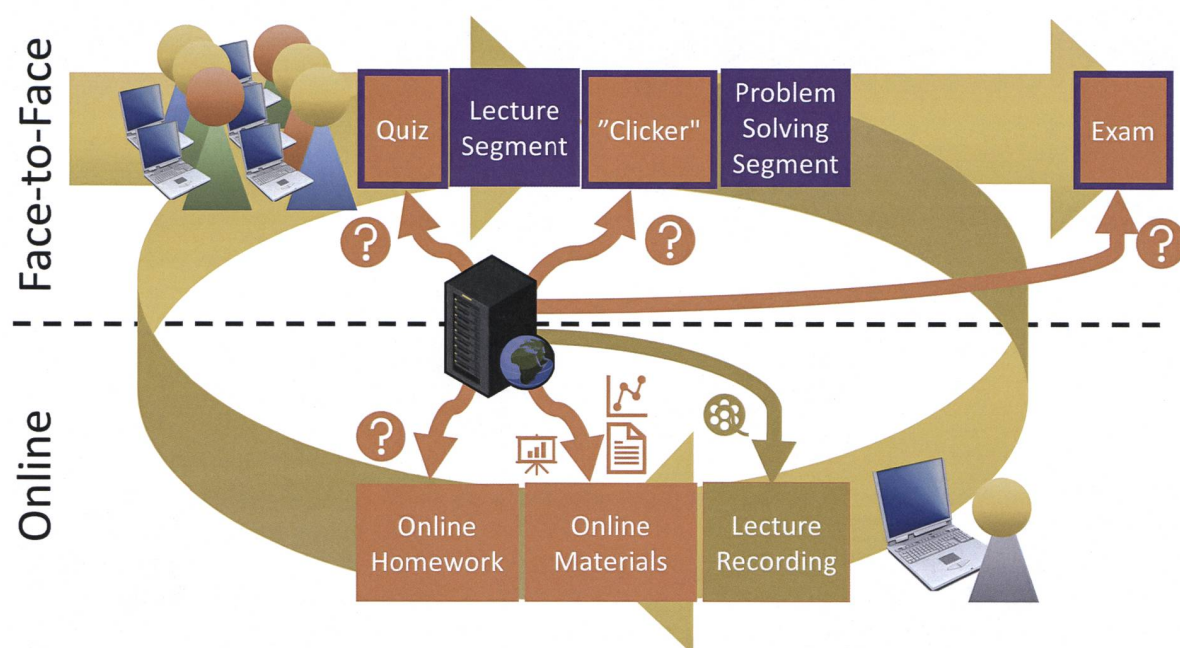


Figure 2. Example of a blended learning cycle

components of courses – in a truly “hybrid” fashion. It is unfortunate that many universities have decided to call their mixed scenarios for the upcoming fall “hybrid,” since those emergency scenarios might require double the energy rather than afford synergy.

True synergy would spring from freeing up face-to-face time for discussions, tutorials, peer-instruction, and collaborative problem-solving, that is, activities that are best done in person and led by an expert, by moving knowledge transmission and initial, formative assessment into the online realm. This entails making learning resources available asynchronously (lower orange branch in Figure 1) to support and back up the synchronous face-to-face scenarios (purple branch). By the reverse token, the green branch of synchronous lecture transmission runs counter to this approach. The beige branch of recorded lectures, particularly those from earlier semesters, takes on a new role as preparation or solidification of face-to-face activities. The blue branch of video conferences is relegated to scenarios where logistical challenges make face-to-face meetings impossible.

Asynchronous learning resources can be web pages, articles, simulations, short instructional video sequences, or worksheets and interactive activities. Face-to-face time is used for a mix of activities and targeted lecture segments. In addition to summative exams at the end of the semester, frequent online quizzes and formative assessment can significantly increase learning success.<sup>11</sup> In its most developed stage, results from

online assessments influence the emphasis and foci of the face-to-face sessions.<sup>12</sup> As we pride ourselves in our academic culture on campus, this approach puts increased value on interactive and activating face-to-face time, while delegating transmission activities to the online realm, where they can be carried out without much loss in pedagogical effectiveness.

The resulting iterative truly-hybrid interplay of online and face-to-face instruction is illustrated in Figure 2. This, of course, is nothing new, and these “blended” and “flipped” scenarios have been around for a while,<sup>13</sup> but they still carry around a slightly non-mainstream flair.

The approach in Figure 2, particularly due to its frequent formative assessment, also allows for monitoring learning success through continual learning analytics and data mining of access logs. Not only can students-at-risk be identified and adaptive recommendations be given, this approach also enables gathering large-scale, hard evidence for the effectiveness (or lack thereof) of each intervention.

A valid counter-argument, though, is that university should not simply be an extension of high school, and that students need to acquire skills of self-regulation and assume responsibility for their learning – implementing the educational scenario in Figure 2 should not end up in spoon-feeding students, which would

<sup>11</sup> Laverty, J. T., Bauer, W., Kortemeyer, G., & Westfall, G. (2012). Want to reduce guessing and cheating while making students happier? Give more exams!. *The Physics Teacher*, 50(9), 540–543.

<sup>12</sup> Novak, G. M., Patterson, E. T., Gavrin, A. D., & Christian, W. (1999). *Just in time teaching*. Upper Saddle River, NJ: Prentice-Hall.

<sup>13</sup> Bishop, J. L., & Verleger, M. A. (2013, June). The flipped classroom: A survey of the research. In *ASEE national conference proceedings*, Atlanta, GA (Vol. 30, No. 9, pp. 1–18).

be counter the cross-curricular competencies we aim to foster. However, the challenging nature of the content materials may take amply care of that concern: in spite of doing the best possible job teaching, and in spite of any technological assistance that can be given, the responsibility for learning is still with the students.

Being somewhat behind the international curve of online teaching, and having gracefully missed out on hyped-up scenarios of virtual universities, may enable Swiss universities to take a measured, discriminate, but assertive approach to the usage of online media.

ETH Zurich has all the ingredients to leap-frog international peers in terms of digitization of learning: very solid technological infrastructure, entrepreneurial faculty, and the ability to assume leadership in the creation of enabling technologies. If the Fall semester does not burn us out, we could approach future semesters with a new openness to the synergetic use of the online realm, not by attempting to replace what

is best done face-to-face, but by freeing up face-to-face time. In the absence of an emergency where we have to transition whole courses at once, this can be done in small steps, transitioning courses one small step (activity, lesson, topic) at a time, but in the end amount to a giant leap.

## 7. Conclusion

The past Corona semester was a giant step, but not necessarily into the direction that we want to go: moving face-to-face instruction online via video technologies is a small leap within the much larger landscape of the digitization of learning. The lasting impact may instead be a new openness to break with unquestioned traditions and move toward a synergic mix between online and activating face-to-face settings. Constructing evidence-based instructional strategies and platforms, anchored in a solid value system of what higher education should encompass, will be the next giant leap. ■