# Five Tips for Integrating Khan Academy in Your Course

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Khan Academy (KA) is one of the world's most popular open educational resources (OER), with more than 57 million registered users[1] and 15 million monthly site visits as of May 2016.[2] It is popular with students seeking additional resources for their math studies, and gaming features (in the form of points, badges, and missions) add to its appeal. As yet, there is little research-based advice on how such a system (of which KA is not the only one) can be effectively integrated into a course.

We have used KA with our students for three years. In this period, we have conducted and published both quantitative and qualitative analyses of our students' learning.[3-5] In this paper, we draw on our successes and failures to make five practical recommendations for effective integration of KA in existing courses, but note that what we have learned could apply to any similar OER. We will not focus on the technical details of integrating KA; readers interested in this are referred to the KA website.[6]

## Context

We work within the largest teacher-training program in Norway, teaching introductory physics and math education to pre-service and in-service teachers. Although our students have met a certain mathematical requirement to enter the program, these qualifications may have been completed a considerable time ago, and it is not uncommon for students to lack the prerequisite mathematical knowledge or fluency in key areas for our courses. To try to bridge this gap between the mathematical prerequisites and students' actual knowledge, we have added a significant element of KA to the resources employed during the course. We chose KA because it was free and easy to use, well structured, and an instructor can set work and monitor student progress as a "coach." (Instructors can find more information about coaching and how to set it up by signing up for a "teacher" account on the KA site.[6])

## Research on KA

Research on KA is scarce, but in recent years the results of a few pilot projects have been published, both from the K-12[7,8] and college levels.[9,10] The pilot studies cover thousands of students and hundreds of teachers, spanning a wide variety of ways of integrating KA into existing courses. Most teachers prefer to use KA as supplementary material for topics already introduced in class.[7-9] Particular benefits are the "gigantic cache" of exercise problems,[9] rapid feedback from automatic marking,[7] personalized math education both for accelerating and at-risk students,[7,8] and closer monitoring of students.[7]

None of the pilot studies have primarily set out to evaluate the learning effect of KA through a randomized control trial design. However, several studies, including our own, show positive relationships between completing KA exercises and improved scores on math tests,[3,4,7-9] and students report feeling that their understanding increases[5,7,9] and that KA helps them get into a "mathematical mindset."[5]

Khan Academy should not be seen as a closed system that is in itself sufficient for learning mathematics, a so-called "silver bullet."[9] Such an approach would be a return to independent personalized study, which was used in many schools in the 1970s. In a landmark paper,[11] Erlwanger[12] reported on an in-depth study of one pupil who had developed a number of misconceptions on such a program. This result is regarded in the mathematics education community as typical of the limitations of independent personalized study.[11] This is supported by a pilot study involving 1226 students using KA as a supplement in remedial or developmental math courses across twelve community colleges in New England, where the majority of students agreed that "KA can't replace my professor."[9] Thus the way KA (or any similar system) is integrated into a course is of vital importance to the impact it will have, which is the focus of our recommendations.

## Recommendations

### *1) Introduce KA in a hands-on session*

Khan Academy is sufficiently different from other resources that our students needed an introduction to the main features. We ran an introductory KA session with an overhead projection of the computer screen demonstrating the following: setting up an account, joining a class with an assigned coach, the home page with recommended mathematics problems from a coach, how to find other mathematics problems, and what to do when you are stuck on a problem (such as using hints and videos). Step-by-step instructions detailing these procedures were subsequently uploaded to the online learning management system. Students said that the demonstration session was helpful, but that by the time they started using KA, many had forgotten some of the features, such as the videos. In response to student feedback, we changed the introduction in the next iteration of the course to be a hands-on session in a computer lab. Students set up an account during the session, which removed the barrier for doing this independently outside class time. We also carefully assessed the main features of KA for our courses and made sure that the students tried these in the session.

Additionally, we adopted a student suggestion of showing a video (or part thereof) of Sal Khan talking about the history and philosophy behind KA.[13] The students expressed that understanding the pedagogical underpinning made KA a more valuable resource, which could motivate them to make more use of it. This viewpoint may, however, be specific to pre-service teachers given the meta-pedagogical nature of their education.

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### 2) Use external motivators to get students hooked

In one course, students were given the option of completing a set of KA problems instead of the written assignment at the end of semester. The instructor made the KA problems available in weekly installments (using the coach recommendations feature in KA) so that the students could spread out their assignment workload, but they were checked concurrently with the written assignment. Our experience with this format was that the majority of the students chose to submit the assignment using KA,[4] but hardly anyone commenced work until the last two weeks before the assignment. In interviews, students mentioned the gaming features as the main motivating factor for completing the assignment in KA, and one student commented: "It's completely different doing it on a computer instead of doing sums in a book... so you get a bit more motivation." Games are designed to keep a player sufficiently entertained or motivated to keep playing, drawing on our innate psychological need for mastery and positive physiological response to reward. Motivational features of games integral to KA include "levels" (i.e., topics in KA) to complete and progress through representing mastery progress, and points, badges, sounds, and visuals rewarding correct answers and completion of topics.

The other course was run with a flipped classroom approach, in which students were given pre-work for each class. Students who consistently completed their pre-work throughout the semester (by obtaining at least two-thirds of the total marks available) were rewarded by not having to submit the mathematically comprehensive fourth and final question in the end-of-semester course assignment. This small incentive was enough to motivate nearly all students to make significant use of KA.[3] We found that most students chose to do the pre-work even though the total workload far exceeded the reduction in the workload of the final assignment.[3] This was a win-win situation for instructors and students: students spent more time working on math (and preparing for class), they reaped the benefits of "spaced practice,"[14] and the instructor could use the weekly feedback from KA to adapt teaching to the students' mathematical needs.

### 3) Help students realize the learning benefits of KA

Khan Academy problems were carefully selected to be at the students' level and relevant to classwork, but this link was rarely made explicit. Our students reported that they often did not see the connection between the KA problems and classwork, although when they did, they were able to cognitively engage more deeply with the material. The most successful students were consciously looking for these links, but all students expressed a wish for these links to be pointed out in class.[5] Based on this experience, we recommend that instructors are clear in their intensions—both to themselves and the students—for choosing KA problems for students to work on, and communicate the relevance of these problems to the classwork.

We also found that students' intrinsic motivation to engage with KA increased with use, as students themselves realized the learning benefit. Many students completed more problems than assigned, and some students made extensive use of KA. One student explained: "To begin with, the motivation was to avoid that problem [in the compulsory assignment], and then you just end up spending an enormous amount of time on [KA] after each class. It's not just a duty, but you think it's okay and you learn something."[5] Students who completed many more problems felt that KA was a valuable resource for their understanding of mathematics and that the feedback KA provided gave them a sense that they were learning mathematics. One student said: "KA has definitely ensured that I have always managed to follow the physics classes."[5] For these students, the extrinsic motivation became less important, and the intrinsic motivation of the experience of KA aligning with their goals for learning mathematics, and succeeding in class became the primary motivator.[5]

In order to convey the importance of using KA *for learning,* we recommend relaxing the completion requirements for KA problems relative to regular assignments. Some students experienced that they spent a lot of time trying to complete certain problems without increasing their math understanding, and felt that this time could have been used for more fruitful learning activities.[5] One student suggested: "If you've used a certain significant amount of time on it, you have to move on. Because it can steal a bit of time from the theory to be read for the physics in the other problems." We addressed this by requiring that only about two-thirds of the pre-work problems (which included KA) had to be successfully completed, to strike a balance between using extrinsic motivation to push students and promoting intrinsic motivation to flourish through in-built flexibility. Provided that students regularly did their pre-work, this enabled them to skip some problems in which they felt they were wasting time.

### 4) Use KA to optimize teaching activities

Class time was prepared with in-built flexibility so that it could be tailored once the results of the relevant KA problems were known. As an example, students were required to complete the KA topic "Computing in scientific notation" prior to the class on "Light," midway through the physics course. Teacher feedback in KA revealed that students struggled more with this topic than other topics on scientific notation (i.e., fewer students completed the topic and more students failed a sufficient number of questions to be classified as "Struggling" by the system). To address this, the way to perform calculations using $c = f\lambda$ was covered in detail on the blackboard in class, and students were subsequently given an exercise where they in pairs had to solve a problem using $c = f\lambda$ on mini-whiteboards, receiving help from the teacher when needed.

Students who realized how their use of KA influenced class activities expressed that it added value to their time spent on KA, which in turn motivated both their use of KA and their studies more generally.[5] The tailoring of lesson plans also emphasized to the students that the goal was not to complete the problems, but to understand the problems. Due to the powerful effect on students' motivation and cognitive engagement, we inform the students more regularly and to a greater extent about how classes are being tailored.

To address individual needs, we helped students who were struggling to plan remedial action outside regular class time. Where we saw topics that needed extra attention, we provided and encouraged attendance at remedial math workshops, which were open to all students.

### *5) Consider KA's role in toolkit of learning resources*

Khan Academy can give the impression of being a complete teaching package, but we found that it worked best as a revision tool. It was a useful part of our much more comprehensive teaching toolkit, with some clear benefits but also some important limitations. Our students often described the learning value from KA as "working on their mathematical mindset," regarding KA as a particularly useful and effective tool for revising and assimilating mathematical knowledge.[5] It was also useful for making students aware of the limits of their knowledge.[5] However, when students had misconceptions, did not see the relevance of the mathematics to the topic being studied, or the topic was completely new to them, a more integrated approach to using KA was necessary.[5] Students with misconceptions sometimes resorted to a pattern reproducing strategy just to complete the problems, which led to frustration and reduced motivation.[5] For these topics, the weekly deadlines were invaluable because we could identify the misconceptions and address them in class, thus effectively spending class time precisely on material students were unable to learn on their own.[3] Once misconceptions had been resolved, we assigned further practice to KA, which optimized both class and self-study time.

## Final thoughts

We set out to use KA as a tool to help our students bridge the gap between the expected prerequisite knowledge for our courses and the students' actual knowledge. Our experience using KA for this purpose has been a positive one, but we learned some valuable lessons along the way regarding how to best integrate KA into our courses. In this paper, we have shared the most important lessons as recommendations, the absence of any one of which had a significant impact on our students' engagement and learning.[4,5]


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