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Effect of Technology on Children's Education

Abstract

Kindergarten to twelve (K-12) system of children's education has been around for the past 125 years. The technology adoption so far has been relatively minor. In the modern world, we see increasing effect of technology, children are now extremely familiar with digital devices and networked communications, in many cases even before they start kindergarten, while K-12 education is not yet fully utilizing these new capabilities. In this report, we give an overview of the current status of K-12, how education is getting evolved, and the current tech players. We will further describe the challenges in changing K-12 to adopt technology. Finally, we will present some predictions how the system might change, and who will be the winners.

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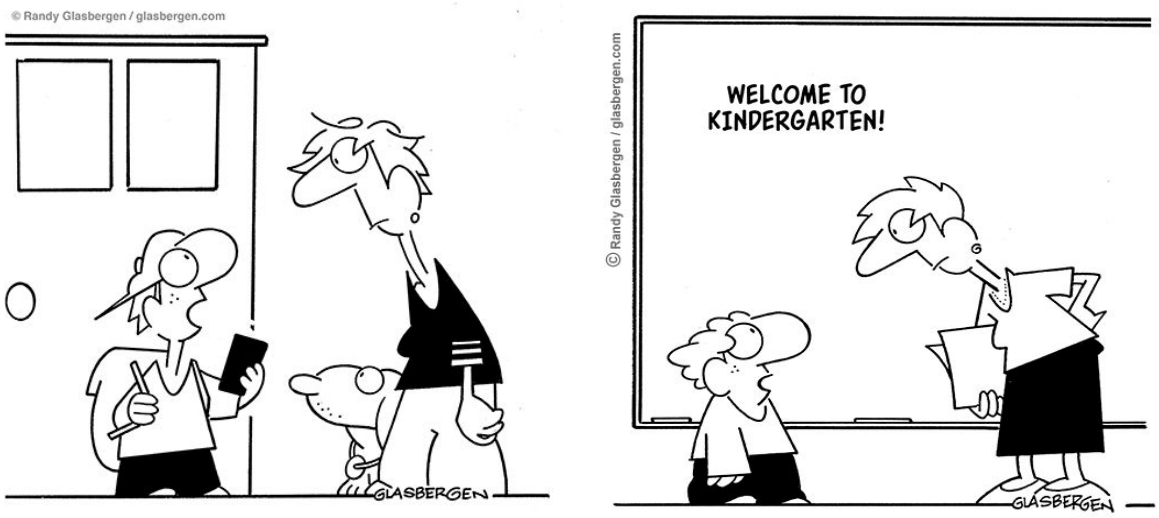
Contents

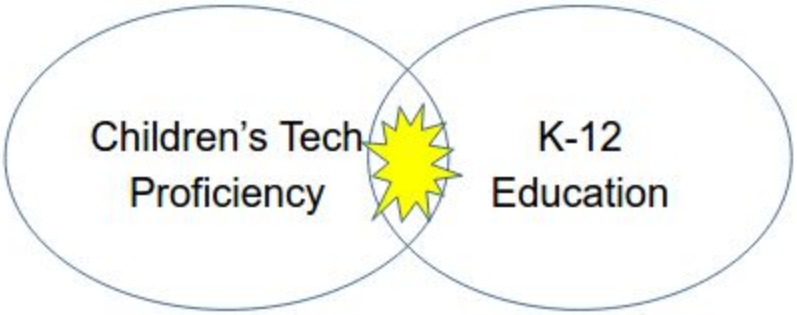
Contents
Introduction: Future of K-12 education
Children's technology proficiency and education will intersect
K-12 Education timeline
    Flipped education
    Mooc's for K-12
Evolution of Curricula
Education Ecosystem
Societal factors
Predictions
Conclusion

Introduction: Future of K-12 education



Today kids are interacting with tech before their first birthday and by age five they show high proficiency towards navigating through devices and apps. They understand networked communications and have experienced streaming media, games and learning softwares. It is typical to see them totally at ease with them often figuring out newer ones by themselves. K-12 is not yet utilizing these capabilities and we hypothesize that: **'Adaptive, personalized curricula will soon revolutionize the K-12 education system'.**

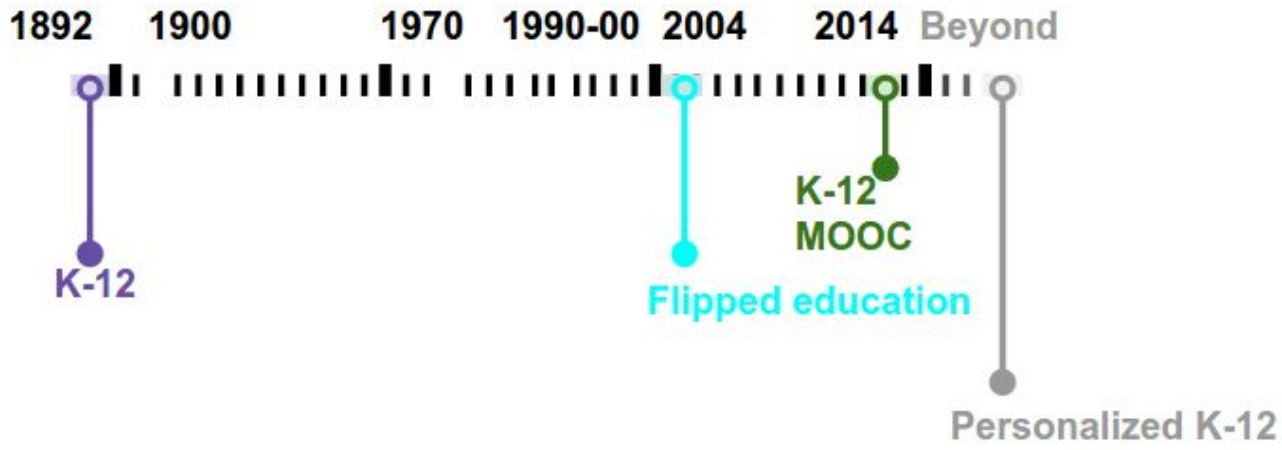
Children's technology proficiency and education will intersect



We feel that children's tech proficiency and K-12 education will soon intersect. This will result in adaptive, personalized education. Online teaching and assessment will result in big data and using it for understanding relationships among student progress/abilities will result in creating

personalized curricula and lead to educational success. For students, such a change will provide better education, easier and faster. For schools and communities this will provide, better quality focussed education at reduced cost, especially in areas with low population densities.

K-12 Education timeline



K-12 education system had existed for a while(exact dates unknown), and got formalized in 1892. There had been use of tech as aids for assignments etc, but K-12 education has still been largely the same. In last decade, some experiments utilizing technology have been tried: e.g Flipped education and mooc's for K-12 that we will describe below.

Flipped education

In flipped education, students receive their teacher's lectures at home and do their homework in class. This was first tried in 2004 as pilot, however, a much more significant adoption of this model was made later by Principal Greg Green of Clintondale high school where they flipped all classes in 2011. He mentions: We have been able to quadruple the amount of time our student have with their teachers. Clintondale high school, which was in worst 5% of Michigan, had immense success - english failure rate dropped from 52 to 19%, maths 44 to 13%, science 41 to 19% and social studies 28 to 9%. Clintondale high school (http://www.flippedhighschool.com/) which describes itself as 'changing education, one class, one student at a time' continues to run with flipped education

Mooc's for K-12

Mooc(massive open online course) have been tried a lot for higher education and had some success in continued education. Data about Mooc's for K-12 has been little so far. In 2014, EdX

has started mooc's for high schoolers to better their grade in AP tests. It is very early to analyze success/failure of mooc for K-12.

Evolution of Curricula

In a traditional K-12 classroom, the class is taught the material by a teacher. As represented in Figure 4, the teacher gains real-time feedback on his/her students' engagement during instruction through assessments of eye-contact or class participation. More substantial feedback regarding student understanding of the material comes in the form of homework or tests that require days or weeks for the student to complete and an investment in time by teacher themselves. With knowledge of the students' engagement, performance, and overall course progress, the teacher can correct his/her teaching style and material presentation to maximize the class's understanding by focusing on learning styles suiting a majority of the students (e.g., visual vs. auditory learning, theory vs. examples). This obviously requires a fair amount of the teacher's time and puts a significant amount of pressure on the attentiveness, perceptiveness, and creativity of the teacher to optimize this maximum likelihood estimation problem. Furthermore, this approach never actually optimizes the curriculum for a given student, only for the class.

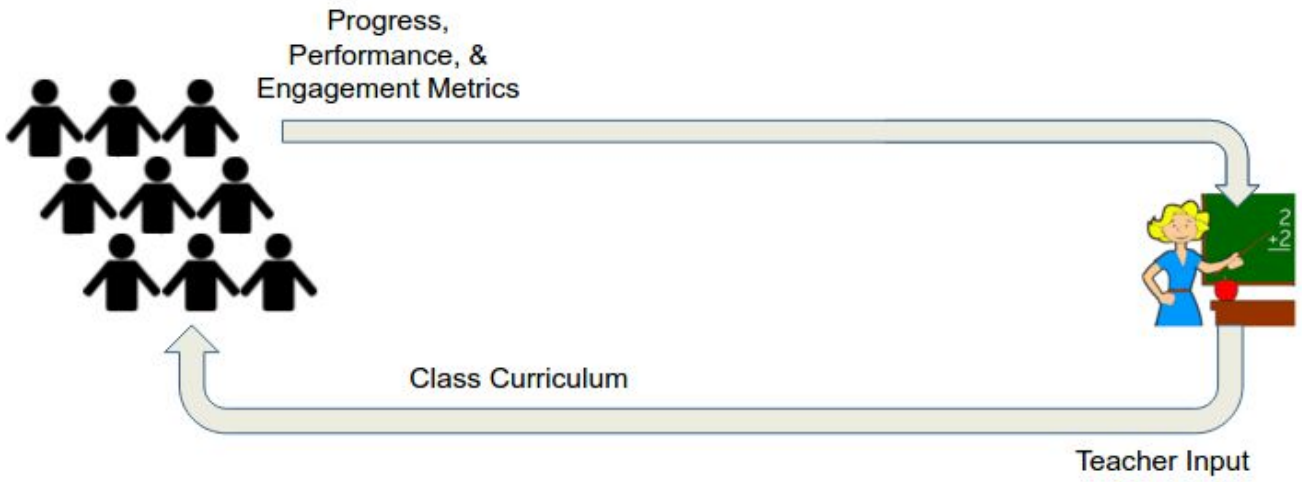


Figure 4. Traditional Curricula

Though a number of approaches have addressed tailoring education for the individual student, many require a significantly increased amount of resources per capita (e.g., homeschooling and low student-to-teacher ratios). Another approach, illustrated in Figure 5, that some institutions have introduced has been to utilize the concept of flipped education and give the students tablet computers with personalized playlists of material on them that they are required to complete. These playlists form a sequence of discrete lessons or knowledge quanta that can be pulled from a diverse library of lessons maintained both in open source communities and through existing instructional material vendors.

Some institutions also perform knowledge assessment on these tablets. The students' progress, performance, and engagement metrics are then extracted via data analytics from the digital instruction time, sequence, cadence, and assessment results. These results are then delivered to the students and teacher (and sometimes the parents) for course corrections for the students' playlists and student/teacher/parent effort/involvement.

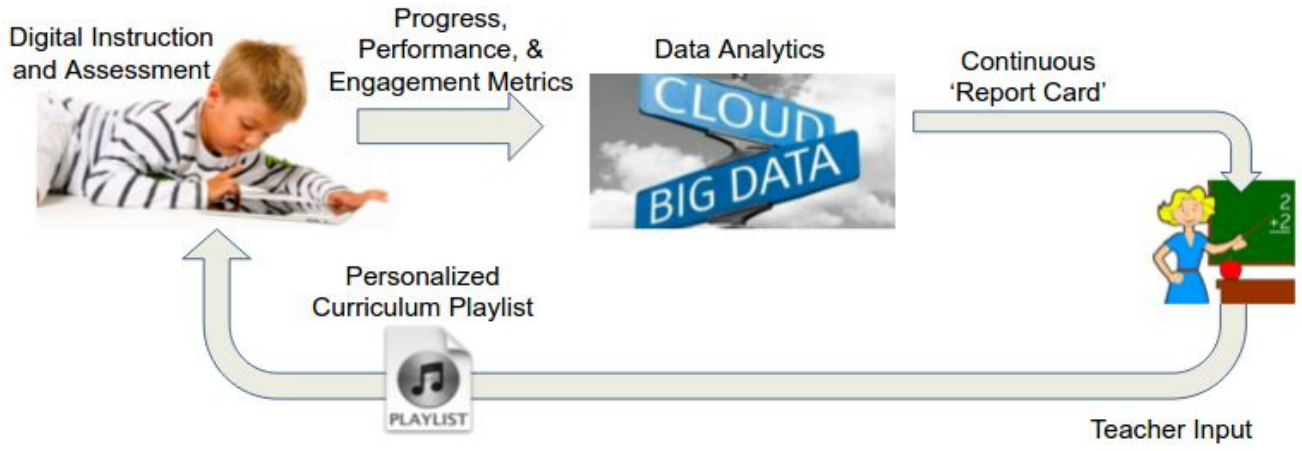


Figure 5. Personalized Curricula

This obviously address one of the shortcomings of the previous model (Figure 4 in the previous section) by personalizing the curricula to a given student. Each student's learning needs can be better addressed (e.g., pace of material/explanation, prose vs. demonstration) instead of optimizing for the 'lowest common denominator.' It still puts a heavy burden on the teacher to maintain and adapt the playlists for the individual student's needs. The teacher has to get to know the student and their learning style to assist in the optimization. If the teacher does not have the time/resources to keep up with these tasks, the model can easily slip back to the teacher prescribing the entire class the same playlists, thereby regressing to the less desirable goal of optimizing for the class.

The question then becomes, how can this feedback loop be tightened to more quickly adjust the students' playlists, reduce the intellectual burden of personalization on the educator, and improve the child's education as a whole?

Figure 6 shows that by adding cloud-based Curriculum Personalization Engine path to optimize the playlist for the student, a secondary path is created for this function beyond the teacher's involvement. This engine has the data showing how other students have performed in the past in relation to a given student and recommend the appropriate playlist entries to maximize this student's probability of acquisition of the knowledge and retention for following lessons. The

teacher still has the ultimate authority for review and modification of more significant optimizations, but if the teacher's attention is required elsewhere, the student's playlist is still tailored in some way.

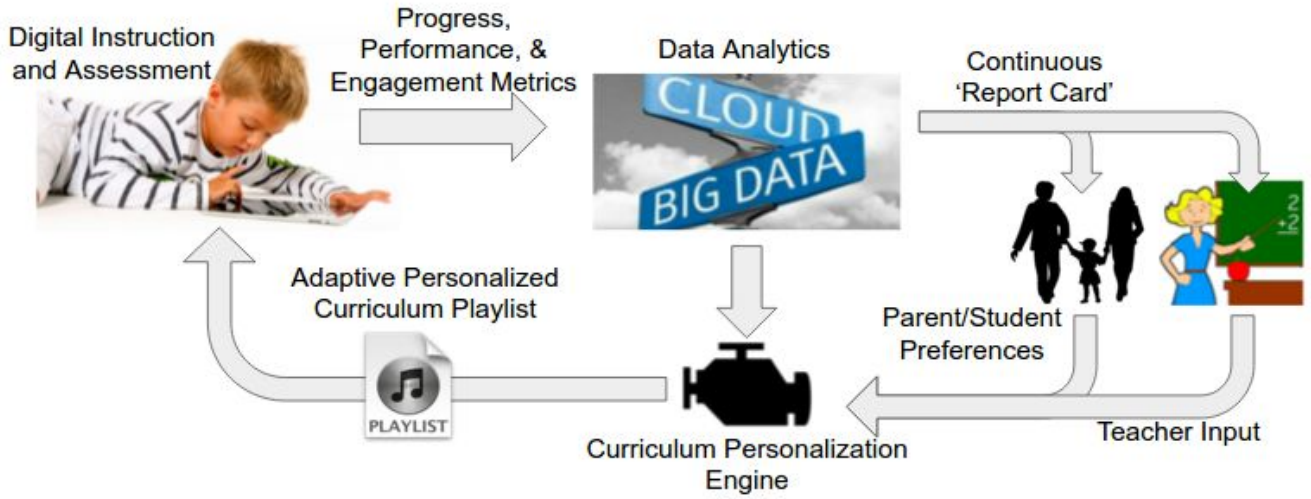


Figure 6. Adaptive Personalized Curricula

In addition to the teacher's directives into the playlist, the parent's and/or student's preferences can be input into the system, similar to parent/student's requesting electives. For instance gamified lessons in mathematics may be prefered by one student, whereas others prefer the shortest teaching/assessment time period.

Since the personalized curricula feedback loop is automated, the child's curricula or playlist can be continuously tailored in real-time. If the student demonstrated trouble in an area, more or different questions can be presented to maintain motivation, solidify a potentially problematic theme for that child, or make sure the concept has been learned adequately.

In summary, automated generation and real-time modification of a child's digital curricula has the potential to significantly disrupt the existing knowledge acquisition process, the role that student's and teachers have in this process, and benefits that are reaped.

Education Ecosystem

School curricula at the macro level is influenced by a number levels of the government as well as societal expectations. In this study, we accept and expect that there will always be outside bodies and influencers that will guide what high level topics will be taught. Those players are outside the scope of this work.

In this work, we are focusing on the companies and institutions around the business of instructional materials and the activity of instruction. In comparing the existing players in this space, we believe it is instructional to define each of the players with respect to their competencies and/or dependency on the following three areas:

- Brick & Mortar - physical school and capital investments involved
- Traditional Educational Materials - textbooks or other more traditional instructional material
- Personalized Curriculum - customized curricula for a given student

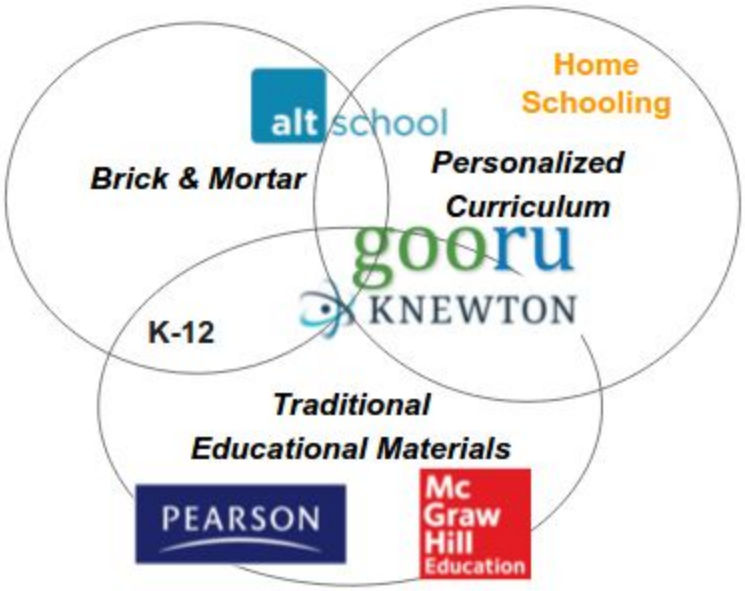


Figure 6. Adaptive Personalized Curricula

As reference points in this space, observe the traditional K-12 educational institution located at the intersection of Brick & Mortar and Traditional Educational Materials in Figure 6. Several of the Traditional Educational Material vendors are listed (i.e., Pearson and McGraw Hill) whose main revenue source is the textbooks and other instructional materials. They have been making some moves toward digital instructional materials, but are more reactive in this endeavor than disruptive.

At the alternate extreme of K-12, Home Schooling makes the minimum use of the Brick Mortar establishments and Traditional Educational Materials while maximally exhibiting Personalized Curriculum. In this situation, the educator is typically a loved one of the student and the curriculum is completely customized for this student.

There are three main companies poised to most disrupt the traditional educational system through personalized curricula: AltSchool, Gooru, and Knewton. AltSchool actually owns and

runs schools that specialize in personalized curricula, consisting of project-based group projects and personalized playlist education on tablets. They have also developed an operating system to enable these schools to quickly establish themselves in urban, rented spaces by streamlining much of the logistics and processes of school set-up, communications, grading, and personalized curricula generation. Their business model is to sell this operating system as a service. It still requires significant capital cost outlays significant hands-on participation from technologically savvy educators with skills for guiding a broad range of personalized projects for small groups. For this reason, this model will be difficult to scale and does not exemplify the gains to be had by Adaptive Personalized Curricula Generation.

Gooru participates significantly in providing a broad range of options for educators to personalize their students' curricula, having partnered/stimulating a large open-source community around generation and improvement of digital lessons to be used in students' digital playlists. Dashboards within the Gooru app, generated using data analytics of a student's performance and engagement, are presented to both teachers and students to better inform and guide the student/educator in maximizing academic performance.

Knewton does similar activities as Gooru, with dashboards, open source content generation, and personalized curricula on digital platforms, but they also dynamically adjust lesson content and complexity based on performance, progress, and engagement metrics. The also build the infrastructure for instructional material generators to make their lessons and material adaptive. With these capabilities in place, we believe they are closest to enabling the Adaptive Personalized Curricula generation as described in the previous section.

Societal factors

Despite the widespread recognition that the US educational system is flawed, needing reform and modernization, there is still resistance in attempts to change. For example, distribution of tablet computers for multimedia-based learning and digital lesson delivery and assessment is sometimes viewed as spending a lot of taxpayer money to distribute 'iPads' to irresponsible children. But generally, students take very good care of these devices and it can be very cost efficient vs.maintaining textbooks.

There is also general resistance to change from parents. Parents generally don't consider the significant change in their children's expectations for engagement being brought up in the age of digital media and modern entertainment content delivery. Parents contrast this with their more traditional education and don't see the rationale. In addition, there is recognition of a concern about their children's' privacy and the potential for security problems. These worries are understandable given every detail of their academic performance is recorded for the length of their education, though in truth, the details are no more damaging than report card records.

As this evolution in education continues to occur, school districts' and teachers' roles will shift within the school, causing some resistance. The district's instructional material funding structure will have to change from buying textbooks to tablet computers. Also, more funding will be required to support IT infrastructure, which will now become a much greater supporting role for the children themselves. The teachers become less responsible for lecturing in the class and become more responsible for monitoring progress and supporting struggling students. There will also be a greater need for more technologically savvy teachers, able to troubleshoot tablets and interact with more complex online dashboards and data analysis and visualization tools.

There is the potential for better educated students for less money, pleasing children, parents, and taxpayers. In addition, universities should benefit from more students attending college as employers should appreciate better qualified and more technologically familiar candidates.

Finally, as educational materials become crowd-sourced, making equivalent education more readily available across school districts and socio-economic classes, this has the potential to erode some of the premium prices some neighborhoods enjoy that have the best schools.

Predictions

Based on our understand of the space, we believe Knewton is best poised to capitalize on the $10B+ market of educational material reform to adaptive personalized curriculum generation. They have an executive team previously from Kaplan Education and have made a number of strategic partnerships with the large existing players in the market. They also have the platform to enable the instantaneous feedback to students lessons and playlists that are required to make the difference we have highlighted in this study.

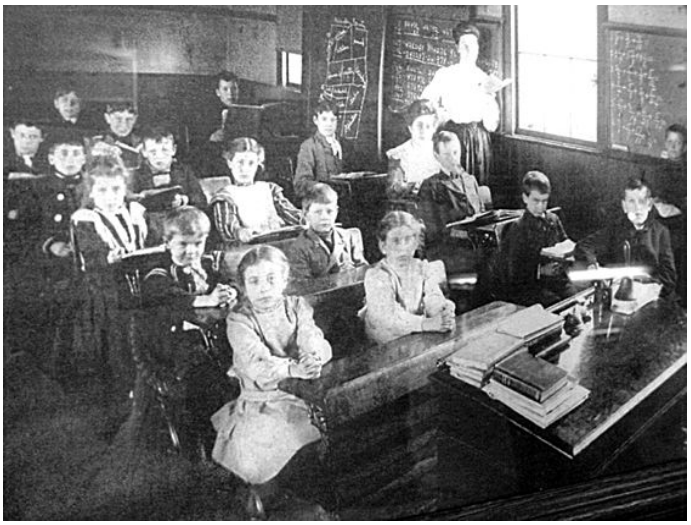
Because of the societal factors involved and the inertia of the system, both schools and students, we believe this change will happen relatively slowly over a 10 year period. College bound student numbers will increase, and those students will be better prepared and better specialized for the field they would like to pursue. In addition, more material can be covered in a given school year, due to increased knowledge acquisition efficiency.

As we discussed previously, adaptive personalized curricula has the potential to do a lot for the institution of education in regards to knowledge acquisition, but it will not benefit students socially or physically. Physical fitness and social interaction will forever remain an important part of a school system's purpose and benefit.

Conclusion

In conclusion, education has changed significantly since 1892 when the K-12 educational system was formalized. The next step will be adaptive personalized curricula generation delivered through digital platforms. This will allow for optimized learning for a given student while reducing complete dependency on teachers to manually monitor and maintain individualize playlist customization for their students. The data analysis and machine learning tools have evolved to more than capable of addressing the problem and the computational power is readily available at insignificant cost. We believe Knewton is the company that is best position to benefit from these changes, though many players will emerge in this promising new space.

We encourage all parents and teachers to embrace this change as adaptive personalized curricula generation comes to their neighborhood.



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