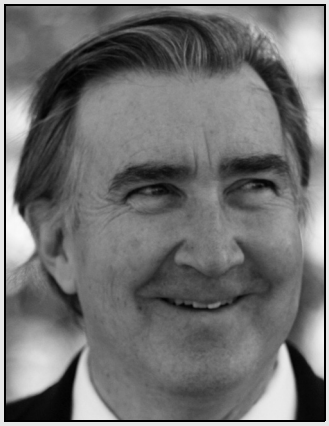
Teaching Principles of Economics Courses Using Adaptive Learning Platforms

Michael Luzius

Adaptive learning is a computerized learning environment in which software evaluates how well students learn course content. Students read textual materials, view videos and listen to audio files. The software then creates an individualized learning path for the student based on how well they perform in quizzes embedded in their lessons. As such, adaptive learning is well suited for the student centered or "flipped" classroom. In addition, textbook prices are causing students to look for alternatives, and textbook publishers to shift towards digital learning materials, including adaptive learning platforms. The advantages of adaptive learning platforms are they are effective tools for presenting course content and evaluating students' understanding of their lessons. The platforms are flexible, and can be used in a ground based or an online environment. They can allow for the submission of written assignments or problem sets. In addition, adaptive learning systems can provide instructors with measures of students' progress, mastery of the material as well as the areas of content where students need help. Some evidence points to a telling difference between traditional lecture and recitation structure for principles classes and principles courses that have incorporated adaptive learning platforms. While evidence is mixed, when students are able to interact with their instructors, the gains from incorporating adaptive learning are more apparent.



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Sea Change in Textbook Publishing Industry

Education is being transformed by technological and economic forces that are mani-

festing in the adoption of adaptive learning platforms as well as the student centered learning model, the flipped classroom. With approximately $3.2 billion in annual sales, the textbook industry is facing a major sea change as a result a number of factors (Barnes, 2018). Those factors include increasing publishing costs, student loan debt, changing demand trends, legislation and educational technologies (Opidee, 2014; Oremus, 2015). The College Board estimates that college students spend approximately $1,200 per year on books and supplies (College Board, 2018). It is not surprising that students and educators would look for lower priced alternatives to textbooks. Lumen learning and OpenStax represent two such efforts (Opidee, 2014). Rice University's OpenStax provides access to free textbooks. In 2016, they estimate that 1.5 million college students used one of their textbooks, and those numbers appear to have increased in 2017 (Boyd, 2016).

Transformation

As textbook prices have risen; students have looked for substitutes such as buying used books, using library copies or even photocopying their friends' texts. In a sort of perverse response, textbook companies seem to have raised prices further, thus exacerbating these trends. Along with the developments in textbook publishing, corporate trainers, educators and computer scientists have been developing a variety of computer and web based learning models. Those include online learning, MOOCS, Intelligent learning systems, and adaptive learning systems (Wakelam et al., 2015).

Broich and others argue that the textbook publishing industry is being transformed (Broich, 2015). One trend is the conversion to digital content and adaptive learning materials. Traditional textbook publishing companies such as Pearson and Cengage have converted much of their print materials to e-books. In addition they are moving into multimedia learning materials that deliver content and assess student learning (Opidee, 2014).

In addition, the transformation is occurring through partnerships between publishers and educators. The move is away from delivering course content in lumpy, static products to content delivery products in which students can interact with the content. In this movement, videotaped lectures and e-books are intermediate steps, digital versions of the old brick and mortar textbook and lecture approach. The model that seems to be taking over is of dynamic learning products that adapt to students' individual learning patterns. (Broich, 2015; Oremus, 2015).

Some of the major publishers have been moving in this direction. Cengage Learning has partnered with Knewton to create an adaptive learning platform, MindTap. (Cengage, 2016; Knewton, 2014). McGraw-Hill has developed LearnSmart Advantage, a suite of adaptive learning materials including an adaptive learning ebook (McGraw-Hill, 2013). Pearson has developed MyLab and Mastering adaptive learning products that offer learning content for a wide variety of courses in the sciences, business and the social sciences. (Pearson, 2018).

Among the variety of digital coursework products adaptive learning products seem to be becoming more prominent for one reason, they deliver the same course content as textbooks but at lower prices and presumably lower costs. While development costs are high, each additional copy has nearly zero marginal cost. Moreover, the Oremus claims that McGraw-Hill Education's revenues from computer based products increased by 24% in 2014, amounting to approximately $660 million by 2015 (Oremus, 2015).

Intellipath, RealizeIT

Intellipath is an adaptive learning system developed by the Irish software company, RealizeIT. The program uses adaptive learning algorithms to assess students' level of understanding. It first assesses the student's knowledge state, whatever the student knows about a particular subject. The information is used to devise a learning space, the set of possible combinations of topics that students must study to master the course content. To move from one set of topics to another, students must obtain proficiency by learning an additional topic that they did not know previously.

There are large numbers of such possible combinations of knowledge states that represent what the student knows. The adaptive learning software assesses the students' position within this mass of possible knowledge states. The software then constructs personalized learning pathways for each student. The step that initiates this process is an assessment of the students' current knowledge state. Its purpose to determine what the student knows and what they don't know about the course content. The software will then periodically assess the student to determine the degree of their retention.

Flipped Approach and Student-Centered Learning

Broadly, in the flipped classroom approach, instructors do not lecture to a group of students during the class' meeting time. Rather, students access their lessons outside of the class. Course content is delivered to the students wherever they might be through videos, digital learning materials or adaptive learning platforms. During class hours, student work on assignments and if they are in need of help, the teacher offers individualized instruction (Bishop & Verleger, 2013; Schmidt & Ralph, 2016).

Support for the flipped approach of student centered learning is mixed. Several papers support the flipped approach. One study by Day and Foley (2006), compared student performance in a flipped classroom to a traditional classroom, where the flipped classroom required that students watch videos and complete interactive learning activities in class. While Bishop and Verleger point out some shortcomings, the results were promising. The students in the flipped classroom studied by Day and Foley increased their performance on exam questions covered in the videos by 21% (Day & Foley, 2006). In another study, Lewis and Harrison presented lecture online prior to class meetings to the treatment group. The control group had regular lecture meetings. The authors report that the treatment group scored significantly higher on their assessments than did the control group (Lewis & Harrison, 2012).

Other more recent papers question the effectiveness of the flipped classroom. These works did not find significant differences in student performance between groups of students from traditional classrooms and flipped classrooms; after controlling for any a priori differences using a pretest assessment. The authors conclude that there is not adequate justification for adopting the flipped classroom model. (Lape et al., 2014; Zoe et al., 2014). McNally et al. (2017) also take a cautionary approach indicating that if the flipped classroom is adopted with the intention of improving student outcomes, the courses should incorporate assessments that are designed for the flipped classroom; and flip the entire course. More recently, Craft and Linasek (2020) report mixed results of a comprehensive comparison of flipped and traditional classroom methods, finding no significant differences overall.

Technology and Flipped Classroom

The increased reliability of the internet made it possible to deliver video and audio content in real time or asynchronously

(EDUCAUSE, 2012; Estes et al., 2014). This increases access for students with many demands on their time. The changes in technology does not mean that faculty involvement is not needed.

Faculty support is an important component of the flipped approach (EDUCAUSE, 2012; Estes et al., 2014). Fisher and LaFerriere (reported higher levels of student satisfaction when the flipped classroom was integrated with the use of digital technologies. Other research also stresses the need for more instructor involvement in an online environment (Weisenberg, 2001). While mentioning the need for increased instructor engagement, Estes et al. (2014) also state that students must have or acquire the skills they need to learn effectively in an asynchronous environment.

Intellipath, RealizeIT

Intellipath is an adaptive learning system developed by the Irish software company, RealizeIT. The program consists of three components, and artificial intelligence engine, a set of adaptive learning algorithms, a set of textual and interactive learning materials, and an interface that allows students and instructors to access and interact with the system (Howlin & Lynch, 2014).

The artificial intelligence engine is a set of adaptive learning algorithms used to assess students' level of understanding. It first assesses the student's knowledge state when students complete the determine knowledge task. That information is used to devise a learning space, the set of possible combinations of topics that students must study to master the course content. To move from one set of topics to another, students must obtain proficiency by learning an additional topic that they did not know previously (Dziuban et al., 2017; Howlin & Lynch, 2014).

There are large numbers of such possible combinations of knowledge states that represent what the student knows. The adaptive learning software assesses the students' position within this mass of possible knowledge states. The step that initiates this process, a task that RealizeIT calls Determine Knowledge, is an assessment of the students' prior knowledge state or mastery level. The software then constructs personalized learning pathways for each student. The artificial intelligence software will then periodically assess the student to determine the degree of their retention of bits of knowledge and grade them on their level of mastery (Howlin, 2015; Howlin & Lynch, 2014).

Intellipath lends itself well to an instructional approach that is consistent with the flipped classroom approach to teaching. There are a variety of measures and indicators available within the system that instructors can read quickly. These tools allow instructors to monitor the students' progress, to provide encouragement, to assign tasks within the system, and to use information gathered within Intellipath to prepare or modify lectures. While the following discussion contains several figures with the interactive graphics used in Intellipath, there are several other pages containing similar information that are differently formatted.

The Interface and Learning Map

The Learning Map is a graphic representation of the arrangement of lessons within a unit. The content for Intellipath assignments is arranged into units (or objectives), and units are divided into discrete lessons (nodes). Each lesson is represented by a small circle or rectangular shape, and connected to other lessons in the unit by arrows. Generally, they are arranged left to right, following the sequence implied in the content.

Students can open their lessons and access their lessons by clicking on the lesson in the map. When the lesson opens, the student will see textual materials, links

to videos or audio files, and question sets to assess their mastery.

The Learning Map View

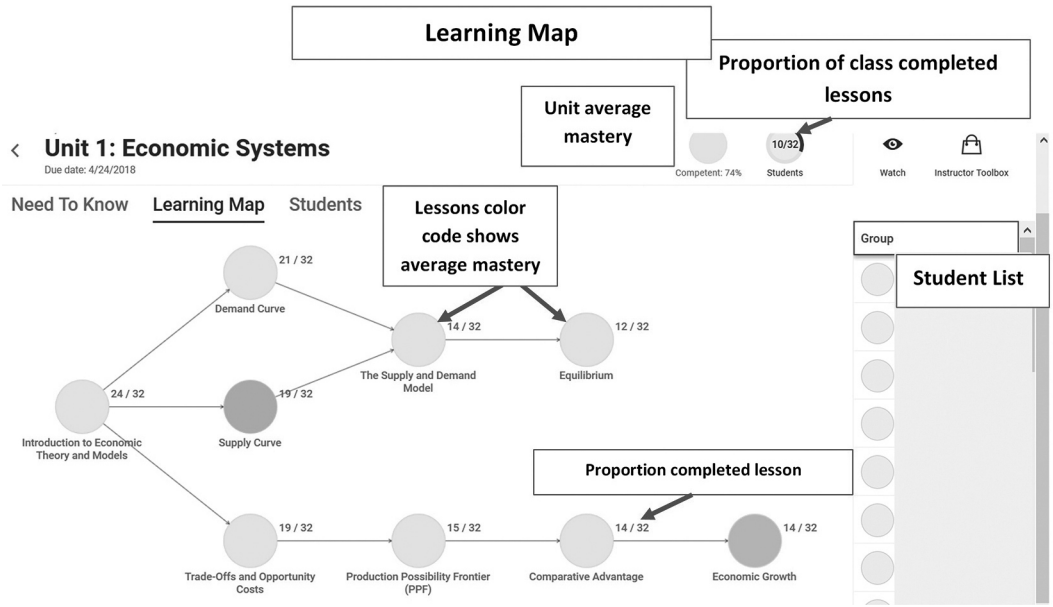
The learning map is a diagrammatic, visual representation of the arrangement of the lessons within each unit. Each lesson is represented by a color coded circle, and linked to other lessons by thin arrows. Five colors are used, red (0–60%), orange (60%–70%), yellow (70%–80%), light green (80%–(90%) and dark green (90%–100%) Generally, the lessons are arranged left to right. However, the arrangement is not really linear, but rather a network. This provides instructors with a quick read of the class' progress and average mastery levels for the unit and each lesson in the unit. By scanning the indicators on the page, the instructor can determine whether the class is on schedule, behind or ahead of schedule, as well as get a sense of the overall level of understanding of the material (American Intercontinental University, 2019).

Individual Student Learning Map

The individual student's learning map is helpful for quick read of an individual student's progress and mastery level. The instructor can see which lessons have been completed, the mastery level in comparison to the class; those lessons yet to be completed, and those that are locked until the student completes the prerequisite lessons to the immediate left (American Intercontinental University, 2019).

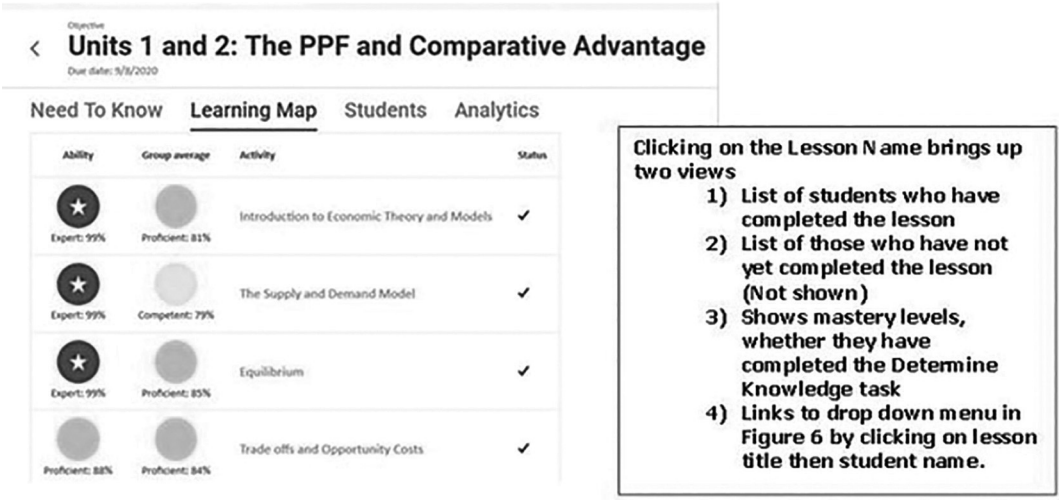
The graphic interfaces

Formerly, RealizeIT used the term dashboard to refer to the set of graphic interfaces that instructors use to monitor students' progress and mastery, to assign learning tasks, and to interact with the students (Howlin, 2015). The term dashboard



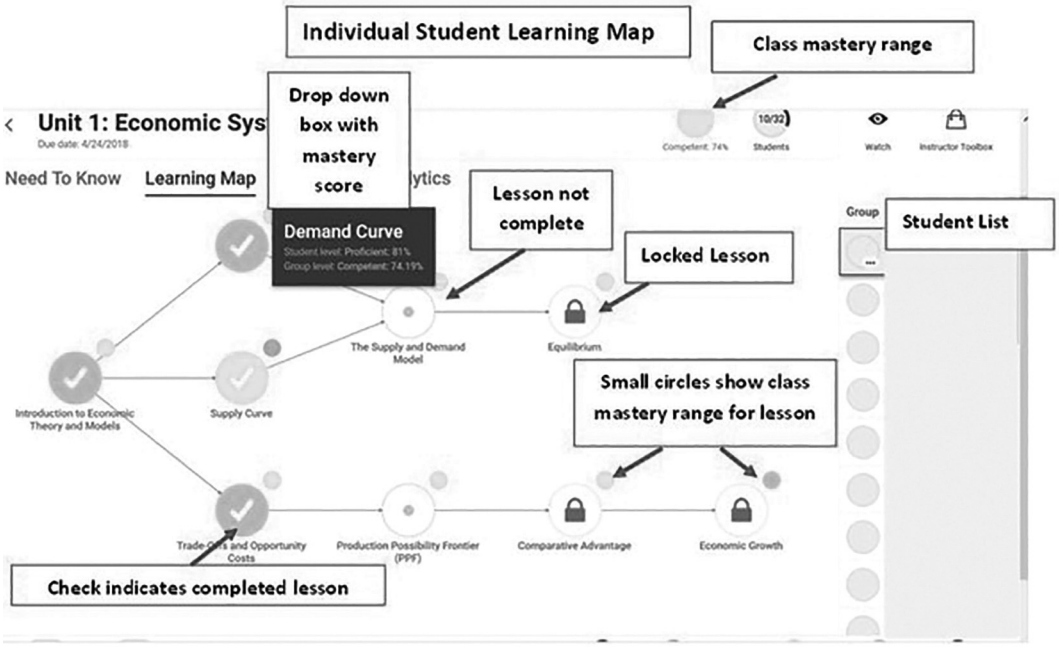
Source: American Intercontinental University (2020).

Figure 1. Class learning map.



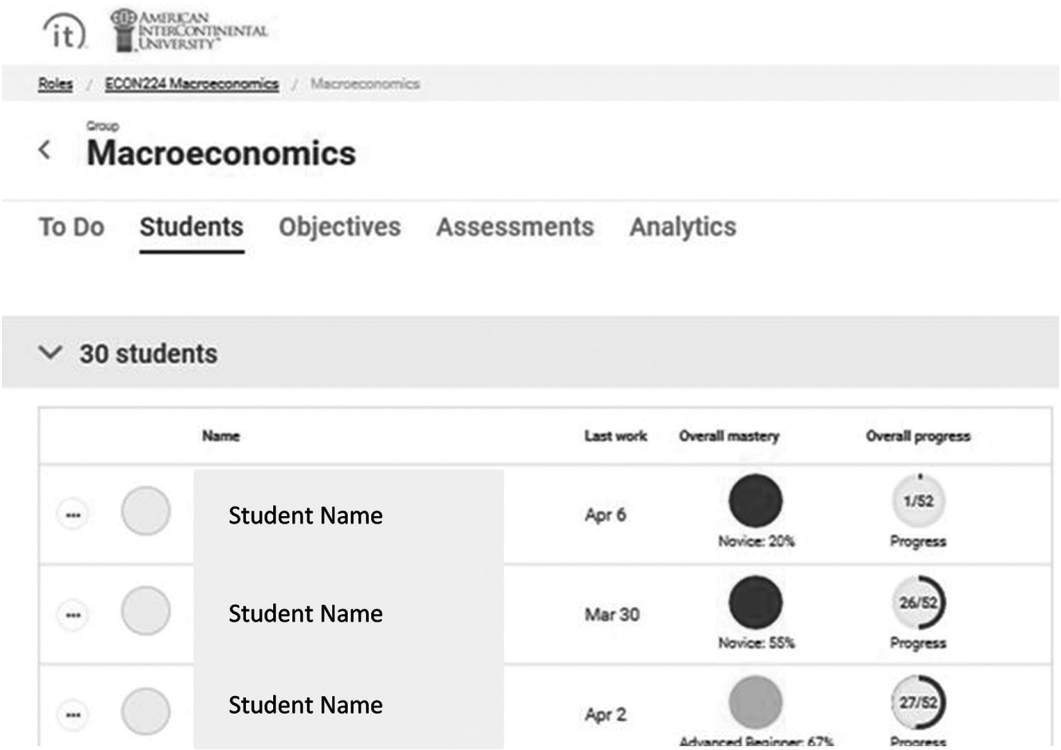
Source: American Intercontinental University (2020).

Figure 2.



Source: American Intercontinental University (2020).

Figure 3. Individual student learning map.



Source: American Intercontinental University (2020).

Figure 4.

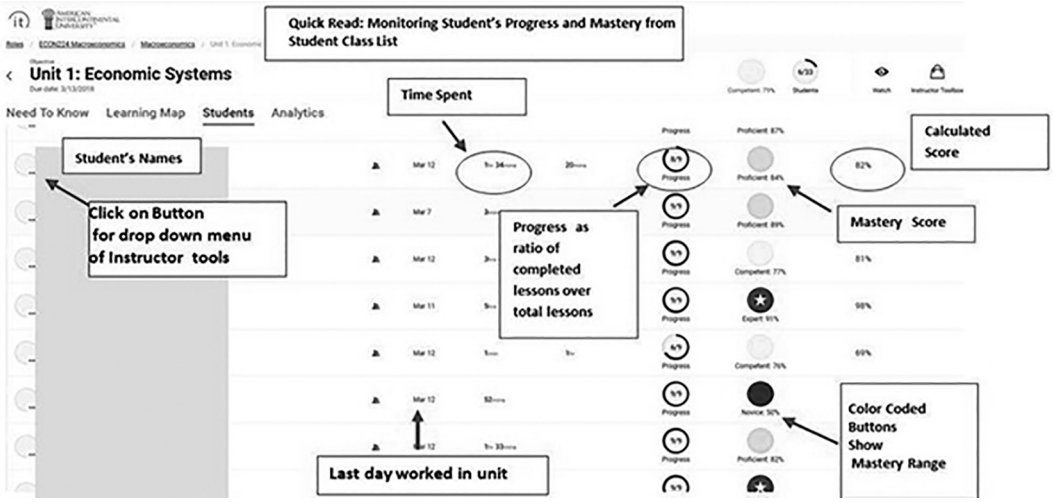
implies one interactive page. Actually, there are several linked pages that instructors navigate (American Intercontinental University, 2019). The instructor's initial view upon loading AIU's Intellipath system is shown in Figure 4.

After the student completes the determine knowledge, the system assesses their current level of understanding, and based on the pattern of their responses as well as any previous work the learner has completed, it assigns each student an individual learning path. It adapts the content to suit the learner. Once a student has completed the assessment within the lesson, it closes and they may either go on to another lesson or revise the lesson they have just completed. This is represented both the Learning map for the class and in the student's individual learning map (American Intercontinental University, 2019).

Useful Indicators

At a given time, the set of indicator's for an individual student provide a profile to the instructor which they can use to identify which tasks to assign or messages to send. Figure 5 is an expanded view that shows some of the useful measures and indicators that Intellipath provides for instructors. These measures give instructors a quick read of students' mastery of the content and progress working through their lessons (American Intercontinental University, 2019).

Time Spent, the two progress measures, the progress score and the calculated



Source: American Intercontinental University (2020).

Figure 5. Class list with indicators of student mastery and progress.

scores give instructors a quick read of a few things. For instance, if the student is not repeating the course, and they are spending less than 20–25 minutes per lesson, they are probably pushing through without retaining the information they read (American Intercontinental University, 2019).

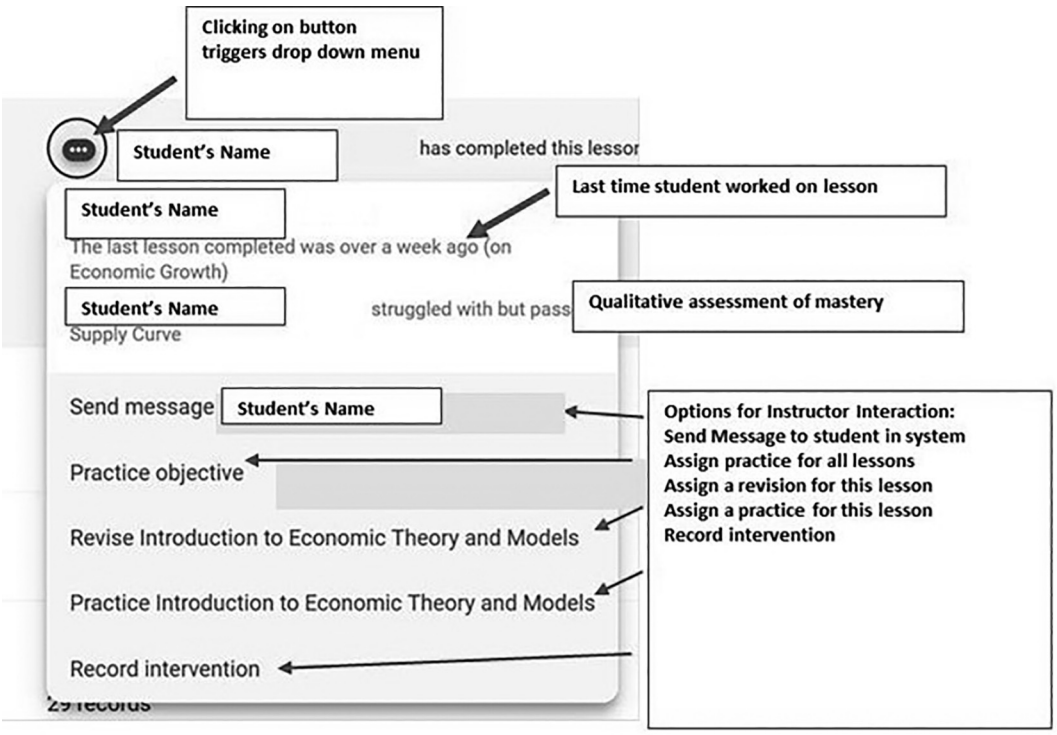
The icons in the Progress column show the ratio of completed lessons to total lessons in the unit. If the student has not completed more than one third to one half of the lessons by the middle of the time period for the unit, they are lagging, and that may prompt a message or email from the instructor. The mastery scores indicate a student's level of understanding with the percentage of questions they answer correctly at the end of their lesson. The calculated score is a weighted average of the progress and mastery scores (American Intercontinental University, 2019).

The color coded circular buttons provide a quick read of the students' level of understanding with red being the lowest (0–60%), next orange (60%–70%), yellow (70–80%), light green (80–89.9%) and dark green representing mastery scores between 90% and 100% (American Intercontinental University, 2019).

Revisions and Practices

Instructors can encourage students to take notes as they read through their lessons. In addition to helping reinforce the readings, the notes also help the students as they complete other reinforcing activities: revisions and practices. Low mastery scores, less than 70%, prompt instructors to direct the students to revise the lesson by reviewing the reading materials and retaking the quiz (American Intercontinental University, 2019).

Revisions allow students to review the reading, repeat the quiz questions, and thus help them reinforce what they have just learned. Figure 6 shows the drop down menu for an individual student and lists the messaging utility as well as tasks that can be assigned. Although all messages are recorded and stored, the record intervention provides instructors with an additional way to document their inter-



Source: American Intercontinental University (2020).

Figure 6. Drop down menu, messaging, assigning revisions, and practices.

ventions (American Intercontinental University, 2019).

The "Practice objective" task allows instructors to assign the practice task for all the lessons within a unit. Or, instructors can assign practices for individual lessons. With revisions, students are presented with the original question set for a lesson. For practices, the student is presented with the same number of questions, but the questions differ from the questions they were given in their first attempt. By assigning revisions or practices, instructors help students to reinforce their learning (American Intercontinental University, 2019).

The message utility is a text box in which instructors can place messages to students such as messages of encouragement, reminders to complete tasks, or to indicate that they have assigned the student a revision or practice (American Intercontinental University, 2019).

The practice task can be assigned to students when the student has a mastery score above 70%, but below 90%. The reasoning is that students understanding is adequate, but that they would benefit from engaging new questions for the lesson that have been taken from a broader question set (American Intercontinental University, 2019).

Message Utility

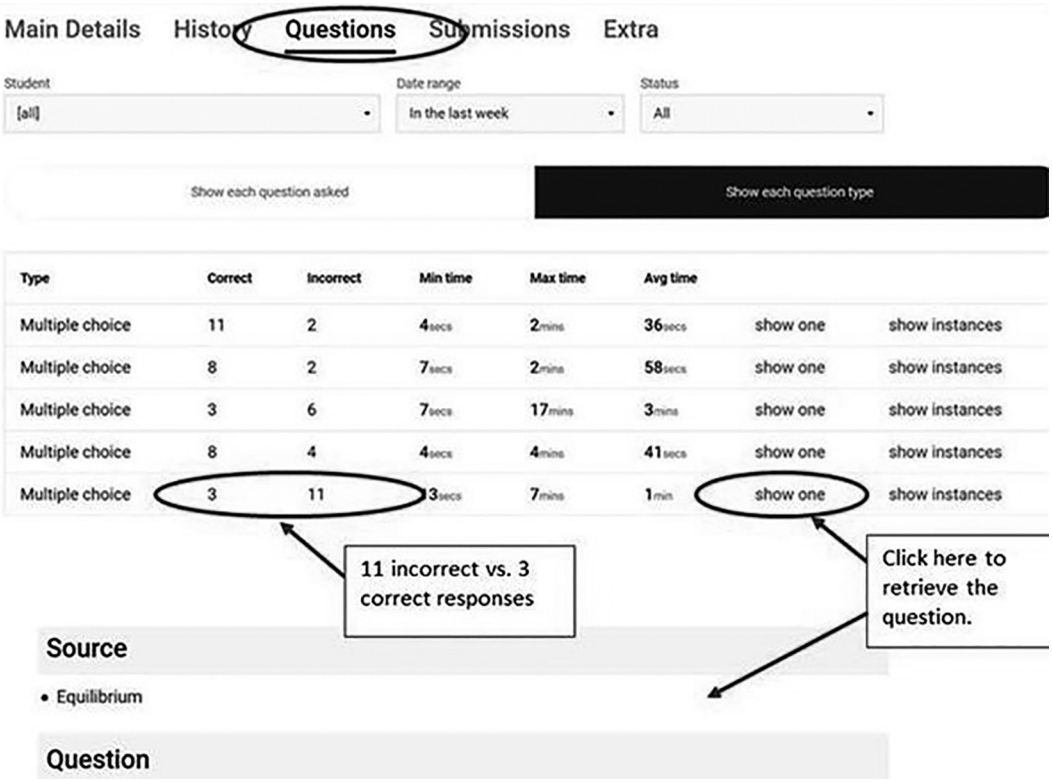
Instructors can send messages to students within Intellipath to notify them whenever they assign a revision, or a practice. In addition, they can send messages to students if the student is falling behind the rest of the class, or seems to need some

other form of support (American Intercontinental University, 2019).

How to Use Information From Intellipath to Adjust Instructor Interactions With Students

There are several views within Intellipath that yield similar information. One of the most useful of these is the "Questions" feature. This lists each question attempt by each student, as well as grouping attempts by question. The former feature is useful in examining a particular student's understanding, while the latter is very helpful to see which questions and topics that causes the class to struggle. Instructors can then adjust their live sessions to emphasize those topics (American Intercontinental University, 2019).

Although it cannot be shown in this paper due to copyright concerns, the above question concerns determinants of demand and supply. There were eleven incorrect responses and three correct responses. That seems to indicate that students are having difficulty understanding nonprice determinants of demand. To address the issue, the instructor would adjust their remarks in class or during a live session to emphasize the topic. They could devote more time to determinants of demand, explaining the effects of the different nonprice determinants on the demand curve, and the equilibrium price and quantity. If there are a few questions in which students struggle with determi-



Source: American Intercontinental University (2020).

Figure 7. Questions results, correct versus incorrect responses.

nants, instructors could devote a full hour to the topic.

Summary

Adaptive learning platforms are being adopted, currently with changes in the textbook publishing industry and changes in pedagogy. Adaptive learning seems to be very well suited to the flipped classroom approach, for instance. Intellipath is the adaptive learning platform developed by the Irish software company, RealizeIT. Students engage the content through the features of Adaptive Learning Platforms including textual content, videos and quizzes. Instructors then monitor students' progress and direct resources to students' weak areas, as well as change their live presentations to address areas where students seem most in need of explanation.

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