CHAPTER 5

How AI Can Support Teachers

Work Smarter, Not Harder

DRAMATIS PERSONAE

DAVID KELLERMANN: Lecturer in School of Mechanical and Manufacturing Engineering, University of New South Wales (UNSW), Sydney

T.A.: Human teacher's assistant

QUESTION BOT: Artificially intelligent teacher's assistant

STUDENTS: Introduction to Mechanical Engineering students

SCENE

University of New South Wales, Sydney, is an Australian public research university established in 1949 (Figure 5.1). It is ranked first in New South Wales, third in Australia, and 45th in the world, according to the 2017 QS World University Rankings.

TIME: April 2018

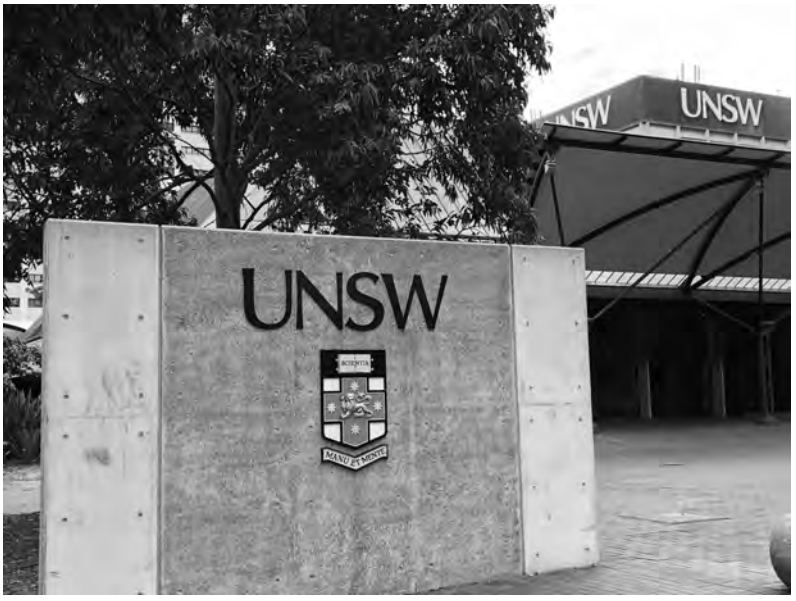

Figure 5.1
University of New South Wales in Sydney, Australia.

ACT II

Scene 5

SETTING: Introductory mechanical engineering class of 500 students—350 in person, and 150 joining online.

AT RISE: As 500 students study for their final exam, the online forums are abuzz with questions day and night. Kellermann, his teaching assistant, and his tutors work hard to answer as many questions as possible. Wonderfully, the students are also answering each other's questions. But in the fire hose of inquiries, questions still go unanswered. Tutors don't know who should answer whom, and they often spend time answering questions that have already been resolved, or whose answers can be found in the lecture recordings or course materials. Worst of all, at the end of semester, the forum will close and all the valuable dialogue will be lost in preparation for a new semester.

A week later, the stack of mechanical engineering final exams is overwhelming, to say the least. Imagine an exam 24 pages long, and multiply that by 500 students. That's 12,000 pages that need to be taken home to grade. The exams arrive in six enormous bags, carried slung over the T.A.'s shoulder. Imagine the mastery of physics required to

move those inertial pages from one location to another without upsetting the stack—or the students. There are many tripping hazards between the lecture hall and the T.A.'s car. Worse yet, each exam paper must be passed along to 12 different graders, each of whom must evaluate all 500 answers to a given question—a task that requires them to leaf through the booklets to find the question they are grading. Finally, there is the day-long process of data entry. It all amounts to a mind-numbing exercise in logistics.

ACTION: Things are running differently this semester. Kellermann has designed, developed, and deployed a bot named *Question*, which students tag in the forum. Each topic from the syllabus has its own channel, so the bot knows which topic each question regards as well as who asked the question. Based on enrollment data, it also knows which tutorial class the student is in and who the tutors for that class are. Upon receiving a query, *Question* sends push notifications to the phone and PC of the two tutors responsible for the student. The bot also keeps track of the question's status, providing a button to click once it has been answered. If a fellow student answers it first, the push notifications are canceled. The system allows tutors to keep track of all unanswered questions posed by their 40 students. Whenever someone answers a question, the bot adds the Q&A to its knowledge database, which is sorted by topic. In Figure 5.2, the tutor can click the "Answered" button once the question has been resolved. This signals the bot to file the information within the appropriate syllabus topic—"Energy methods," indicated by the channel.

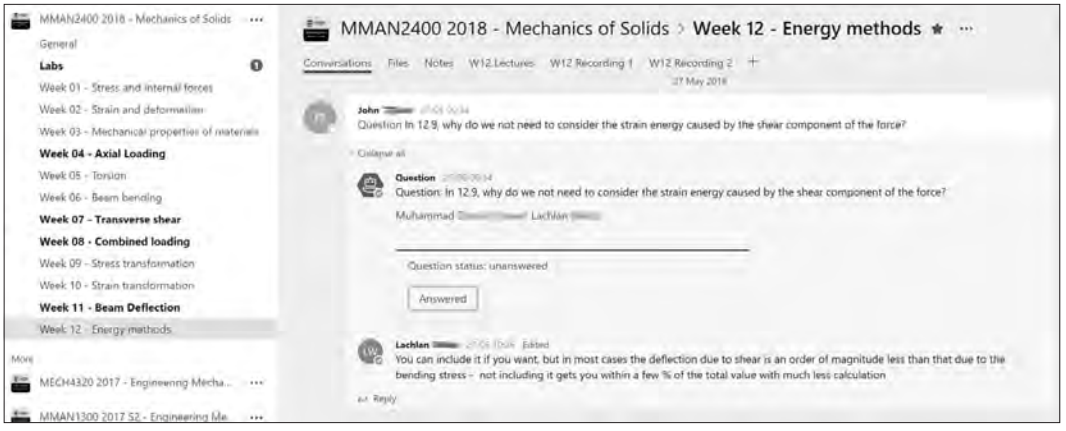

Figure 5.2 As students' questions are answered, the bot adds each correct response to its knowledge base, which it can draw upon to answer similar questions in the future.

Not only does the bot serve as an invaluable study resource for students, but it can also use its natural language processing APIs to understand questions similar to those asked earlier in the semester—or, eventually, even those posed in previous years. It has already started to harness the collective knowledge of the lecturer, the T.A., 12 tutors, and the students themselves. Moreover, yet another AI tool has automatically generated closed captions for the lecture recording, and the *Question* bot is able to determine if the student's question has already been answered in the lecture transcript. If it has a confident match, the bot provides a deep link directly to the exact moment in the lecture where the answer lies, and the video begins to play. The tutors' workload is reduced as the bot starts to take care of the easier questions, allowing them to focus on the difficult ones. Their ability to add deep human insight to the conversation has been leveraged.

Come exam time, the 12,000 pages of exams are fed into an automatic scan feeder. An AI bot reads the student number from every front page and separates each question into a two-page PDF. Each lot of 500 questions is batch uploaded to the cloud, and grading tasks are assigned to the tutors, who are ready to go with a rubric and touch buttons. They will assign marks directly to the spreadsheet. The bags full of exams are gone. The round robin of booklets is gone. The hundreds of hours spent leafing through pages to find the right questions are gone, as are the hours of laborious data entry. The tutors can grade exams anywhere, with nothing more than a laptop or tablet, and they can even provide feedback using digital ink. But the AI bot is not done assisting with digitized exams. It can read the final numerical answers and automatically give full marks to perfect calculations. If the final answer is wrong, it flags the question for human review. The AI bot can also utilize machine learning to mark graphs and diagrams that are correct—it has been trained using the graded exams from last semester. It can also parse the language of the written explanations and map them against a sample of acceptable responses. All this has immensely reduced the logistical workload of the lecturer and tutors, freeing them up to spend more time writing insightful feedback for students to learn from. Because the AI bot can map every exam question to every topic, every conversation, and every attendance item, it is able to provide analytical feedback on an individual student basis. And this is just the beginning.

End Scene 5

Automating Tasks to Free Up Educator Time

In a visit to UNSW, Sydney, in April 2018, I spoke with David Kellermann about how AI supports him as an educator at the School of Mechanical and Manufacturing Engineering. He gave a vivid description of stacks of papers; in pre-university settings, not many of us end up with 12,000 pages to grade at the end of a term, but that visual can evoke a great deal of empathy in any educator who has had to haul and grade a huge stack of papers.

It may be of interest to note here that in the design thinking (DT) process, empathy is the first step on the path to innovation. In Kellermann's class, for example, there are not enough seats at the university to physically accommodate everyone, leaving some students to take the course online. He noticed a discrepancy between students who took his course in person, and those who listened to online recordings of his lectures. So he set out to discover why.

Human Aspects of Sociocultural Learning That Make a Difference

Kellermann determined that nonverbal communication, visual aids, and participation in face-to-face class discussions were contributing to the gap. He had discovered a clear learning disparity between those who engaged in the social process of learning and those who learned directly from a machine, in isolation from others. He wanted a more equitable solution, even if not everyone could attend in person. During our conversation, he asserted that massive open online courses (MOOCs) and flipped classrooms can kill engagement and feedback, removing collaboration and communication from the learning process and leaving some students with an impoverished experience. Introductory mechanical engineering can be a challenging course, he said, and students need the sociocultural aspects of learning.

In a case like this, an educator alone cannot balance the load without personal knowledge of the nuances in students' struggles and gaps. Kellermann found, however, that when students used their real photos as profile images in Microsoft Teams—and when they began interacting online to answer each other's questions—they were able to instantly connect upon seeing each other in person. Some educators may have experienced a similar phenomenon when they've met someone in person at a conference after following them on social media or seeing their work online. Digital interaction seems to

help people forge a deeper and more immediate connection in person, allowing them to initiate conversations more quickly compared to educators who have never communicated though technology prior to meeting in person.

Since moving to Microsoft Teams, Kellermann has seen an 800% increase in discussion posts. At the conclusion of his course, 100% of the students who participated from a distance reported in their student experience surveys that they "felt part of the learning community." Their learning community became anchored in Microsoft Teams.

While technology can remove human interaction from the learning equation, leaving students deprived, it can also provide tools that help support the sociocultural aspects of learning. Through platforms such as Microsoft Teams, machine learning has the computing power to assist educators in identifying areas that need support, notifying humans when intervention is required, and facilitating socially mediated learning (Vygotsky, 1987). In the example at the beginning of the chapter, Kellermann used technology to augment human connection. Contrast that with the scene from the animated film *WALL-E*, in which technology supplanted human communication. When a tool can help educators build community, student engagement increases.

COLLABORATE USING MICROSOFT TEAMS

Microsoft Teams is a digital hub for educators and students. It allows users to collaborate around classes and assignments, connect in professional learning communities, and communicate with one another.

Learn more or get started at **tiny.cc/1b6r0y**.

Data Mining

Schools collect a massive volume of assessment and performance data, which can reveal trends and patterns in student progress—valuable information educators can use to improve teaching and learning. But the data remains fallow if no one has the time or expertise to analyze it. Fortunately, AI has stepped up to fill in the gap. **Data mining**, an interdisciplinary subfield of computer science, is the computational process of discovering patterns in large data sets using methods that stem from the intersection of artificial intelligence, machine learning, statistics, and database systems (Wikipedia, n.d.).

Educators are increasingly using data mining to process and deliver student performance data to teachers, allowing them to more easily spot struggling learners who need extra help (Haigh, 2007).

Assessment

In Kellermann's course, data mining had a measurable impact on student success. Exam pass rates for the class using Microsoft Teams increased from 65% to 85%. As part of his data mining efforts, he wanted to move beyond multiple choice tests and basic responses to find out whether his students understood the material and were able to apply the knowledge. That required the ability to demonstrate understanding in a more fluid way, including through drawings with digital ink. This posed a challenge for automating assessment. Figures 5.3 and 5.4 are examples of real student work from a sample assessment.

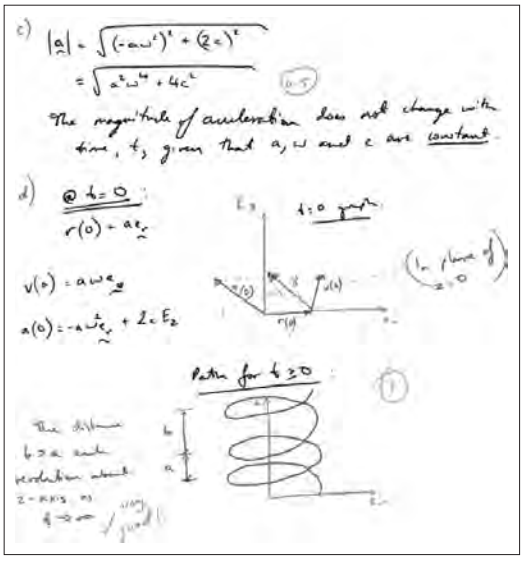

Figure 5.3 Student example done in digital ink.

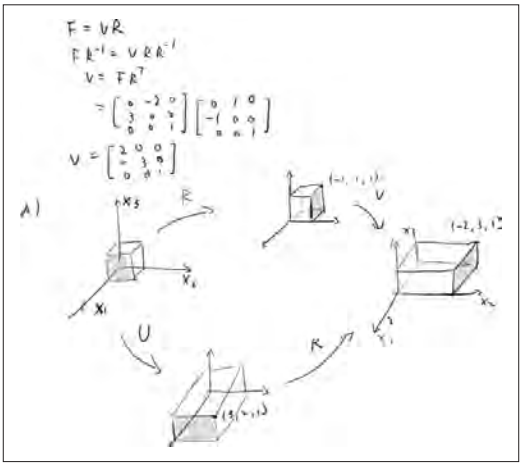

Figure 5.4 Student example done in digital ink.

To assess this type of work, Kellermann needed more complex machine assistance. He identified four categories of response types and matched them with the corresponding marking technology needed to assess student work:

1. Yes/no, multiple choice, or numerical: *Boolean*
2. Written answers: *O.C.R., natural language processing, and AI*

3. Graphs and diagrams: *Machine learning for positives*
4. Mathematical reasoning: *Humans when flagged for review*

In addition to processing multiple choice and "yes" or "no" answers, assessments can now incorporate machine learning, natural language processing and computer vision, and human judgment. With machine learning for positives, the AI only gives positive marks. If the computer identifies all components of a problem as correct, including written ones, the item is marked as correct. When there is a discrepancy, the machine flags a human to review the answer and use their judgment to understand where the student went wrong. With every answer, the machine continues to learn. This has reduced the job down to 20% of what it used to be by automating everything except the flagged items. It scrapes away all of the repetitive work, allowing educators to focus on the rich, human part of assessment—to look at the nuances.

Throughout the course, educators are now able to pull assessment data into Power BI, an analytics service provided by Microsoft, and display it in students' personal sections in OneNote (shown in Figure 5.5) so they can visually see their progress.

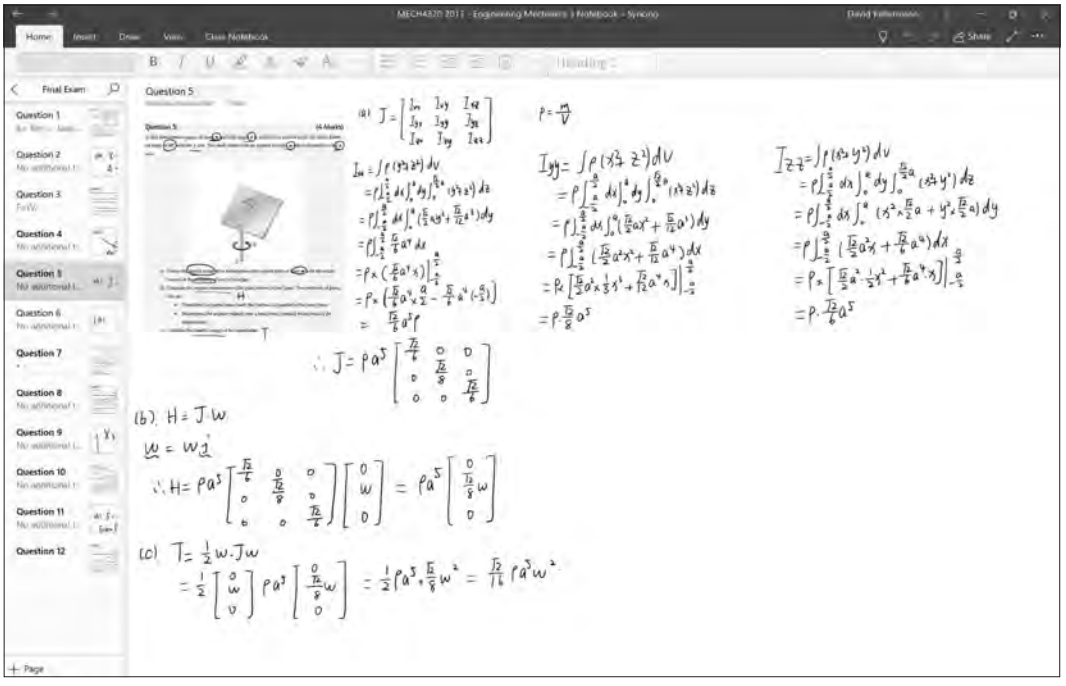

Figure 5.5 An example of a structured final exam in engineering, using digital ink with real-time synchronization in OneNote.

Success Supported by Augmentation from AI, Machine Learning, and Human Interaction

After deploying AI, Kellermann's survey results indicated that his first-year mechanical engineering students felt successful, connected, and part of a community. The responses were unprecedented—a stark contrast to previous survey results, as well as the results of other mechanical engineering courses in which this method is not yet in use. Kellermann has identified what made this application of AI different:

> *Looking back, we can see that the use of AI was not about convenience—such as the way a digital assistant can save you 10 seconds by giving you the weather, or setting a reminder or alarm. It was also not about saving money in educational delivery. The AI enabled insight to be leveraged in different ways, such that each of those 500 students gained more from their educational experience. (D. Kellermann, personal communication, and 2018)*

Beyond the technology, beyond the human connection between students, perhaps the most compelling part of Kellermann's story is his desire to provide early intervention for students who may be struggling. Machine learning has helped him with early detection, allowing him to predict the likelihood that students will continue to struggle—or even drop the course. Because he was able to identify these cases earlier, and because the chatbot fielded all of the student questions that had already been addressed in the course content, he was able to devote his time to interventions that could change a student's trajectory and support continued learning in STEM career fields.

AI, and specifically machine learning, can also highlight specific areas where students consistently show strength, giving educators the opportunity to suggest electives, highlight natural aptitudes, and recommend skills matches earlier. It can help identify particularly rare combinations of skills that organizations will highly prize in future employment—skills that may otherwise get lost in a numerical grade or percentage. Some employers miss out on that perfect match because tests highlight only one aspect of a job candidate's learning while areas where the student shines can't be easily demonstrated. This can cause frustration for students, who may end up changing majors or even choosing an entirely new career path. The world needs talents and skills that aren't clearly demonstrated through test scores—especially as we work to define what humans can contribute in a world where machines can excel at the same skills our assessments were created to measure.

Beyond these grading and assessment examples, AI and machine learning have provided Kellermann with a single hub for students, simplifying class administration. He can now quickly push a meeting, assignment, or exam date to all students from within their own Outlook calendars. Lecture notes are synchronized in OneNote. Videos are available through Microsoft Stream, and chatbots can direct students to the precise section of the video that holds the answer to their question. These technologies working together have revolutionized both this instructor's experience and that of his students.

Working Out a Roadmap for Smarter, Not Harder

Creating an AI-driven system like Kellermann's requires pulling together multiple AI tools into one framework. In a conversation with LeiLani Cauthen, CEO of The Learning Counsel and author of *The Consumerization of Learning: How educators can co-opt consumer-grade digital courseware to transform learning in the Age of Experience*, I asked her what she wanted educators to know about AI and how she imagined it could support them. This is what she had to say:

> *AI in the realm of education is going in the direction of recommendations engines for lessons, for remediation, for tangential content, and for personalized pathways. Inside adaptive courseware and resource collections websites is one area where AI is forming with complex algorithms. It's there that the burden is shifted from search-and-deploy manually in framework systems to more of an automatic deployment with feedback analytics and leveraging for teachers. The biggest hurdle is the disparate subject-focused systems, and working out a roadmap to tie together those pieces into one curriculum map with a multiplicity of directionality for personalization. (L. Cauthen, personal communication, May 4, 2018)*

Although pieces exist and advancements have been made, individual educators must still put in a lot of work to find, vet, and combine AI tools to produce a working system that helps teachers work smarter, not harder. As people like Kellermann refine their systems and abstract the framework to facilitate the transfer from university level to K–12 classrooms, incorporating AI will become easier—but there are limitations for replicating a structure such as Kellermann's in a K–12 setting. Elementary school teachers typically teach most or all subjects, and while that type of scaling is possible, the technology just isn't there yet. Machines also need vast amounts of training data before they can help

assess exams with images and words. UNSW has 500 students in one term, but smaller classes would take longer to produce enough iterations to train the machine. However, as we saw from some of the work Google is doing with imagery, there have been strides in the ability of a machine to recognize or predict drawings.

Arts, Music, and AI

We've seen many examples of how AI can facilitate student learning. Programs like ALEKS support mathematics teachers in assessing and correctly identifying gaps in understanding. Programs like Mia Learning can assist educators in differentiating reading instruction and gaining a better understanding of their students' progress. OneNote Learning Tools not only offer accessibility features but also help students in typically developing classrooms with listening, revising, reading, and comprehension. But what can machine learning do to support educators in teaching arts like drawing and music?

MIXING TOOLS FOR MUSIC CLASS

At Northwest Council for Computer Educators (NCCE) in February 2018, I had the opportunity to speak with Andrew Fitzgerald, instrumental music teacher at Franklin Classical Middle School in Long Beach, California. Although he did not specify AI, he uses a range of tools—including Kahoot!, Go Formative, Socrative, Office Forms, and the Office business analytics tool Power BI—to become more efficient and help his students understand their own progress as they pursue their learning goals (Figure 5.6). In an article for the Microsoft Education blog, he described how he uses a mix of tools to more effectively assess student growth.

> *Assessing the individual performance of my music students is a time-consuming process, especially with a class of 50+ students. . . I assess every student—and their classmates provide feedback when they perform. We use an Office Form in which to enter scores and constructive feedback for each student. . . By importing my data into Power BI, I can organize scores and feedback specific to my instrument sections and individual students, easily share it with them, and use this data for personal reflection and growth mindset–related activities. (A. Fitzgerald, personal communication, February, 2018)*

Learn more and see examples of how Fitzgerald organizes student assessment data at **tiny.cc/gasbxy** and on his blog, **andrewfitz.net**.

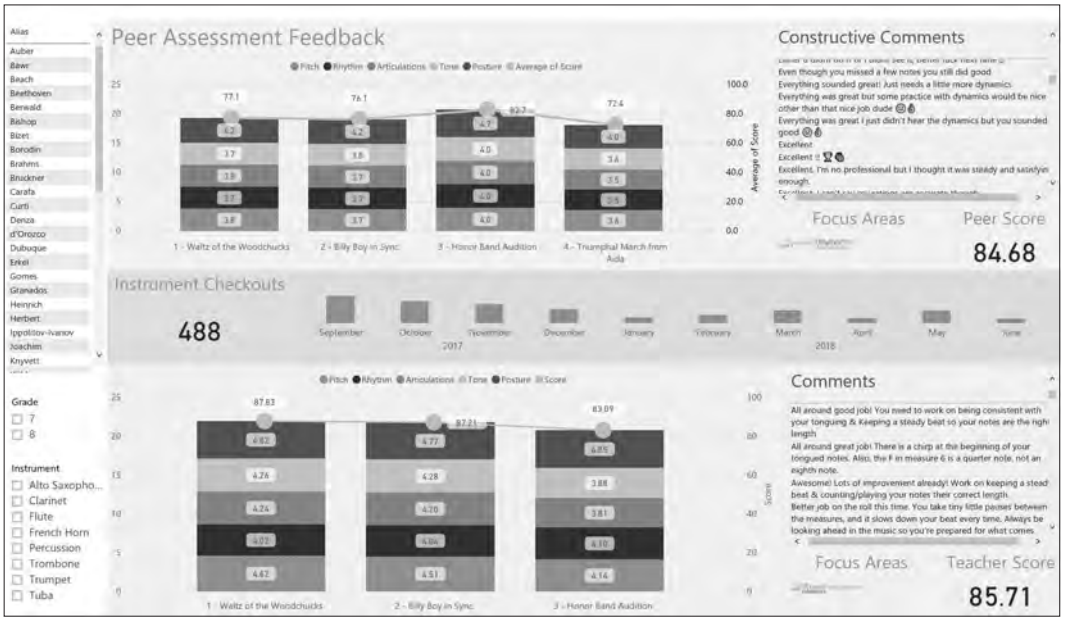

Figure 5.6 Digital tools assist with both teacher and peer assessment of instrumental music skills.

PORTFOLIO TOOLS FOR ART ASSESSMENT

AI can support traditional art assessment with portfolio tools that simplify the process of student reflection, providing an easier way for educators to track works in progress. Using a machine learning algorithm to optimize aesthetics for their final presentation, students can focus their time and effort on creating the artwork rather than on designing their portfolios. Although art teachers may not take home thousands of pages to grade at the end of the term, art courses in traditional mediums pose a challenge when it comes to keeping and scoring the final products. Such works either take up a lot of space in the classroom, or students must carry large portfolios to transport their work.

Tools like Office Lens can take photos with a mobile device and remove parallax for a more polished presentation. As shown in Figure 5.7, having students document their progress in completing graphite grid pictures provides a level of self-reflection and peer-assessment; and an artifact to submit, keep, and share on social media—or even their LinkedIn profiles. Because projects of this complexity are an important part of STEAM learning, this format allows for a more complex review of content and better communication with families so they might understand the significance of students' artwork.

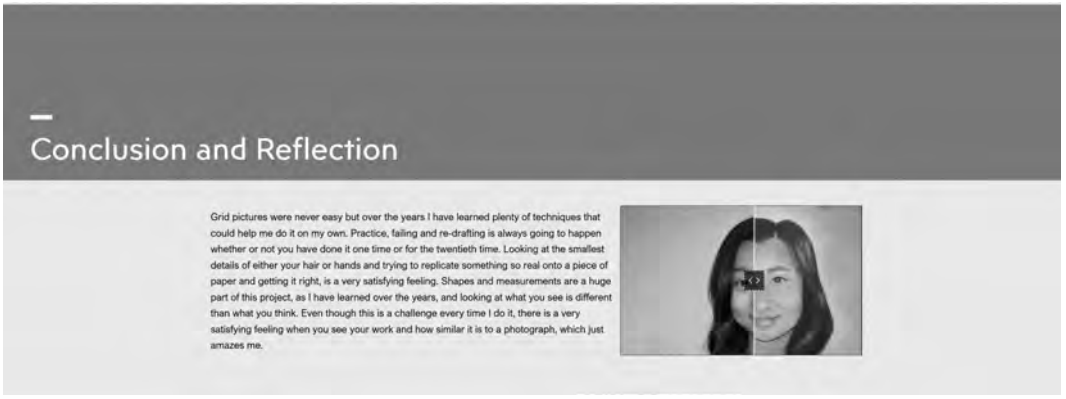

Figure 5.7 A student uses Sway to reflect on the process of drawing graphite grid pictures.

STUDENT EXAMPLES IN SWAY

Explore examples of students reflecting on their art progress in Sway:

- Myra Tso's Grid Picture Progress by Myra Tso:
  sway.com/0sO7CNLVWIhhGPIJ?ref=Link&loc=mysways
- The Story Behind My Gift by Sharice Lee:
  sway.office.com/AbARTZpfM5VtW6vR?ref=Link
- Red Dot Fuji by Afomeya Hailu:
  sway.office.com/3O1bo95AOvEgJJ1f?ref=Link
- The Story Behind My Gift by Emmy Sung:
  sway.office.com/D8oCdEZjcWDsB3sP?ref=Link

Apprenticeship in the Digital Age

The added benefit of an assessment method that captures progress, rather than just assessing the finished product, is that others can gain insight into the student's process. Educators can model assignments based on what they see, while students can learn from others who have completed the work in advance. The ability to learn from another person's process is the basis for apprenticeship, a time-honored learning technique. While that type of one-on-one support and guidance is not possible for an individual teacher with a large classroom, AI can help fill the gap. As repetitive and basic tasks are increasingly performed by machines, humans can move more toward apprenticeship

models of learning with higher levels of human interaction. This aligns with the high-touch and high-tech model.

The apprenticeship model (Rogoff, 1991) describes the relationship between a novice and a more experienced expert, who guides the novice through hands-on involvement in a shared activity. The expert decides how to divide the activity into smaller subgoals on a scale the apprentice can handle, while also providing helpful advice on how to apply the tools (Cole, 1989) and skills required (Rogoff, 1991). Jonathan Grudin, design researcher at Microsoft, touched on the value of apprenticeship when discussing whether AI will replace educators:

> *What I would want to tell educators would depend on whether they were teaching about what AI is, how the world will be with a relatively conservative prediction of AI plus other technologies, or how they can or will use AI in doing their work. I would lean on the augmentation or supplement side. I would say that as far as education goes, people are wired to learn by apprenticeship as we did for millions of years, from other people, and that won't change. No technology will replace a good, insightful, empathic, inspiring teacher, but it can help the teacher and sometimes be available when the teacher can't be. (J. Grudin, personal communication, 2018)*

From a sociocultural perspective, teaching and learning is about more than just a brain and a body. There are complex processes that happen in the presence of others, including the development of empathy and ethics.

AI for Augmentation to Support Educators

We have learned from research that motivation can be crucial in learning (Ryan & Deci, 2000). When asked about the role of AI in education at Alan November's Building Learning Communities conference in Boston in July 2017, Zoran Popovic, University of Washington professor, director of the Center for Game Sciences, and founder of Enlearn, replied that when they trained machines to prompt educators to physically give students a high-five hand gesture, rather than delivering a reward on the screen, students performed better. Human teacher input matters. Harnessing data and collecting artifacts is one thing. How we use them to support and encourage student learning is another.

One way both educators and those experienced in AI can work across disciplines is to help identify goals for future generations. Motivation to persist when things get difficult (Ryan & Deci, 2000) is crucial for more than just academics. What Grudin says makes sense alongside empirical research findings. Humans have innate psychological needs, including the need for relational connection, a sense of choice, and a feeling of success. In Ryan and Deci's (2000) work, they refer to this as "relatedness, autonomy, and competence." When those three innate psychological needs are met, people are more likely to persist when things get difficult. It makes sense that AI would help boost autonomy and competence, but a human connection is needed to build a sense of relatedness. We see this happening in mentoring with both older and younger children, as well as in in success stories across the globe.

What Teachers Can Add to AI Augmentation

The image in Figure 5.8 is of a real student dashboard within ALEKS, described on the website (**aleks.com/about_aleks**) as "a Web-based, artificially intelligent assessment and learning system." She is a motivated student who appreciates being able to excel in academic content. Using her dashboard, she can identify a clear goal and see the outcomes of her progress. For some students, this is motivating; others, however, may feel defeated and shut down. According to Grudin, "Some kids will respond well if the system gives them increasingly difficult problems until they get one they can't do. Other kids will feel deflated if every problem session ends with a failure. Teachers can get insight into motivational differences that these systems don't have time or ability to pick up. AI can help them; but it won't replace them" (2018).

Educators have the capacity to learn the nuances of a student's behavior and determine how to motivate them differently. That is where the power of ML comes in, identifying when human connection is needed and prompting an educator to step in—combining high-touch with high-tech. Even in an apprenticeship for mathematics, it would be difficult for a human to know all aspects of mathematics mastery and pinpoint gaps in understanding. This is where AI excels.

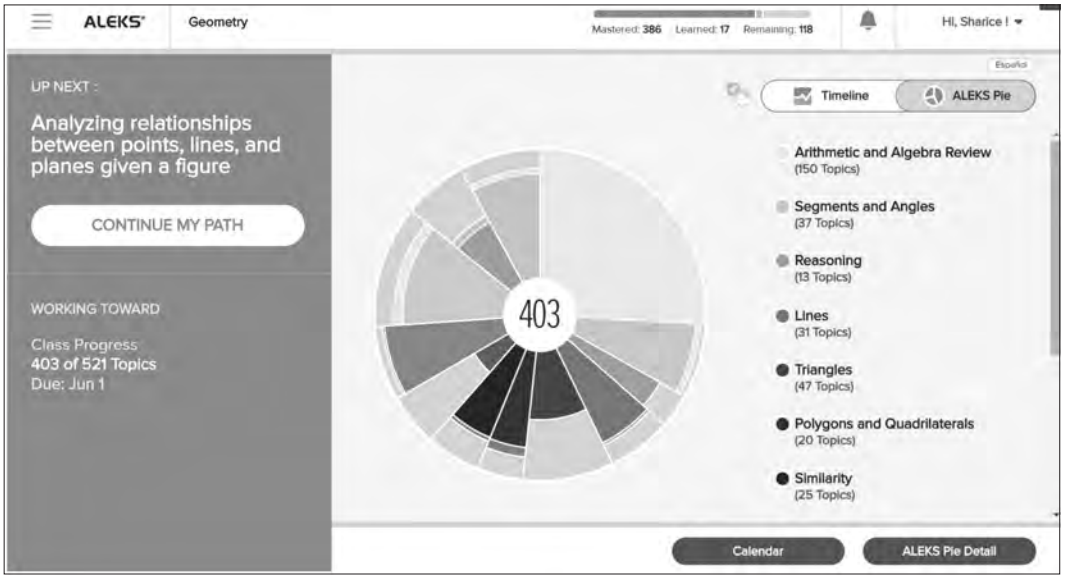

Figure 5.8 A dashboard displays a student's progress through the ALEKS mathematics courses.

Students who complete ALEKS mathematics courses, for example, can track their own progress via a dashboard, which defines progress to completion and the breakdown of core concepts that comprise that particular math course. In Figure 5.8, the amount of color filled in demonstrates the amount of mastery achieved in that learning path. On the left, the adaptive program offers recommendations for the student's learning path. The progress bar on the top shows how much of the course has been mastered and how much remains. This program is used in colleges to assess math level and gaps as well as to better adapt to student pace and progress.

REFLECTING ON AI

- What are ways you imagine AI can support you as an educator?
- What ways do you imagine may be possible in the future based on what you have learned?
- In what ways do you have the capability to excel at supporting students where machines are not effective?
- What do you think about using facial recognition in classrooms to identify emotions or behaviors?
- What does it mean to work smarter, not harder?

The Importance of Teachers: Physical Education as an Example of AI Augmentation

Motivation does not end with mathematics, engineering, or the fine arts. Physical education is another area where educators may begin using AI to support learning. In the sports industry, AI is being used to analyze performance, human biomechanics, and health data to offer coaching support for performance and training (SportTechie, 2018).

Seismic (**myseismic.com**) is addressing human biomechanics to optimize performance, tracking body movements in real time with MotionScience Platform (**tinyurl.com/yalqm6jj**). Data is already supporting the use of AI in wearable technology designed to improve posture (Lumo Lift), while a coaching platform for runners (Lumo Run) has proven effective at helping runners perform more efficiently and improve their run times (Bradley, 2017).

While AI will continue to advance, giving rise to more wearable technology designed to support athletics and sports training, educators and coaches will remain important. Grudin made this point in a conversation on May 5, 2018:

> *My example is from my first paid job as a tennis instructor. It seemed like what we did was teach how to hit each stroke. At the time, you could get instruction on how to hit each stroke from videocassettes, and later YouTube, but that didn't put tennis coaches out of work. What might AI do? Let's say it gets so awesomely good that it can identify every mistake a player is making from analyzing videos. (I doubt it can now, my guess is that it might suggest things to a coach who can look at the videos and do a better analysis, but let's say it can.) It can identify the eight mistakes that the student is making on forehand and backhand. It notifies the coach. Is the coach out of a job? No, the coach will size the student up and decide how motivated he or she is. It is unclear whether the student will react well or badly to hearing that there are eight problems with these strokes. Perhaps the coach will only mention three at first—decide which two to focus on now, and how hard to push the student before high-fiving and heading for the shower. As a tennis coach, I actually thought there were two crucial things: 1) to keep the player motivated and playing (my advice was, find someone you like to play with and play a lot), and 2) to teach them to serve correctly, as no one self-learns a good serve. I could help with the other shots, of course, but motivation was key. Recognition and machine learning systems won't be going there.*

Developing Chatbots

Ashok Goel has referred to the simplified intersection of cognitive systems, robotics, and machine learning as parts of AI that are not yet integrated. He is also known for his work with Jill Watson, a chatbot that he created for his college course. His regular courses at Georgia Tech had at most a few dozen students, but his online students numbered 400 from all over the world. He fielded more than 10,000 questions in a semester—a load he and his staff couldn't feasibly handle. And, as we heard before, there is a discrepancy in learning between those who take a course in person and those who learn online. Educational researcher Katy Jordan has demonstrated that fewer than 15% of students actually complete MOOC courses after they've enrolled (**katyjordan.com**). Goel created Jill Watson, an intelligent tutor, while he was teaching a course on Knowledge-Based Artificial Intelligence. Although Jill Watson wasn't immediately effective and provided some strange answers, it became 97% effective at responding to basic questions. Just to begin training, though, he needed to upload four semesters' worth of data, which comprised 40,000 questions and answers, along with other chatter.

Goel told *Wired* magazine that Jill Watson isn't ready to teach or take on the responsibilities of a human T.A.: "We're not months away or years away. We're decades, maybe centuries away, at least in my estimation. None of us (AI experts) think we're going to build a virtual teacher for 100 years or more."

UNDERSTANDING AI

- Read more about Ashok Goel's work with Jill Watson in *Wired*: **wired.com/2016/12/a-secret-ops-ai-aims-to-save-education**.
- Read the research he wrote with Lalith Polepeddi on Jill Watson and AI applications for online education: **smartech.gatech.edu/handle/1853/59104**.
- Review the Crash Course video on natural language processing to learn more about chatbots and parsing answer trees: **youtu.be/fOvTtapxa9c**.

When Grudin worked on a chatbot project, he discovered that chatbots can be considerably more difficult than he had imagined. Marching a person through a question-and-answer tree, like a telephone answering system, is one thing; imbuing a bot with personality, on the other hand, is very difficult.

WORKING WITH CHATBOTS

While virtual teachers may be a long way from becoming a reality, you can create a chatbot with your students using existing tools. Chatbots—applications that perform one or more automated tasks using conversation as the interface—are used in a number of ways across the internet and on various devices. They provide services such as:

- **Information retrieval:** Lookup, reference, and information seeking. For example: "What subjects are offered for year 12 in 2018?" and "When are the trains leaving on Thursday?"
- **Transactional:** Look up information and make amendments. For example: "Upgrade my account to plan B" and "Book two tickets for film A on Monday using my credit card."
- **Advisory role:** Prescriptive guidance via "expert systems" based on user input. For example: "Are these school shoes appropriate?" and "Should I add another component to my service plan?"
- **Social conversations:** Sense sentiment and engage in open-ended conversation within the bot's area of expertise. For example: "Your product is terrible, I would like a refund." and "I have had a terrible experience, who can I talk to?" (Afshar, 2018)

Discuss with students the role chatbots play in our lives. Brainstorm other possible applications for chatbots and virtual assistants. Explore the following resources for building a chatbot:

- How to Build a Chatbot in 10 Minutes (**tinyurl.com/y6u3jofq**): Inspired by a workshop on Azure and Chatbots by Ray Fleming at the Microsoft Learning Partner Summit in January 2018, this blog walks you through the process of building a chatbot using a variety of tools.
- How to Build a Chatbot Without Coding (**tinyurl.com/y868ex8f**): This Coursera course using Watson natural language processing capabilities doesn't require coding knowledge.
- Build a Chatbot with IBM Watson APIs (**teamtreehouse.com/go/build-a-chatbot-with-watson-apis**): Treehouse has teamed up with IBM Watson to create this course, which shows you how to build a chatbot using natural language processing services available from IBM Watson and IBM Cloud Platform.
- Amazon Lex (**aws.amazon.com/lex**): Experiment with the same algorithms and technologies that power Amazon Alexa.

How Educators Around the World Are Considering Their Role in Educational AI

You may be wondering if schools are already replacing educators with AI, and how your school compares to others in preparing students for a future with AI. I asked a range of educators from different countries about their thoughts on AI. After the caution I received from researchers to not get swept up in the AI hype seen in headlines, I wanted to investigate more. After all, learning to ask questions is one of the proposed methods for preparing for a future with AI. I found myself making assumptions that countries with a lot of media headlines must surely be further ahead in the AI race than the U.S. The first educator I asked was Hidekazu Shoto in Japan. It was clear that his school was creating a solid learning foundation to prepare students for the future of technology.

HIDEKAZU SHOTO, JAPAN

Hidekazu Shoto is head of the ICT department and an English teacher at Ritsumeikan Primary. With as much media as I've seen about Japan being highly advanced in AI, I assumed that schools in the U.S. must be far behind Japan in the use of AI. I asked Shoto, "There is a lot of conversation on artificial intelligence and people asking if it will ever replace humans to teach children. What do people at your school think about this?" He responded, "We are facing this problem. Actually, to be honest, many teachers don't think too much. Japan is very behind other countries" (personal communication). I searched for other stories that may have provided more context and found an article from Japan Policy Forum that discussed artificial intelligence, the Japanese game Shogi, and how AI's success at the game helped shift attitudes toward AI in a positive direction (Mataki, 2016). From my research, and as a result of speaking with experts, Ritsumeikan Primary is elegantly preparing their students for a future that will implement AI in classrooms and also will continue to appreciate humanity while seeking effective ways technology can augment what we can do as teachers.

PHUTI RAGOPHALA, SOUTH AFRICA

Phuti Ragophala is a Varkey Teacher Ambassador from Seshego, Limpopo, South Africa. I met the former principal of Pula Madibogo Primary School at the Global Educator Exchange in Singapore in March 2018. She said she believes everyone is born with his or her intelligence. There may be variation in the level of intelligence, but now we live

in environments and times where we have machine learning and AI as part of our daily lives. Still, she said, it shouldn't replace teachers. She added:

> *We need to empower, add up, and boost our level of intelligence through reading, learning, and teaching. And one of those tools to be used to learn is technology in order to adapt to the era where we are. To me, artificial intelligence works because if it was not for it, I would not have been where I am today. Living a natural life today is not enough. Yes, in the olden days maybe it was possible, but gone are those days where natural intelligence alone can serve a purpose in life. (P. Ragophala, personal communication, March 2018)*

NAM THANH NGO, VIETNAM

A 2018 Global Teacher Prize Top 50 Finalist from Da Kao, Nam Thanh Ngo said machines may be able to replace teachers on the podium in the future, but teachers do not simply teach knowledge. Teaching is not the same as throwing out information and expecting others to remember it, like copying data to a hard drive, and it will never become an old-fashioned profession. Besides providing knowledge, it also requires insight and teaching methods that are appropriate for each subject. So far, there has been no sign that AI has the power to teach children spelling or arithmetic. He expects AI will help people work hard, but it cannot replace humans.

AGGELIKI PAPPA, GREECE

Aggeliki Pappa from Athens, Greece, is an ambassador at Varkey Teacher Foundation and an advocate for students with dyslexia. She weighed in on this topic, saying, "As all things in life, they become useful or dangerous according to the way we use them. The answer lies in our choices. Let's be wise and use technology for our common benefit, respecting all different parameters and dimensions."

Rather than fearing AI as a possible replacement, teachers can benefit from embracing the technology as a tool that enhances their ability to foster deeper learning. As machine learning and automation take over the more repetitive tasks associated with teaching, educators will have more time to focus on the human side of learning. Working side by side with AI, teachers can improve student outcomes while also modeling the types of human-machine collaborations students will encounter in their future jobs.