ADDRESSING THE CHALLENGE OF IMPROVING EDUCATION IN THE US THROUGH INNOVATIVE TECHNOLOGY
The Use of IBM Watson Cognitive Computing Technology

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The following is a case study of one approach for improving the effectiveness of the U.S. Education System in preparing students for tomorrow’s global economy. Research indicates that improving teacher effectiveness is a key determinant in improving student performance. IBM, along with education experts and support from funders, undertook the development of Teacher Advisor with Watson, an application using IBM Watson cognitive computing technology to help teachers improve their knowledge, skills and classroom effectiveness leading to improved student performance. Significant portions of the material used in this case study draw upon materials made available by IBM.
Executive Summary

The 21st Century has witnessed a growing gap between job opportunities and the labor pool with the education and skills required. The 21st Century has seen a shift away from manufacturing to service industries. Better paying jobs are found in the information technology fields and more broadly in the Science, Technology, Engineering and Mathematics (STEM) fields. These jobs require a different skill set than those required in manufacturing. Critical thinking, problem solving and ability to work under conditions of uncertainty are some of the skills demanded in today’s global economy.

In a global economy, U.S. students compete with students from around the world for the best paying jobs, and international corporations seek high performing students to join their workforce. In a number of international measures, U.S. students perform only average compared to students from other developed countries. In October 2013, the first-ever international comparison of workers’ skills in 23 industrialized nations revealed that younger Americans rank near the bottom in reading literacy, numeracy, and (ominously) “problem solving in technology rich environments.”

This case study explores how a diverse group of individuals and organizations representing the public and private sectors joined forces to improve performance of U.S. students. The IBM Corporation, working in collaboration with teachers, educators, government officials and education funders, undertook an innovative project using next generation technology to help improve teacher instruction. Teacher Advisor with Watson incorporates high quality, vetted content and effective pedagogical practices, to help teachers improve their instructional practice.

In addition to documenting the development of Teacher Advisor with Watson, the case study is also intended to provide CUNY students competing in the CUNY-IBM Watson Competition 2017 the steps required to turn an idea into a viable product or service that meets a social need. Five stages of development and design are discussed. The challenges of building consensus among various stakeholders in the outcome of the design and implementation process, from customers to investors, need to be involved. The five stages are:

1. Ideation - Choose an idea to work on.

2. Interdisciplinary team formation - Key to success is having a team with students from different schools and with different skill sets.

3. Design Thinking - latest methodology in refining your idea and defining the functionality your application needs to have to be successful.

4. Tech Workshop – Identify the appropriate technologies that are best suited to use to build a pilot, using IBM cloud and Watson's cognitive computing technology.

5. Pilot creation – build prototype and pilot test with a small sample of potential users.
MEETING THE CHALLENGE OF IMPROVING EDUCATION IN THE US

BACKGROUND

The 21st Century has seen a shift away from manufacturing to service industries. Better paying jobs are found in the information technology fields and more broadly in the Science, Technology, Engineering and Mathematics (STEM) fields. These jobs require a different skill set than those required in manufacturing. Critical thinking, problem solving and ability to work under conditions of uncertainty are some of the skills demanded in today’s global economy.

In a global economy, U.S. students compete with students from around the world for the best paying jobs, and international corporations seek high performing students to join their workforce. How is the U.S. doing in preparing its young to compete in the global economy? Unfortunately, not well - in October 2013 the first-ever international comparison of workers’ skills in 23 industrialized nations revealed that younger Americans rank near the bottom in reading literacy, numeracy, and (ominously) “problem solving in technology rich environments.” (Wendy Kopp, Do American Schools Need to Change? Depends What You Compare Them To, Atlantic Magazine, Oct 25, 2013)

The Federal Government and States have undertaken efforts to improve student performance. In 2001, Congress passed the No Child Left Behind Act (NCLB), an effort to improve student performance by establishing standard-based education with measurable goals. By 2015, it was clear this program was not achieving its intended goal.

In 2015 the Congress passed and President signed into law the Every Student Succeeds Act (ESSA) that replaced the No Child Left Behind Act and shifted federal accountability to the states but retained provisions that required periodic standardized testing. In addition, ESSA focused on college and career readiness.

In 2009, the Council of Chief State School Officers (CCSSO) and the National Governors Association promoted a new approach from state standards to Common Core Standards that reflected the real world and the knowledge and skills young people need for success in college and in careers, placing them in a position to compete in the global economy. A primary intent of the standards was to eliminate state variation and ensure high expectations for every student across the US. While initially adopted by 45 states, Common Core has suffered significant political backlash. However, reports suggest that teachers across the US are using the standards to guide their instruction.

The U.S. Education System

America spends more per pupil than nearly every other country and yet on the best international assessments of critical-thinking, our results are mediocre at best. Since 2000, the United States has participated in a comparative study conduct by the Organization for Economic and Co-Operative Development (OECD). Assessments are conducted every three years using the Programme for International Student Assessment (PISA) instrument. PISA focuses on the subjects of mathematics, science and reading literacy. The assessment is designed to measure
how well students can extrapolate from what they have learned and can apply that knowledge in unfamiliar settings, reflecting the fact that modern economies reward individuals not for what they know, but for what they can do with what they know.

2000 was the first year the PISA was administered to a sample of 180,000 students in 32 countries (28 OCED, 4-non-OECD). In 2000, the U.S. scored average in all subjects, ranking 19th in Mathematics, 14th in Science and 15th in Reading Literacy among the countries included in the study. In 2015, the U.S. rankings had not improved, scoring average in Science (ranked 25th) and Reading Literacy (ranked 23rd) but below average in Mathematics (ranked 37th) among the 72 countries participating in the PISA. 540,000 students were included in the 2015 PISA.


What Can Be Done To Improve K-12 Education in the US?
IBM, and other companies, have a stake in building a skilled labor pool in the US from which to draw a growing number of hires in the “new collar” jobs. Finding ways to improve student performance is critical for this to occur.

After reviewing the research literature, and after convening key education stakeholders for an initial leadership summit at the Roosevelt House Public Policy Institute at Hunter College in New York City in April of 2014, it became even clearer to IBM that teachers mattered more to student achievement than any other aspect of schooling. Research affirmed that it is how teachers teach – the techniques they use in their classrooms – not where they went to school or where they have taught – that impacts students the most. Effective teachers tend to stay effective even when they change schools. (“Teachers Matter,” Rand Corporation, 2012)

IBM, informed by guidance from attendees at the April Roosevelt House convening, also realized that while a plethora of tools existed to support student learning at all grade levels and academic areas, few innovative tools were specifically focused on teachers, with the goal of helping strengthen and support their instruction. As the demands on educators increase, teachers need ongoing opportunities to build their instructional and content expertise to help them better meet the needs of their students and enable them to achieve at higher and higher levels.

**STEP 1: Identifying A Possible Solution-Development of Teacher Advisor**

The research team sought to understand how teachers learn and develop professionally. In teaching, perhaps more than any other profession, learning from peers has been widely acknowledged as an important method for raising teacher quality. By observing peers, especially those more experienced, teachers see theory come alive in practice, learn new instructional strategies, and get helpful feedback.

There are a number of factors that influence how teachers learn best from “teacher leaders.” These include but are not limited to when teacher leaders: understand and take into account the emotional temperature of its teacher audience (which could include feeling overwhelmed or overworked); can explain pedagogy in the context of real examples of both classroom practice and student work; provide targeted and brief information and strategies; and have an understanding of where individual teachers are in their own development so that they can help
them make the leap to better teaching with specific advice, strategies and tools that they can add into their current repertoire.

According to a report in *Educational Leadership*, “teachers learn best in the same ways that most students learn best: actively, drawing from prior knowledge, and in a comfortable environment.” (“How Teachers Lead Teachers,” Margolis, 2009)

IBM leadership asked whether it was possible to develop an application using the power of Watson cognitive computing to help the professional development of teachers and provide them access to the information and knowledge needed to improve instructional practice. IBM was making inroads in medicine, helping physicians better treat cancer patients by teaming with Sloan Kettering and applying Watson’s capabilities to plough through decades of information on cancer diagnoses to actually assist in making more accurate diagnoses of cancer. This has proven to be a real breakthrough in healthcare. IBM envisioned a similar approach in education: Building a tool, powered by cutting-edge cognitive computing technology, to help teachers better serve the needs of their students. *Teacher Advisor with Watson* would be “by teachers, for teachers,” trained by education experts, including teachers and an Advisory Board of respected thinkers in education – all focused on one purpose: the professional development of today’s modern educator. Teacher Advisor with Watson would be made available to teachers free of charge.

**BACKGROUND ON WATSON**

In 2011, IBM’s “thinking” supercomputer, Watson, beat some *super* humans on a special episode of *Jeopardy!* Watson's win showed the world what cognitive, or thinking, computing was capable of, by analyzing hundreds of millions of pages of data and converting answers to questions using natural language.

Watson represents a first step into cognitive systems, a new era of computing. Watson is able to turn information into insight, by rapidly analyzing huge amounts of unstructured data to tease out hidden patterns and deliver evidence-based responses that can drive higher performance and better decisions. The combination of three capabilities makes Watson unique:

- **Natural language processing:** to help understand the complexities of unstructured data which makes up as much as 90% of the data in the world today
- **Hypothesis generation and evaluation:** by applying advanced analytics to weigh and evaluate a panel of responses based on only relevant evidence
- **Learning system:** Watson learns and improves its performance as it gains experience, getting smarter with each iteration and interaction.

[IBM Watson: How it Works](https://www.youtube.com/watch?v=_Xcmh1LQB9I)

The first release of Teacher Advisor with Watson focuses on 3rd grade mathematics, which is the first year that many students formally work with fractions and develop an understanding of fractions as numbers. According to the National Research Council and others, fractions, in particular, are both challenging and critical to future work. Students must master these concepts in order to be successful in later grades because they form the basis of understanding in algebra and advanced mathematics, such as probability and rational expressions, as well as the basis of the rational number system, an area in which many U.S. students struggle. Finally, 3rd grade math is the first year of standardized testing, a major teacher pain point.

Teacher Advisor with Watson is being customized specifically the for the education domain. Based on their understanding of the factors that influence teacher effectiveness, IBM decided to focus their initial efforts in building Teacher Advisor with Watson functionality that would enable teachers to tackle a number of challenges they face.
In addition, IBM envisioned that Teacher Advisor with Watson would provide teachers with the ability to use natural language to ask Watson questions on content and pedagogy. Watson Dialog and Natural Language Processing guides and enriches their interactions, making Teacher Advisor with Watson a non-judgmental and completely confidential “coach.”

**STEP 2: IBM Design Thinking is design thinking for an ever-evolving world**

The next step in building the Teacher Advisor with Watson application is to take the conceptual idea to a plan for building the application. A key principle of the IBM Design Thinking process employed by IBM is that systems of the world should work in service of people. At the heart of IBM’s human-centered mission is IBM Design Thinking: a framework to solve users’ problems at the speed and scale of the modern digital enterprise. **IBM Design Thinking** keeps the project focused on what matters to users from ideas to outcome. The principles that guide IBM Design Thinking are:

1. A focus on user outcomes
2. Restless reinvention
3. Diverse empowered teams

1. **A Focus on User Outcomes**

   a. Testing Proof of Concept: On September 30, 2014, IBM unveiled the “proof of concept” for Teacher Advisor, reconvening at Roosevelt House before an audience of 100 teachers, education thought leaders, policy makers, and funders. The session also included discussions among a panel of education leaders (see Attachment I-A) and teachers about how Teacher Advisor could be a game changer for educators. The feedback was overwhelmingly positive, confirming that the vision and general direction for the development of the technology was on course.

   b. Developing Database of Highest-Quality, Unstructured Data for Teacher Advisor: IBM’s main content partner is UnboundEd a team made up of education experts, many of whom came from EngageNY, which was created and is currently maintained by the New York State Education Department (NYSED) to support the implementation of key aspects of the New York State Board of Regents Reform Agenda. UnboundEd was specifically hired to ensure that Teacher Advisor’s content was of the highest quality as the foundation for improved instruction. UnboundEd was responsible for the identification and collection content, the curation process and development for the 3rd grade math pilot (see Attachment I-B). All the identified content is not only Open Source, but also vetted to ensure its rigor against high standards. UnboundEd also is organizing teacher groups who are offering insight into good pedagogy throughout tool development.

IBM’s work to develop Teacher Advisor with Watson was also guided by an Advisory Board, made up of state education leaders, deans of education, and renowned thinkers in education, who while agreeing broadly on goals for the American education system. Divergent views were intentionally built into the selection process. Bringing together all of the major stakeholders in reforming public education was critical if Teacher Advisor with Watson was to be adopted. The head of the Teachers Union worked with the heads of state and federal education departments to find common ground for ways to improve public education in the U.S. By itself, a strong technology solution would not solve this problem; what was required was a buy-in from all
stakeholders – teachers, union and government officials and other organizations involved in K-12 education. (ATTACHMENT II).

2. Restless reinvention
The reinvention began by redefining teachers access to technology. Unlike the medical profession, which has adopted cutting edge technology everywhere from research to medical records, the education field has been slow in its adoption of technology. Teachers are usually the last professionals that have access to cutting edge technology to strengthen their practice. Teacher Advisor with Watson would change that.

Teacher Advisor with Watson is now being built to serve as a trusted, nonjudgmental resource for teachers to go to when they have questions about how to improve their practice, address specific classroom and/or student challenges, and adapt to changing classroom circumstances. IBM researchers and content experts are working with teachers to develop Teacher Advisor so that it is individualized to where teachers are in their ongoing growth, based upon information that they choose to input into the system and their ongoing usage patterns. IBM researchers also are working with teachers to ensure that the software is presented in a manner that feels personal and knowledgeable about the challenges that each teacher faces. The Teacher Advisor with Watson team has sought feedback through both informal and formal opportunities. This feedback will drive the process of “review and revise” as teachers gain experience using Teacher Advisor with Watson.

The initial conceptual design for Teacher Advisor envisioned an interactive User Interface showcasing a Knowledge Map that presented teachers all of the interrelated 3rd-grade math standards and concepts that students need to master. The Knowledge Map looked similar to a flower with many buds, each bud presenting a different domain of standards, and continuing to "blossom" to more detail as teachers clicked on specific content clusters and standards. Teacher Advisor's original "proof of concept" also offered teachers a suite of lesson and unit planning resources, allowing them to generate their own lessons from scratch, build their own problem sets, and create full units using Teacher Advisor's vetted content corpus.

After user testing the initial designs to a various teacher groups in December of 2015, it became clear that the development priorities needed to shift somewhat from the original proof of concept. Teachers liked the visually appealing layout of standards, but did not think the "flower view" offered an intuitive and easy way to access 3rd grade standards content. Teachers also expressed a clear need to customize existing lessons, but less of a need to build lessons from scratch. Furthermore, the ability to build whole units, while "nice to have," wasn't a priority for teachers.

Responding to teacher feedback the Teacher Advisor stakeholders refined their designs and functionality for the tool over the course of 2016, all while regularly seeking the input of sponsored teacher users. In 2017, the following four functions described above were redefined to the following set of functions, which are now being built into Teacher Advisor with Watson:

*Exploring Academic Standards*
Teacher Advisor helps teachers learn what they need to teach and importantly, how to effectively teach it. Teachers can:
• Learn about a specific concept or academic standard in depth
• See connections to pre- and post-requisite standards
• View related instructional strategies aligned to a selected standard/concept

Finding and Customizing Lesson Plans to Fit Classroom Needs
Teacher Advisor enables teachers to easily identify lessons targeted to specific concepts or standards that have been vetted by educational experts. Teachers can:
• Select full-length, vetted lessons and export to their personal workspace for use
• Customize lessons to meet specific classroom needs using a bank of high quality activities.
• Receive guidance from Watson as they customize their lessons

Finding an Activity or Worksheet
Teachers do not always need a whole lesson. For that reason, Teacher Advisor with Watson helps teachers identify and select vetted activities aligned to academic standards that teachers can use to:
• Review prior learning
• Elaborate on a particularly complex concept
• Prepare students more effectively for an upcoming lesson

View Instructional Strategies
All teachers need resources to enhance their instruction, encourage reflection, and enable teacher growth. Teacher Advisor provides teachers with a corpus of instructional resources that will grow in diversity and depth over time. Teachers will be able to find materials in the following categories:
• Curriculum materials
• Mathematics standards
• Mathematics teaching strategies
• Engaging and managing students
• Supporting diverse learners

This restless reinvention is ongoing, with a new Watson functionality known as Watson Discovery Services currently being developed in early 2017 to help teachers better access Teacher Advisor’s high quality content more quickly and efficiently. Teacher Advisor hopes to leverage this cutting-edge, “cognitive search” capability to provide more targeted guidance and recommendations to teachers, based on their stated intentions and instructional needs, by the end of 2017.

3. Diverse Empowered Teams

The team brought together to design and build Teacher Advisor is a diverse empowered team consisting of IBM technical personnel, IBM Corporate Citizen and third-party subject-matter experts https://www.youtube.com/watch?v=-lRaS2ro8CM

a. Move faster by empowering diverse teams⁵ to act: While it’s important to focus on user outcomes, it’s equally important to design the way our teams are organized to achieve those
outcomes. To ensure the teams’ ability to generate better ideas and deliver real-world outcome for users, the team considered two important team factors: diversity and empowerment. IBM also brought together a diverse group of stakeholders with potentially divergent interests to support and guide the project.

b. Differentiation through diversity\(^6\):

According to IBM, diversity is more than just a moral responsibility; it’s fundamental to the success of its teams. Consider this: when building teams, you aren’t just assigning resources—you’re framing your approach to the problem. Each team member brings their unique perspective and expertise to the team, widening the range of possible outcomes. If you want a breakthrough idea, you’re more likely to get it with a diverse team.

Diverse teams see the same problem from many angles. They have a better understanding of any given situation and generate more ideas, making them more effective problem solvers. While it takes effort to harness and align such different perspectives, it’s at the intersection of our differences that our most meaningful breakthroughs emerge.

c. Speed through empowerment\(^7\): If diversity helps teams generate breakthrough ideas, empowerment enables them to turn those ideas into outcomes. Consider a design team that can quickly deliver mockups but has to wait for a separate engineering team to implement the work. Or consider a team bogged down in meetings, constantly trying to win stakeholder agreement for every little operational decision. Neither situation enables a team to move fast.

In contrast, empowered teams have the agency to make every day operational decisions on their own. They’re equipped with the expertise and authority to deliver outcomes without relying on others for leadership or technical support. By pushing operational decisions down to the lowest level, we give our teams the ability to achieve the rapid iteration our users and clients demand.

In practice the following principles are followed:

- Assign team leadership
- Form self-contained teams
- Consider these different aspects of identity, experience, and expertise. No single dimension defines who any team member is. Rather, they combine together to shape each person’s unique perspective.
- As a team member, be inclusive
- Take advantage of conflict
- Take initiative

**STEP 3: MAP TECHNOLOGY TO FUNCTIONALITY**

One of the challenges in developing a complex system such as Teacher Advisor is to match the functionality with the technology that performs the desired function. In addition, the technology needs to be user-friendly and address the previously articulated “paint points” of end users, in this case teachers. IBM developed a cloud-based platform, called Bluemix, for developing
application that simplifies and shortens the development cycle. Since its introduction Bluemix has grown significantly, enabling enterprise developers to build, run, and manage applications without the expense and complexity of maintaining the computing infrastructure typically associated with modern software development. In addition, Bluemix also provides a broad catalog of services and adheres to IBM’s strict commitment to provide options for enterprises to run hybrid cloud environments. http://www.ibm.com/developerworks/cloud/library/cl-bluemix-dbarnes-ny/index.html

Bluemix is the home of 130+ unique services, including offerings like IBM Watson and Weather.com, and millions of running applications, containers, servers, and more. IBM initially selected four Bluemix services to meet the functional of Teacher Advisor with Watson. The four Bluemix services include two Watson Services, Dialog and Natural Language Classifier, and two core services, a database service called Single Sign On and Cloudant. In 2017, a new and comprehensive Watson Service, known as Watson Discovery Services, will be added to the system.

As of early 2017, the Watson services being used to power Teacher Advisor are Natural Language Classifier, a service that applies cognitive computing techniques to return the best matching classes for a sentence or phrase, and Dialog a service that enables a developer to automate branching conversations between a user and an application, to use natural language to automatically respond to user questions, walk users through processes or applications, or even hand-hold users through difficult tasks.

The other two core services used by the Teacher Advisor are Single Sign On (Security layer), which enable user authentication for web and mobile apps quickly, using simple policy-based configurations, and Cloudant, a NoSQL database that is an operational data store optimized to handle concurrent reads and writes, and provide high availability and data durability.

Figure 1 shows the flow of interaction between the user and Watson, highlighting the Bluemix Services employed. Bluemix services plays the following roles:

Single Sign On - On 'log in' the app routes users to an SSO container to process their logging in. On successful log in, that app routes the user back into the Teacher Advisor experience. SSO also holds all of our users Usernames/passwords (our identity source provider).

Cloudant - Cloudant holds all of the documents we surface on our site. From lesson plans to standards to videos to user data, all meta data and text documents are housed in our Cloudant.

Dialog/NLC - Dialog and NLC work in tandem on the service side to create the Watson chat experience that you see in our app. Our app handles parsing/surfacing data returned from Dialog, as well as formatting users input to send to Dialog.
STEP 4: FIELD TESTING AND ASSESSING TEACHER ADVISOR

Taking an idea from conceptualization to implementation/adoption introduces a major non-technical challenge: user adoption. The innovation introduced by Teacher Assistant with Watson, by definition requires change, change in individual teacher behavior, change in work routines, and change in how teachers prepare course material through the use of Watson technology. This requires that project planning and management accounts for the unanticipated events that can occur when Teacher Advisor is field tested by teachers. As a first step in testing begins with a smaller group of teacher users to ensure buy-in and efficacy before expanding to larger pools of educators.

From the beginning, IBM researchers and content experts have worked with teachers to develop Teacher Advisor so that the software is presented in a manner that feels personal and knowledgeable about the challenges that each teacher faces. At every step of development, IBM wove in feedback loops for teachers to give input into development efforts. This feedback enabled IBM to ascertain whether or not each functional area of Teacher Advisor was meaningful to teachers from both a content and technical perspective. Based on their feedback, IBM was able to make changes and improvements to the development efforts to ensure the integrity of project goals.
ATTACHMENT I-A: Panel of Educators at September 30, 2014 Teacher Advisor Session at Roosevelt House Public Policy Institute at Hunter College in NYC

- Randi Weingarten, President, American Federation of Teachers
- Mitchell Chester, Commissioner of Elementary and Secondary Education, Massachusetts Department of Education
- Michael Cohen, President, Achieve, Inc.
- James Shelton, Deputy Secretary, U.S. Department of Education
- John King, Commissioner, New York State Department of Education

ATTACHMENT I-B: UnboundEd Unstructured Data Sources

- Illustrative Mathematics
- Eureka Math
- National Academy Studies
- Hunt Institute
- Student Achievement Partners
- Achieve
- CPALMS
- North Carolina Department of Instruction
- Massachusetts model curriculum units
- Teaching the Core
ATTACHMENT II: Members of Teacher Advisor’s Advisory Board

- Mitchell Chester, Commissioner of Elementary and Secondary Education, Massachusetts Department of Education
- Michael Cohen, President, Achieve, Inc.
- John Corrigan, Vice President, Customer Experience, ACT
- Rashid Davis, Founding Principal, Pathways in Technology Early College High School (P-TECH)
- Stephen Helgeson, Vice President, New Products and Services, National Board for Professional Teaching Standards (NBPTS)
- Timothy Kremer, Executive Director, New York State School Boards Association
- David Steiner, Executive Director, Johns Hopkins Institute for Education Policy
- Jim Tallon, President, United Hospital Fund of New York, and Member, New York State Board of Regents
- Randi Weingarten, President, American Federation of Teachers.
- Hardin Coleman, Dean of the School of Education, Boston University
- Stephen Pruitt, Commissioner of Education, Kentucky
- John White, Commissioner of Education, Louisiana

ENDNOTES

1 PISA is administered by the Organization for Economic and Co-Operative Development (OECD every three-years starting from 2000.
2 In 2000 a total of 180,000 students from 28 OECD member countries and four non-OECD countries (Brazil, Latvia, Liechtenstein and the Russian Federation) participated in the first PISA assessment. Between 4,500 and 10,000 students were tested in each country. The student samples were selected such that they are representative for the total population of 15-year-olds enrolled in educational institutions. A copy of the report can be found at https://www.mpib-berlin.mpg.de/Pisa/PISA-2000_Overview.pdf
3 The curation process includes developing question and answer pairs used to Train Watson.
4 IBM has contacted content providers to ensure that Teacher Advisor has approval to use their content.
5 Team is a group of people working together toward a common outcome
6 Diverse is composed of differing elements or qualities
7 Empowered is having the expertise and authority to achieve a desired outcome
8 https://www.ibm.com/watson/developercloud/nl-classifier.html
9 Dialog is being retired and replaced by Conversation, a Bluemix service that has Natural Language Classifier (NLC) built in. In newer apps and future versions of Teacher Advisor the only service connection needed would be to 'Conversation', instead of needing both 'Dialog' and 'NLC'. https://www.ibm.com/watson/developercloud/conversation.html
10 https://console.ng.bluemix.net/docs/services/SingleSignOn/index.html#sso_gettingstarted