Microsoft

Personalized Learning for Global Citizens

Transformation Framework

Personalized Learning
for Global Citizens

Developing
a Learning
Community

Curriculum and
Assessment

21st Century
Pedagogy

Teacher and
Leader Capacity

Establishing
a Vision

Leadership
and Policy

Physical Learning
Environments

Designing Technology
for Efficient and
Effective Schools

Organizational Capacity,
Strategic Planning and
Quality Assurance

Partnerships and
Capacity Building

Personalized
Learning

Inclusion,
Accessibility and
Sustainability

Introduction

This paper examines one of ten critical components of effective transformation in schools and education systems. Each paper is produced by an expert author, who presents a global perspective on their topic through current thinking and evidence from research and practice, as well as showcase examples. Together, the papers document the contributions of 'anytime, anywhere' approaches to K-12 learning and explore the potential of new technology for transforming learning outcomes for students and their communities.

Personalized Learning for Global Citizens

Personalized learning is neither a new concept, nor a complete departure from established education practice. The concept has resurged in recent years as educators have recognized the merits of technology's role in facilitating cost-effective personalized learning and bringing it to scale. Around the world, technology is allowing schools to design customizable learning pathways for individual students and provide data-rich feedback cycles for teachers and students. Today, when educators think of personalized learning, they think of students choosing courses, goals, and pathways to achieve those goals. They think about the use of technologies that will allow for the customization of personalized learning paths for students by way of data dashboards that help students navigate through their learning.

In this paper, we highlight the research on personalized learning, provide examples of personalized learning facilitated by technology, and offer guiding principles for leaders and educators who are planning personalized learning programs.

What is the Education Transformation Framework?

The Microsoft Education Transformation Framework helps fast track system-wide transformation by summarizing decades of quality research. It includes a library of supporting materials for ten components of transformation, each underpinned by an executive summary and an academic whitepaper detailing global evidence. This provides a short-cut to best practice, speeding up transformation and avoiding the mistakes of the past. Microsoft also offers technology architectures and collaborative workshops to suit your needs.

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What's all the hype about?

> Personalization refers to instruction that is paced to learning needs, tailored to learning preferences, and tailored to the specific interests of different learners.

Personalization isn't new. It's based on decades of theory.

In the last few years, personalized learning has become a popular topic in education circles around the world. Major theories and hypotheses including cognitivism,[1] constructivism,[2] universal design for learning,[3] situated learning,[4] connectivism,[5] differentiation,[6] revised Bloom's taxonomy,[7] and recently Depth of Knowledge levels[8] are often associated with personalized learning.

Many organizations have created their own definitions of personalized learning. In 2010, the U.S. Department of Education published the following definition in the National Educational Technology Plan: "Personalization refers to instruction that is paced to learning needs, tailored to learning preferences, and tailored to the specific interests of different learners. In an environment that is fully personalized, the learning objectives and content as well as the method and pace may all vary."[9]

The International Association for K-12 Online Learning envisions personalized learning as "tailoring learning for each student's strengths, needs, and interests – including enabling student voice and choice in what, how, when, and where they learn – to provide flexibility and supports to ensure mastery of the highest standards possible."[10]

In the early 20th century, two educational movements in the United States helped to set the stage for personalized learning. The first was the Winnetka Plan of 1919, which focused on the "whole child" and his/her physical, emotional, social, and intellectual education. The Winnetka Plan used mastery learning and required the student to become competent in the content before moving onto the next concept.[11] In 1920, the Dalton Plan introduced the need for balance between a child's individual needs and those of the community. The Dalton Plan provided the opportunity for students to manage their learning time and incorporated the teacher as a resource rather than a lecturer. Additionally, the Dalton Plan

tailored learning to each student's needs, interests, and abilities, promoting their independence and dependability, while enhancing their social skills as well as their responsibility toward others.[12] At a similar period in Europe, Montessori education was first initiated, offering students a choice of learning activities tailored to their needs and freedom of movement within the classroom.

In 1970, the term personalization was coined by Victor Garcia Hoz in his work Personalized Education.[13] According to Hoz, personalization is the learner's journey to developing their freedom of choice. Hoz believed that the learner should be in control of his/her life experiences. Similar to the Winnetka and Dalton Plans, Hoz felt that the learning environment should be cognizant of the learner's cognitive, affective, and social-emotional development. Based on Hoz's work, personalized education had two objectives:

- Learning goals should be created with input from the learner and should be based on the following personal developmental characteristics, including learner preferences, creativity, freedom, originality, autonomy, socialization, and communication; and

- Learning environment and activities should be organized around the learner, and the work should be designed to allow for student control of learning where the student can create and discover by using a variety of learning resources. Teachers guide the autonomous learning of the student.

The evidence behind personalization

Having laid the historical, theoretical, and semantic groundwork for personalized learning, we next take a look at the important practical evidence base that exists to support it. A large part of the research that has been done for personalized learning was compiled by the UNESCO International Academy of Education's International Bureau of Education in their publication on How Children Learn.[14] Within this publication is a list of 12 elements of personalized learning, each of which was supported by research

The 12 elements are discussed in this paper, in conjunction with their research base. A few of the elements are combined due to their close relationship with one another. Also included, where available, are examples of current practices in schools.

The 12 elements of personalized learning

1. Active involvement
2. Social participation
3. Meaningful activities
4. Relating new information to prior knowledge
5. Being strategic
6. Engaging in self-regulation and being reflective
7. Restructuring prior knowledge
8. Aiming towards understanding rather than memorization
9. Helping students learn to transfer
10. Taking time to practice
11. Developmental and individual differences
12. Creating motivated learners

1   Piaget, 1985
2   Piaget, 1950
3   Orkwis & McLane, 1998
4   Lave & Wenger, 1991
5   Siemens, 2014
6   Tomlinson, 1999
7   Anderson & Krathwohl, 2001
8   Webb, 2005
9   DoE, p. 38
10 Patrick, Kennedy, & Powell, 2013, p. 4
11 Butts & Cremin, 1953; Cubberley, 1947; Gutek, 1986
12 Dewey, 1922
13 Hoz, 1982; Hoz, 1997
14 Vosniadou, 2001

Active involvement and aiming toward understanding

More active understanding, less rote memorization

Learning requires the active and constructive involvement of the learner in applied learning situations.[15] The maker movement,[16] a trending topic around the world inspired by Dewey's learning by doing[17] and Papert's learning by making[18], is an example of a learner's active involvement in their educational experience. From the Homebrew Computer Lab of the 1970s to Code. org's Hour of Code, and student events like Imagine Cup, the idea of active involvement is key to inspiring creativity, self-reliance, problem-solving, and decision-making in learners.[19]

Another way to promote active learning is project-based learning, which encourages students to explore real-world problems by working through the possible solutions.

For example, a group of seventh graders at King Middle School in Portland, Maine, worked with science experts to understand bacteria and how it impacts their lives. The students reported their findings to the wider community in an e-pamphlet (Edutopia.org). The project incorporated multiple disciplines – science, math, language arts, social studies, art, and multimedia – which also contributes to active learning.[20]

Learning is more authentic when it is organized around general principles and explanations, rather than the memorization of isolated facts and procedures.[21]

Project-based learning and other applied learning strategies help us move beyond the testing structures that focus on memorization, instead emphasizing understanding. Companies such as Pacific Metrics, Smarter Balanced Assessment Consortium (SBAC), and the Partnership for Assessment of Readiness for College and Careers (PARCC) are developing new technologies that allow for better assessment of students' understanding.[22]

> Active involvement is key to inspiring creativity, self-reliance, problem-solving, and decision-making.

15 Elmore, Peterson, & McCarthy, 1996; Piaget, 1978; Scardamalia & Bereiter, 1991.
16 See makerfaire.com or diy.org
17 Dewey, 1916.
18 Papert & Harel, 1991.
19 Robinson, 2011.
20 Torp & Sage, 1998.
21 Halpern, 1992; Resnick & Klopfer, 1989; Perkins, 1992.
22 Winter, Burkhardt, Freidhoff, Stimson & Leslie, 2013.

Meaningful activities and helping students transfer

Consolidating knowledge through relevant activities

People learn best when they participate in activities that seem useful and culturally relevant.[32] Relevance helps bridge the gap between what students are doing in school and what they do in life, which builds more authentic learning and better transfer of knowledge. Learning becomes more meaningful when the lessons are applied to real-life situations.[33]

For example, Michigan Virtual School (MVS) connects its students together with students in England for a Global Issues course. This requires co-teachers: One from MVS, one from England. The course exposes students to worldwide issues such as global warming and hunger, illustrating differences in perspective, culture, proposed solutions and scale. This deepened conversation helped students create an impact plan, bringing their learning to life.

In addition authenticity, learning needs to be culturally relevant.[34] This is sometimes called culturally appropriate,[35] culturally congruent,[36] culturally responsive,[37] and culturally compatible.[38]

In culturally relevant learning environments, students are engaged in activities that help them learn about and develop their understanding of their own culture, and are encouraged to be critically conscious of cultural norms, institutions, and values.

Culturally relevant education can be incorporated into all disciplines. For example, in physical education courses we can introduce culturally-based games like Mulambilwa, an African bowling and running game, Kho-Kho, a chase game originating in India, Yemari, a Japanese handball game, and La Pelota, a Mexican ball game.[39]

> Within culturally relevant learning environments, students have the access and equity that help them to attain academic success.

32 Brown, Collins, & Duguid, 1989; Heath, 1983.
33 Bruer, 1993; Bransford, Brown, & Cocking, 1999; Bereiter, 1997.
34 Ladson-Billings, 1994.
35 Au & Jordan, 1981.
36 Mohatt & Erickson, 1981.
37 Au & Jordan, 1981.
38 Jordan, 1985.
39 Harbin, 1964.

Social participation

Using negotiation and social skills to help students learn

Learning is a social activity and participation in school social life is crucial.[23] According to learning theory, negotiation in learning helps students understand what they are learning. So, conversations and shared understanding is key. Social participation has been strongly related to self-efficacy, respect for diversity, self-confidence, collaborative skills, avoidance of risk behaviors, and resilience.[24]

Forward-thinking schools are giving students a voice in systemic improvement[25] - even involving them in service learning at the community level. For example, a group of visually-impaired students in West Virginia raised money for a local animal shelter by producing, packaging and marketing their own dog biscuits.[26]

A 3rd/4th grade classroom in Michigan are using online and community-based social strategies to try and get the Northern Spring Peeper frog adopted as their state amphibian. This exploded to a multi-faceted learning immersion project

spanning government, language arts, visual arts, interviewing, communications, and social media. Students have written formal letters, lobbied their local Representative, held radio interviews, created brochures, engaged local businesses, campaigned at events, created T-shirts, and built a Facebook page.[27]

Recently, "serious games "are providing a way for students to engage in both meaningful learning and collaboration.[28]

In Robotics clubs, students work together to build a robot they will enter in a competition. Online learning helps to expand their social circles, connecting them to peers beyond their school.

Another example is the Deeper Learning MOOC where students at High Tech High worked with green housing, energy efficiency and construction experts to build an energy efficient house.[29]

In computer science, Pair Programming helps further learning by letting students build programs in pairs.[30] This is often supported by Kodu Game Lab.[31]

> Forward-thinking schools are engaging their students as stakeholders in the school and providing them a chance to have a voice in systemic improvement.

23 Brown, Collins, & Duguid, 1989; Collins, Brown, & Newman, 1989; Rogoff, 1990; Vygotsky, 1978.
24 Billig, 2000.
25 Holcomb, 2007.
26 West Virginia Department of Education, 2000.
27 https://www.facebook.com/MIspringpeeper
28 Connolly, Boyle, MacArthur, Hainey & Boyle, 2012.
29 https://www.teachingchannel.org/videos/tiny-house-collaborative-project-hth
30 Cockburn & Williams, 2011.
31 http://www.kodugamelab.com

Relating new information and restructuring prior knowledge

Making sense of the learning experience

Learning is partly the acquisition and construction of knowledge, built on the foundation of what is already understood.[40] This is key to comprehension – requiring students to make sense of their learning experiences in the context of what they already know[41] and recognizing these experience build on one another. When this understanding and recognition does not happen, prior knowledge can stand in the way of learning something new.

To overcome this, students must learn how to solve internal inconsistencies and restructure existing conceptions when necessary.[42] One activity that helps is "think-pair-share" in which students have to think about the topic-at-hand silently, then pair up with a partner to talk about what they thought, and then share this with the class.[43]

This could be done when learning a new coding language. While the specific commands and structures may be different, many coding languages are based on basic logical equations (if/then statements) and follow the same logical principles, meaning that students may draw on the prior knowledge learned from one coding language to understand the basics and provide a foundation for learning the new language.

Another tool is Minecraft, which helps students use the knowledge in their 'real life' to take care of themselves in the game. In playing, their prior knowledge is sometimes questioned, and they have to restructure it with the new information from the game.

> Students can build on knowledge through games like Minecraft, which helps students use the knowledge that they have acquired in their life to take care of themselves in the game.

40 Bransford, 1979; Bransford, Brown, & Cocking, 1999.
41 Kujawa & Huske, 1995.
42 Piaget, 1978; Carretero & Voss, 1994; Driver, Guesne, & Tiberghien, 1985; Schnotz, Vosniadou, & Carretero, 1999; Vosniadou & Brewer, 1992.
43 Lyman, 1981.

Being strategic

Powering up critical thinking

People learn by employing effective and flexible strategies that help them to understand, reason, memorize, and solve problems.[44] One of the keys to being strategic is thinking critically. Critical thinking is required for questions that do not have simple answers; in asking such questions educators can promote critical thinking in learners.

Some learning programs are taking it one step further and preparing students to be strategic by teaching them computational thinking.[45] Computational thinking for K-12 provides learners the chance to analyze and logically order data; model data; create data abstracts and simulations; formulate problems for computer assistance; identify, test, and implement possible solutions; automate solutions via algorithmic thinking; and generalize and apply this process to other problems.[46]

Several programs have been developed to foster computational thinking including (but not limited to) MIT's Scratch, Carnegie Mellon's Alice, Microsoft's Kodu and University of Kent's Greenfoot. Code.org, a non-profit is working to provide widespread and easily accessible opportunities to learn coding as well.

Additional examples of fostering strategic thinking in schools around the world also includes mindmapping with technology tools, such as NovaMind Mind Mapper and online journaling in OneNote. These types of activities have come to fruition within blended learning spaces around the world.[47]

> Some learning programs are taking it one step further and preparing students to be strategic by teaching them computational thinking.

44 Mayer, 1987; Palincsar & Brown, 1984; White & Frederickson, 1998.
45 Papert, 1996.
46 Stephenson & Barr, 2011.
47 Ferdig, Cavanaugh, & Freidhoff, 2012.

Self-regulation and being reflective

Managing where students are headed and where they've been

Learners must know how to plan and monitor their learning, how to set their own learning goals, and how to correct errors.[48] Self-regulation is the knowledge and skills that allow learners to reflect upon and respond to their surroundings based on what they see, hear, touch, taste, and smell, and to compare that perception with what they already know.[49]

Research has shown that increasing students' self-regulation results in increased comprehension and achievement.[50] Self-regulation processes include self-monitoring, self-instruction, self-evaluation, self-reflection, self-correction, and self-reinforcement. There are a few common strands across self-regulated learning theories. The first is that learners must have an active role in developing their skills and knowledge towards their learning goals. The second is that self-regulation is an iterative process where the learner sets goals, decides how to achieve those goals, monitors to see how the process is going, and then

changes the course of action if something is not working effectively.

The third idea is that motivation plays a key role in learning, and external motivators may need to be used until intrinsic motivation develops. As Cavanaugh points out, "Blended programs are most effective when they use technology to increase individualization and opportunity for reflection on learning."[51]

In an AP Macroeconomics course at MVS, students were directed to resources in a shared virtual space and tasked to discover which resource was most useful to them.[52]

Another teacher in Michigan, Tara Maynard, was featured on the MyBlend website[53] for using a flipped classroom model in her 8th grade math class. Her students learn content and take notes outside of the course via videos and other resources, and then when they get to class, put their learning to practice. When students have questions, Ms. Maynard can respond and personalize.

> Increasing students' self-regulation results in increased comprehension and achievement in their learning.

48 Brown, 1975; Boekaerts, Pintrich, & Zeidner, 2000; Marton & Booth, 1997.
49 Bronson, 2000.
50 Mace, Belifior, & Hutchinson, 2001.
51 Cavanaugh, 2014, p. 59.
52 http://media.mivu.org/mivhs/apmicroecon/APEconomicsOverview/player.html
53 http://myBlend.org

Taking time to practice

Learning is a complex activity that cannot be constrained to a specific time limit. It requires considerable and variable time and periods of deliberate practice to start building expertise in an area.[54] Some research emphasizes that it takes 10,000 hours to become an expert on something.[55] Other researchers emphasize that there are other factors involved beyond deliberate practice that need to be taken into account.[56] Two key factors are time spent in deliberate practice and the spacing between practice sessions (to avoid burnout).

A key piece to personalized learning is creating personalized pathways for learners and going beyond the seat-based time that is allotted in traditional school days. In practice, this takes the form of students designing their own learning plan based on their current knowledge, learning needs, and future goals, allotting the time they need for each content area. Instead, some states are looking more at competency, mastery, or proficiency-based paths so that learners can learn at their own pace.[57]

A few examples of technologies that could help students with practicing could be collaborative projects with peers and mentors in cloud-based conferencing tools. Simulations, which have a long history in medicine[58] and business[59] training, are also excellent examples that offer unlimited practice on many tasks that are difficult with physical materials, continuous advances in digital technology also afford more realistic, complex, and socially connected simulations.

Online learning also allows students mobile access to learning content 24-7, provides students the opportunity to go at their own pace, and specifically, asynchronous learning gives them the chance to practice and repractice, which is something that we have not been able to replicate in the traditional classroom.[60]

> Online, asynchronous learning gives students the chance to practice and repractice, which is something that we have not been able to replicate in the traditional classroom.

54 Bransford, 1979; Chase & Simon, 1973; Coles, 1970.
55 Ericsson, Krampe, & Tesch-Romer, 1993.
56 Hambrick, Altmann, Oswald, Meinz, Gobet, & Campitelli, 2014.
57 Patrick, Kennedy, & Powell, 2013.
58 Cooper & Taqueti, 2004.
59 Keys & Wolfe, 1990.
60 Cavanaugh, 2009.

Creating motivated learners

Dialing up engagement levels

Learning is critically influenced by learner motivation. Teachers can help students become more motivated learners by their behavior and the statements they make.[65] Some research based strategies for motivating learners include becoming a role model for student interest; getting to know students; using examples freely; using a variety of student-active teaching activities; setting realistic performance goals; placing appropriate positive emphasis on testing and grading; being free with praise and constructive criticism; and giving students as much control over their own learning as possible.[66]

This element is also important when thinking about authenticity. If students are able to learn ideas that are connected to their lives and produce representations of their knowledge in ways that matter, they are more motivated.

Another way students are personalizing their learning is by creating paths that works for them. An example of this is Personalized Learning Environments (PLEs), investigated as an application of Drexler's networked learner, and effective for complex collaborative learning.[67] In a PLE, the student selects the tools and communities that will best meet his or her learning objectives. Allowing students to choose their own path or have choice in their learning motivates them to continue learning. The following section is intended to help practitioners realize personalized learning in their classrooms and schools based on the research base and examples presented above.

> Allowing students to choose their own path or have choice in their learning motivates them to continue learning.

65 Deci & Ryan, 1985; Dweck, 1989; Lepper & Hodell, 1989; Spaulding, 1992.
66 Bain, 2004; Nilson, 2003; DeLong & Winter, 2002.
67 Drexler, in press.

Developmental and individual differences

Children learn best when their individual differences are taken into consideration. [61] There is a need for learning to be designed to meet the developmental and individual differences and needs of all students. One way in which many schools are approaching this is to use Universal Design for Learning (UDL) which is a framework designed to meet the needs of all students. There are three principles of UDL and their subsequent guidelines and checkpoints are detailed below. The research evidence for all Checkpoints can be found on the UDL Center website[62]:

New within the last year at Khan Academy is their Learning Dashboard that allows students to identify their areas of strength and where they need improvement, as well as see their progress and customize their learning path.[63] At Summit Public Schools, students create their own playlists that include courses, course content, and resources for learning in order to master content knowledge.[64] At Michigan Virtual Learning Research Institute (MVLRI), the researchers are looking at ways to visualize student data to help teachers identify students who are struggling.

61 Case, 1978; Chen et al., 1998; Gardner, 1991; Gardner, 1993.
62 http://www.udlcenter.org/research/researchevidence
63 https://www.khanacademy.org/about/blog/post/58354379257/introducing-the-learning-dashboard
64 http://www.activateinstruction.org/story/activate-helps-summit-public-schools-prepare-self-directed-college-ready-students

Universal design for learning: principles, guidelines, and checkpoints

Principle	Guideline	Checkpoints
Provide multiple means of representation	Provide options for perception	• 1.1: Offer ways of customizing the display of information • 1.2: Offer alternatives for auditory information • 1.3: Offer alternatives for visual information
	Provide options for language, mathematical expressions, and symbols	• 2.1: Clarify vocabulary and symbols • 2.2: Clarify syntax and structure • 2.3: Support decoding of text, mathematical notation, and symbols • 2.4: Promote understanding across languages • 2.5: Illustrates through multiple media
	Provide options for comp	• 3.1: Activate or supply background knowledge • 3.2: Highlight patters, critical features, big ideas, and relationships • 3.3: Guide information processing, visualization, and manipulation
Provide multiple means of action and expression	Provide options for physical actions	• 4.1: Vary the methods for response and navigation • 4.2: Optimize access to tools and assistive technologies
	Provide options for expression and communications	• 5.1: Use multiple media for communication • 5.2: Use multiple tools for construction and composition • 5.3: Build fluencies with graduated levels of support for practice and performance
	Provide options for executive functions	• 6.1: Guide appropriate goal-setting • 6.2: Support planning and strategy development • 6.3: Facilitate managing information and resources • 6.4: Enhance capacity for monitoring progress
Provide multiple means of engagement	Provide options for recruiting interest	• 7.1: Optimize individual choice and autonomy • 7.2: Optimize relevance, value, and authenticity • 7.3: Minimize threats and distractions
	Provide options for sustaining effort and persistence	• 8.1: Heighten salience of goals and objectives • 8.2: Vary demands and resources to optimize challenge • 8.3: Foster collaboration and community • 8.4: Increase mastery-oriented feedback
	Provide options for self-regulation	• 9.1: Promote expectations and beliefs that optimize motivation • 9.2: Facilitate personal coping skills and strategies • 9.3: Develop self-assessment and reflection

Summary

Key strategies for deploying personalized learning

Using the research already discussed, the following provides components for creating personalized learning environments for K-12 students.

- Create learning environments that allow students to be actively involved in their learning process. Incorporating project-based learning (PBL) is just one example of this.
- Assess students in meaningful ways where they can apply their understanding.
- Encourage students' social participation in both classroom/learning environment spaces, school communities, as well as the community at large outside of the students' learning space.
- Engage students in meaningful activities that are culturally relevant and true-to-life.
- Scaffold students to support the transfer of knowledge from one context to another.
- Foster students' use of their prior knowledge to build an understanding for new knowledge.
- Urge students to think critically about prior knowledge that does not fit a new concept, and inspire them to restructure their thinking to arrive at a new understanding.
- Nurture and promote students' use of strategic, critical thinking skills for solving problems with creative solutions.
- Support students' self-regulative and self-reflective activities.
- Compel students to practice when they want to become experts in a given area.
- Give students multiple opportunities for representing, acting, expressing, and engaging in their learning

- Motivate learners by allowing them to take control of their learning, using enthusiasm, setting realistic goals, and providing praise and constructive criticism.
- Teach teachers how to use student data to modify learning to meet the needs of each student.
- Integrate technology in seamless ways that will allow for customizable learning for each student's individual path.

Personalized learning through Microsoft's Transformation Framework

Personalized learning is a promising path to differentiate learning for all students and prepare them for college, career and community in the 21st century.[68] In today's mobile and cloud enabled personalized learning environments, the technology is adaptive so students get individually flexible and responsive path, pace, and pedagogy according to their needs, interests, and choices. The technology provides data used by teachers in crafting learning plans for each student.

Effective personalized learning environments provide tools and learning resources that students use in self-directed and self-paced learning.[69] Learner engagement and independence are core goals. Integrated and engaging technology tools can amplify knowledge acquisition, skill development, and application of learning in comprehensive tasks. Adapting the pace and pedagogy require access to content and tools for learning anytime, anywhere, and on any device. Because learning is deepest with guidance and interaction, the content and tools should be collaborative.[70]

Why hasn't personalized learning been realized?

The U.S. Department of Education's Race to the Top District-level grant (RTT-D) awardees provide numerous examples of school districts making the switch to personalized learning.[71] The winning
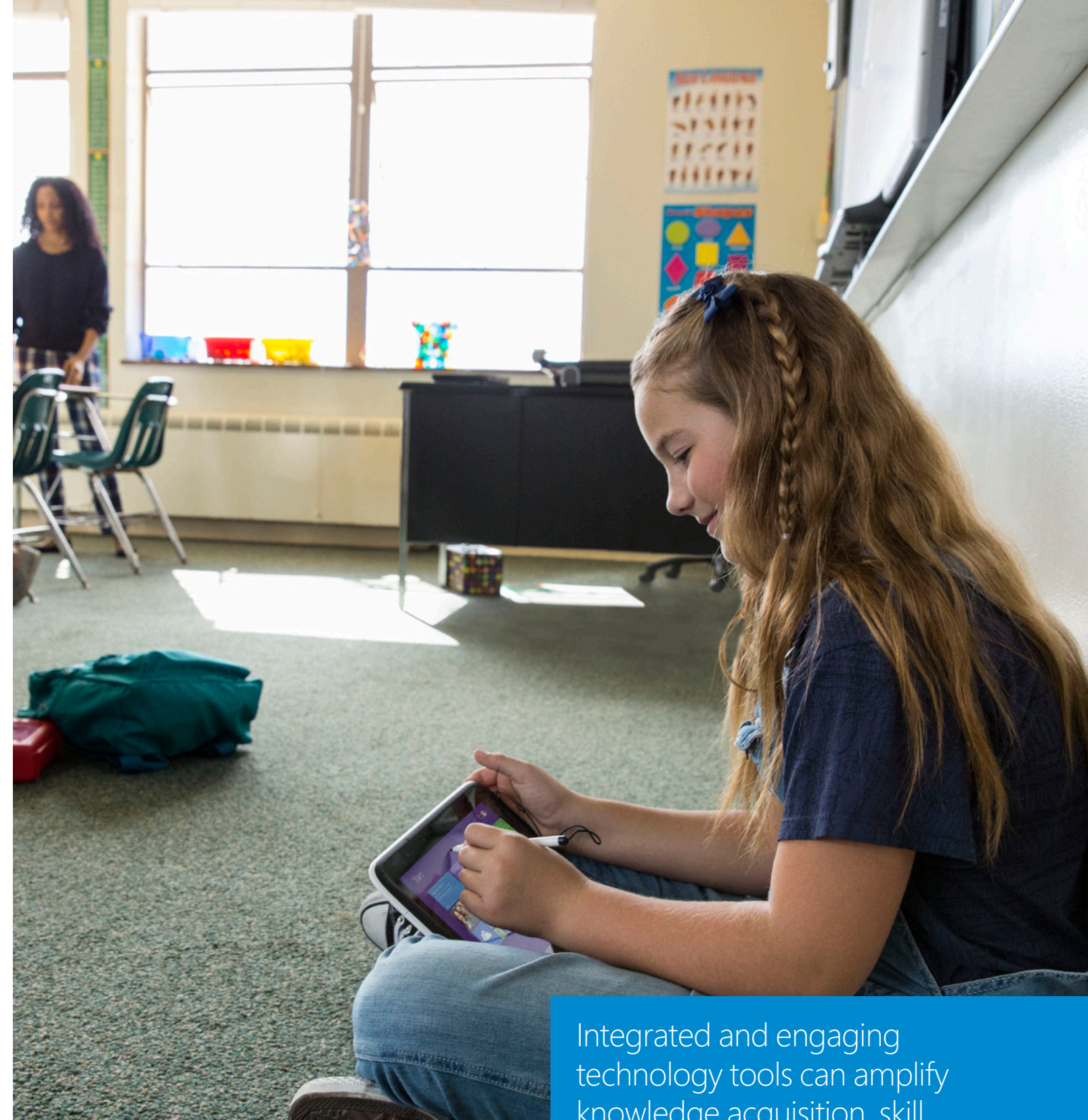
districts had six key strategies that they used to implement personalized learning:

1. Data and data systems that allow for longitudinal/historical student data and formative data for teachers to use to differentiate for each student;
2. Curriculum and teaching that were not time-based and that allowed students to interact with content in multiple ways;
3. Learning materials that allowed for digital books, Open Educational Resources (OER), virtual manipulatives, and adaptive tools for personal paths;
4. Repurposed learning facilities that would allow for more flexible learning in changeable environments;
5. Human capital to understand what personnel is needed and how they are most effectively utilized; and
6. Professional development to arrive at a place together as a learning team to make learning student-centered and personalized.

Many more schools districts like the RTT-D winners are out there, moving towards personalized education for each student. Despite these districts' major efforts and the efforts of others, personalization of learning is not as pervasive as we would hope it to be.

Given the practical advances and research base, why hasn't personalized learning been realized?

One of the greatest challenges for personalization in schools is that it is not implemented in a way that it can be brought to scale, typically due to such issues as human capital limitations, lack of access to necessary resources, and resistance to change, to name a few. Ultimately, personalized learning can be wholly realized when there is a systemic change made within schools, districts, and education-at-large; it is our responsibility as educators to work to put these research-based elements into motion in our early, middle, and secondary schools so our students' true potential can be realized.

Integrated and engaging technology tools can amplify knowledge acquisition, skill development, and application of learning.

68   Weber, 2014.
69   Patrick, Kennedy, & Powell, 2013.
70   Jonassen, 2012.
71   Oliver, et al., 2014.

Technologies schools can use to support change

Student collaboration, personalization and reflection is supported by Windows 10 combined with Office 365 Education and OneNote.

Schools can build a connected curriculum with collaboration tools with Office 365 Education, Lync, SharePoint, Yammer and Skype for Education Microsoft Educator Network.

Microsoft Bing and Wolfram Alpha bring powerful discovery and analysis to each student.

Students can create ePortfolios with OneNote, SharePoint and Office 365 Education.

Developing your own change strategy
Guiding questions for Personalized Learning

- Does the complete learning experience prepare school leavers for college, career, and community?
- Does the learning environment drive students and teachers to be expert learners for life?
- How adaptive learning is supported with data analytics?
- What software accessibility requirements are needed?
- What personalized learning requirements are needed for staff/students?
- How are students and teachers enabled with collaborative, creative, and productive learning?
- How is differentiated instruction supported and enabled?
- How well are we prepared to mix school or workstyle with lifestyle? What does School@home mean for students?

- How can you manage personal identity, safety and integrate workstyle with lifestyle?
- What is the role of a cloud social environment at home, at school?
- How do you facilitate online/ blended/mobile Learning?
- Roaming and mobility – how do you enable all/specific devices?
- Peer to Peer interactions – where do they fit into the learning process?
- Edutainment – what are the roles of class work and games based learning?
- What lifestyle assets should/can be leveraged?
- Are our assumptions on student access, ownership, connectivity and lifestyle correct?

References

Anderson, L. W., & Krathwohl, D. R., et al (Eds.) (2001) A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives. Boston, MA: Allyn & Bacon.

Au, K., & Jordan, C. (1981). Teaching reading to Hawaiian children: Finding a culturally appropriate solution.

In H. Trueba, G. Guthrie, & K. Au (Eds.), Culture and bilingual classroom: Studies in classroom ethnography (pp. 69–86). Rowley, MA: Newbury House.

Bain, K. (2004). What the best college teachers do. Cambridge, MA: Harvard University Press.

Bereiter, C. (1997). Situated cognition and how to overcome it. In D. Kirshner & J. A. Whitson (Eds.), Situated cognition: Social, semiotic, and psychological perspectives, p. 281–300. Hillsdale, NJ: Erlbaum.

Billig, S. H. (2000). Research on K-12 school-based service-learning: The evidence builds. Phi Delta Kappan, 81, 658-664.

Boekaerts, M., Pintrich, P., & Zeidner, M. (2000). Handbook of Self-Regulation. New York: Academic Press.

Bransford, J. D. (1979). Human cognition: Learning, understanding and remembering. Belmont, CA, Wadsworth Publishing Co.

Bransford, T. D., Brown, A. L., & Cocking, R. R., (Eds.). (1999). How people learn: Brain, mind, experience and school. Washington, DC, National Academy Press.

Bronson, M. B. (2000). Self-regulation in early childhood: Nature and nurture. New York: Guilford.

Brown, A. L. (1975). The development of memory: knowing, knowing about knowing and knowing how to know. In H. W. Reese, H.W (Ed.), Advances in child development and behavior. Vol. 10. New York: Academic Press.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18(1).

Bruer, J.T. (1993). Schools for thought. Cambridge, MA: MIT Press.

Butts, R. F. & Cremin, L. A. (1953). History of education in American culture. New York: Henry Holt and Company.

Carretero M. & Voss, J., (Eds.). (1994). Cognitive and instructional processes in history and the social sciences. Hillsdale, NJ: Erlbaum.

Case, R. (1978). Implications of developmental psychology for the design of effective instruction. In A. M. Lesgold, et al., (Eds.), Cognitive psychology and instruction, p. 441–63. New York: Plenum.

Cavanaugh, C. (2014). Blended education for elementary and secondary students. In R. E. Slavin (Ed.), Proven programs in education: Science, technology, and mathematics (STEM) (pp. 56-59). Thousand Oaks, CA: SAGE.

Cavanaugh, C. (2009). Getting students more learning time online: Distance education in support of expanded learning time in K-12 schools. Washington, D.C.: Center for

American Progress. Retrieved from http://www.americanprogress.org/wp-content/uploads/issues/2009/05/pdf/distancelearning.pdf

Cavanaugh, C., McCarthy, A., & East, M. (2014, June). An innovation framework for holistic school transformation: Ten critical conversations for the 21st Century. Published in the Proceedings of ED-MEDIA:

Conference on Educational Multimedia, Hypermedia & Telecommunications. Waynesville, NC: Association for the Advancement of Computing in Education (AACE).

Chase, W. G., & Simon, H. A. (1973). The mind's eye in chess. In W. G. Chase (Ed.), Visual information processing. New York: Academic Press.

Chen, J., Krechevsky, M., & Viens, J. (1998). Building on children's strengths: The experience of Project Spectrum. New York, Teachers College, Columbia University.

Cockburn, A., & Williams, L. (2011). The costs and benefits of pair programming. In Extreme programming examined (pp. 223-243). Boston, MA: Addison-Wesley Longman Publishing Co.

Coles, R. (1970). Uprooted children: The early life of migrant farm workers. New York: Harper & Row.

Collins, A., Brown, J. S., & Newman, S.F. (1989). Cognitive apprenticeship: Teaching the craft of reading, writing and mathematics. In L. B. Resnick (Ed.), Knowing, learning and instruction: essays in honor of Robert Glaser, p. 453–84. Hillsdale, NJ: Lawrence Erlbaum.

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. Computers & Education, 59, 661-686.

Cooper, J. B., and Taqueti, V. R. (2004). A brief history of the development of mannequin simulators for clinical education and training. Quality & Safety in Health Care, 13(1), i11-i18. doi: 10.1136/qshc.2004.009886

Cubberley, E. P. (1947). Public education in the United States. Cambridge: The Riverside Press.

Deci, E. L., & Ryan, R. (1985). Intrinsic motivation and self-determination in human behaviour. New York: Plenum Press.

DeLong, M., & Winter, D. (2002). Learning to teach and teaching to learn mathematics: Resources for professional development. Washington, D.C.: Mathematical Association of America.

Dewey, E. (1922). The Dalton laboratory plan. E.P. Dutton & Company. Retrieved from http://ia600308.us.archive.org/7/items/daltonlaboratory00deweiala/daltonlaboratory00deweiala.pdf

Dewey, J. (1916). Democracy and education; An introduction to the philosophy of education. New York: Macmillan.

Drexler, W. (in press). Personal Learning Environments in K12. In R. Ferdig & K. Kennedy (Eds.), Handbook of Research on K-12 Online and Blended Learning.

Driver, R., Guesne, E., & Tiberghien, A. (Eds.). (1985). Children's ideas in science. Milton Keynes, United Kingdom: Open University Press.

Dweck, C. S. (1989). Motivation. In Lesgold A.; Glaser, R., (Eds.), Foundations for a psychology of education, p. 87–136. Hillsdale, NJ, Erlbaum.

Elmore, R. F., Peterson, P. L., & McCarthy, S. J. 1996. Restructuring in the classroom: Teaching, learning and school organization. San Francisco, CA: Jossey-Bass.

Ferdig, R. E., Cavanaugh, C., & Freidhoff, J. R. (2012). Lessons learned from blended programs: Experiences and recommendations from the field. Vienna, VA: iNACOL.

Gardner, H. (1991). The unschooled mind: How children think and how schools should teach. New York: Basic Books.

Gardner, H. (1993). Multiple intelligences: The theory in practice. New York: Basic Books.

Gutek, G. (1986). Education in the United States: A historical perspective. New Jersey: Prentice Hall 1986.

Halpern, D. F., (Ed.). (1992). Enhancing thinking skills in the sciences and mathematics. Hillsdale, NJ: Erlbaum.

Hambrick, D. Z., Altmann, E. M., Oswald, F. L., Meinz, E. J., Gobet, F., & Campitelli, G. (2014). Accounting for expert performance: The devil is in the details. Intelligence, 45, 112-114.

Harbin E. O. (1964). Games of many nations. Nashville, TN: Abingdon Press.

Heath, S. B. (1983). Ways with words: Language, life and work in communities and classrooms. Cambridge, United Kingdom: Cambridge University Press.

Holcomb, E. L. (2007). Students are stakeholders, too!: Including every voice in authentic high school reform. Thousand Oaks, CA: Sage Publications.

Hoz, V. G. (1982). L' educazione personalizzata: Individualizzazione e socializzazione nell'insegnamento. Firenze: Le Monnier.

Hoz, V. G. (1997). Dal fine agli obiettivi dell'educazione personalizzata, (trad. italiana, dall'edizione originale 1995). Palumbo: Palermo.

Jonassen, D. (2012). Meaningful learning with technology. Upper Saddle River, NJ: Allyn & Bacon.

Jordan, C. (1985). Translating culture: From ethnographic information to educational program. Anthropology and Education Quarterly 16 (105–123); and Vogt, J., Jordan, C., & Tharp, R. (1987). "Explaining school failure, producing school success: Two cases." Anthropology and Education Quarterly 18, 276–286.

Keys, B., & Wolfe, J. (1990). The role of management games and simulations in education and research.

Journal of Management, 16(2), 307-336.

Kujawa, S., & Huske, L. (1995). The strategic teaching and reading project guidebook (Rev. ed.). Oak Brook, IL: North Central Regional Educational Laboratory.

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge: Cambridge University Press.

Lepper, M., & Hodell, M. (1989). Intrinsic motivation in the classroom. In C. Ames & R. Ames (Eds.), Research on motivation in education, Vol. 3, p. 73-105. New York: Academic Press.

Lyman, F. (1981). The responsive classroom discussion: The inclusion of all students. Mainstreaming Digest. University of Maryland, College Park, MD.

Mace, F. C., Belfiore, P. J., & Hutchinson, J. M. (2001). Operant theory and research on self-regulation. In B. J. Zimmerman & D. H. Schunk (Eds.), Self-regulated learning and academic achievement: Theoretical perspectives (2nd ed., pp. 39–65). Mahwah, NJ: Erlbaum.

Marton, F., & Booth, S. (1997). Learning and awareness. Hillsdale, NJ: Erlbaum.

Mayer, R. E. (1987). Educational psychology: a cognitive approach. Boston, MA: Little, Brown.

Mohatt, G., & Erickson, F. (1981). Cultural differences in teaching styles in an Odawa school: A sociolinguistic approach. In H. Trueba, G. Guthrie, & K. Au (Eds.), Culture and the bilingual classroom: Studies in classroom ethnography (pp. 105–119). Rowley, MA: Newbury House.

Nilson, L. (2003). Teaching at its best: A research-based resource for college instructors 2nd ed. Bolton, MA: Anker Publishing.

Centre for Educational Research and Innovation., & SourceOECD (Online service). (2006). Personalizing education. Paris: Organization for Economic Co-operation and Development.

Oliver, K., Clark, T., Hibbard, L., Kennedy, K., LaFrance, J., Oglesby, J., & Swan, B. (2014). Personalization of learning: Lessons from RTT-D Winners. Under review. 13 pages.

Orkwis, R, & McLane, K (1998). A curriculum every student can use: Design principles for student access. ERIC/OSEP Topical Brief No. ED423654. Reston, VA: ERIC/OSEP Special Project.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension monitoring activities. Cognition and Instruction, 1, p. 117–175.

Papert, S. (1996). An exploration in the space of mathematics education. International Journal of Computers for Mathematical Learning, 1(1), 95-123.

Patrick, S., Kennedy, K., & Powell, A. (2013). Mean what you say: Defining and integrating personalized, blended and competency education. Vienna, VA: iNACOL.

Perkins, D. (1992). Smart schools: Better thinking and learning for every child. Riverside, NJ: The Free Press.

Piaget, Jean. (1950). The psychology of intelligence. New York: Routledge.

Piaget, J. (1978). Success and understanding. Cambridge, MA: Harvard University Press.

Piaget, J. (1985). The equilibration of cognitive structure. Chicago, IL: University of Chicago Press.

Resnick, L. B., & Klopfer, L. E., (Eds.). (1989). Toward the thinking curriculum: Current cognitive research. Alexandria, VA: ASCD Books.

Roach, A. T., Elliott, S. N., & Webb, N. L. (2005). Alignment of an Alternate Assessment with State Academic Standards Evidence for the Content Validity of the Wisconsin Alternate Assessment. The Journal of Special Education, 38(4), 218-231.

Robinson, K. (2011). Out of our minds: Learning to be creative. Hoboken, NJ: John Wiley & Sons.

Rogoff, B. (1990). Apprenticeship in thinking: Cognitive development in social context. New York: Oxford University Press.

Scardamalia, M., & Bereiter, C. (1991). Higher levels of agency for children in knowledge building: A challenge for the design of new knowledge media. Journal of the Learning Sciences, 1, 37–68.

Schnotz, W., Vosniadou, S., & Carretero, M. (1999). New perspectives on conceptual change. Oxford, United Kingdom: Elsevier Science.

Siemens, G. (2014). Thoughts on connectivism. Elearnspace Blog. Retrieved from http://www.elearnspace.org/blog/2014/04/25/thoughts-on-connectivism/

Spaulding, C. L. (1992). Motivation in the classroom. New York: McGraw Hill.

Stephenson, C., & Barr, V. (2011 May). Defining computational thinking for K-12. CSTA Voice, 7(2), 3-4.

Tomlinson, C. A. (1999). The differentiated classroom: Responding to the needs of all learners. Alexandria, VA: Association for Supervision and Curriculum Development.

Torp, L., & Sage, S. (1998). Problems as possibilities: Problem-based learning for K-16 education. Alexandria, VA: ASCD.

Vosniadou, S. (2001). How children learn. UNESCO International Academy of Education, International Bureau of Education.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Vosniadou, S., & Brewer, W. F. (1992). Mental models of the earth: A study of conceptual change in childhood. Cognitive psychology, 24, 535–58.

Walsh, R. (2011). Lifestyle and mental health. American Psychologist, 66(7), 579-592.

Weber, C., Biswell, C., & Behrens, W. (2014). Exploring critical issues in gifted education: A case studies approach. Waco, TX: Prufrock Press.

West Virginia Department of Education. (2000). West Virginia's service-learning lesson-plans for K-12 challenged students. Retrieved from https://wvde.state.wv.us/lessons/sllessonplans.pdf

White, B. Y., & Frederickson, J. R. (1989). Inquiry, modeling and metacognition: Making science accessible to all students. Cognition and Instruction, 16(1), 13–117.

Winter, P. C., Burkhardt, A. K., Freidhoff, J. R., Stimson, R. J., & Leslie, S. C. (2013). Astonishing impact: An introduction to five computer-based assessment issues. Lansing, MI: Michigan Virtual Learning Research Institute. Retrieved from http://media.mivu.org/institute/pdf/astonishing_impact.pdf

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