THE EDTECH OPPORTUNITY:

Educational Technology as a Dynamic Growth Sector for Iowa

Prepared For: Iowa Economic Development Authority

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TECONOMY PARTNERS LLC

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EXECUTIVE SUMMARY

Education is a sector of the economy that is fundamental to the performance of all other sectors of the economy. It is also a sector that stands on its own as a distinct market—consuming products, technologies, content, and intellectual assets to enable its work. Increasingly, technology (especially digital technology) has become a key component of the education sector. The educational technology, or "EdTech," market space has emerged as a large, fast-growing, and important domestic and global sector.

Iowa is home to a significant base of companies engaged in EdTech. This includes large corporations such as McGraw-Hill and ACT, together with midsized companies and a growing base of entrepreneurial EdTech business ventures. There are also notable, and complementary, assets in EdTech-related research and development (R&D) and talent development at Iowa State University, the University of Iowa, and the University of Northern Iowa.

TEConomy Partners (TEConomy) identified 28 EdTech companies across Iowa, most of which are directly engaged in providing EdTech products and services with a few additional software development companies acting as key "enabling" entities developing applications. These companies employed 3,126 individuals in 2018.

Analysis shows Iowa's EdTech assets to be concentrated in EdTech applications (primarily software based) as opposed to EdTech hardware. Iowa's EdTech industry predominantly groups into three main clusters of activity:

- **Assessment**—Including providers of educational testing solutions for K–12, higher education, and continuing education/workforce training applications, this is a well-established area of expertise for the state, comprising university-based and industry R&D through to leading high-profile companies in the assessment industry (including ACT, Pearson, College Board, and Iowa Testing Programs). While paper testing in examination settings is still a component of this sector, it is increasingly a platform driven by advanced software applications, a platform in which there is considerable know-how and research expertise in Iowa ranging from the basic science underpinnings of psychometrics and evaluation, through to advanced development of integrated learning and assessment systems enabled by advanced digital technologies. This is the largest of the three existing EdTech platforms identified for Iowa in terms of employment with over 1,800 employees.

- **Content**—Iowa's position in content is rooted in a historical presence of an academic publishing industry in Iowa, particularly in the Dubuque area. Kendall Hunt and McGraw-Hill Education have large-scale Iowa operations in the production and distribution of textbooks, courseware,

and other educational content—content that is increasingly delivered using digital platforms (in addition to traditional print). Pearson is also engaged in content development and distribution, as are multiple smaller business ventures focused in delivering specific content and filling niche market needs for digital educational content delivery. Iowa's expertise in content is particularly robust, from both a research and industry perspective in science, technology, engineering, and mathematics (STEM) content. This is the second largest of the three existing EdTech platforms identified for Iowa in terms of employment, with 619 employees.

- **Content Visualization and Virtual Reality (VR) Systems**—The digitalization of content is enabling educational materials to be viewed in ways that enhance understanding and the educational experience. Using VR and other advanced visualization technologies, students can manipulate and understand 3-D illustrations and fly-through models of biological structures, anatomy, chemical compounds, engineering designs, and a host of other content. Students can take virtual field trips, perform virtual dissections, and build and experiment with structures and components in a safe, nondestructive environment. Currently this is a relatively small cluster in terms of employment in Iowa, but deep academic R&D expertise, in combination with a small but growing entrepreneurial business base, illustrate that Iowa is capable of emerging as a notable hub for the development of visualization applications in education, especially in the area of STEM education.

The EdTech environment in Iowa is further supported by additional companies located in adjacent technology spaces that may support the growth of the sector. This is particularly evident in the presence of several companies that specialize in custom software development, app development, and visual design services that can be readily applied to EdTech applications.

The phenomena of "convergence," so prevalent in tech sectors, is benefiting Iowa through development of an emerging position in a fourth platform—a platform focused on the development of **Adaptive Learning Systems (ALS)**. Adaptive learning, also known as adaptive teaching, is an educational method that uses computer algorithms to manage the interaction with the learner and deliver customized resources and learning activities to address the unique needs of each learner. ALS use the convergence of expertise from pedagogy, content, and assessment to develop learning systems that adapt, potentially in real-time, to the knowledge level of the student, their progress through content, and their understanding of the content as measured through built-in assessment tools. Because of the demonstrated expertise in Iowa within assessment and content platforms, and emerging capabilities in the visualization platform, Iowa looks to be quite well positioned for innovation and business growth in ALS, a sector that market research anticipates growing at a very strong compound annual growth rate (CAGR) of 15.1 percent between 2017 and 2022. By 2022, ALS is expected to be a $2.85 billion market in North America, and Iowa has robust assets to apply to this opportunity.

Analyzing market research projections across all the platforms leads TEConomy to conclude that there is an opportunity to realize upward of 1,000 additional high-paying tech-oriented jobs in the state over the next five years via EdTech platform growth. Realizing this opportunity, however, will require a strategic focus on connecting ecosystem organizations and companies, enhancing

the piloting and demonstration environment for EdTech in the state, improving the EdTech entrepreneurial ecosystem, and a series of focused workforce development activities.

Based on input received throughout the project, and findings from benchmarking examinations of other states' activities in EdTech sector development, a series of strategies and actions have been developed for further consideration as Iowa seeks to advance the EdTech opportunity. It should be noted that TEConomy believes it will be critically important for success that an "EdTech Iowa" advancement organization be convened and that it be actively engaged in finalizing strategies and actions and coordinating their implementation. The strategies and actions recommended herein (Table ES-1), built on a base of knowledge and input gained over the course of the cluster evaluation project, represent a starting point—a series of potential strategies and actions for consideration by the organization that is formed. It will be important that the organization itself set direction, and the strategies and actions herein are proffered as a starting point for discussion toward final action decision-making, rather than a formally stipulated course of action.

Table ES-1: Crosscutting Strategies and Associated Action Recommendations for Iowa EdTech Platforms

Strategy 1: Collaboration Facilitation and Cluster Networking	Strategy 2: Piloting and Adoption Environment	Strategy 3: Entrepreneurial Ecosystem Development	Strategy 4: Workforce Development and Access
Action 1.1: Form EdTech Iowa collaborative cluster organization within an existing Iowa TBED organization (ICAD Group recommended).	**Action 2.1:** Identify existing cadre of K–12 and higher education institutions that have collaborated with Iowa companies for testing and piloting. Plus, target a selection of underperforming schools.	**Action 3.1:** Promote regional incubator and coworking space for EdTech within existing spaces/organizations.	**Action 4.1:** Develop a transdisciplinary EdTech graduate degree program (Education, Comp. Science, Business Studies, etc.).
Action 1.2: Fund initial EdTech Iowa operations with membership dues, potentially supplemented by funds from EDA if current application successful.	**Action 2.2:** Develop a mobile EdTech Iowa Demonstration Lab.	**Action 3.2:** Form EdTech Iowa mentoring network.	**Action 4.2:** Connect rising IT software talent with EdTech companies pregraduation.
Action 1.3: Review opportunities for strategic collaborations with existing complementary Iowa organizations (for example, TAI).	**Action 2.3:** Assess/ consider nonschool environments for piloting and testing.	**Action 3.3:** Develop "Pitch Panel" for annual conference.	**Action 4.3:** Promote connectivity between EdTech firms and Iowa software and app development firms.

Strategy 1: Collaboration Facilitation and Cluster Networking	Strategy 2: Piloting and Adoption Environment	Strategy 3: Entrepreneurial Ecosystem Development	Strategy 4: Workforce Development and Access
Action 1.4: Develop and host annual EdTech Iowa Conference. Start initially with a half-day add-on to existing ACT conference and build from there.	**Action 2.4:** Develop training and exposure program in EdTech for teachers and superintendents.	**Action 3.4:** Build relationships with VC firms and early-stage investors with proven interests in EdTech. Identify investors in Midwest ventures.	**Action 4.4:** Integrate EdTech needs into existing IT workforce development plans.
Action 1.5: Research API platforms as "best fit" for Iowa company connectivity and path to market access.	**Action 2.5:** Conduct needs assessment surveys of K–12 leaders and industry workforce skills leaders. Identify pain points and needs requiring EdTech to address.	**Action 3.5:** Develop an "Assessment Integration Lab" in Iowa City.	**Action 4.5:** Attract and recruit management talent with EdTech experience.
		Action 3.6: Promote EdTech entrepreneurship within Iowa research universities.	**Action 4.6:** Develop EdTech Iowa website for linking employers to job candidates. Also develop "why Iowa" case-making and marketing materials.
			Action 4.7: Conduct occupational needs assessment and demand projections study for the sector in Iowa.

By working collaboratively (engaging EdTech industry, academic, state, and education delivery stakeholders), it is evident that the long-term upside potential for Iowa of investing in EdTech and facilitating its growth is significant. In a knowledge-based advanced economy, education and human capital skills will be a crucial determinant of economic performance and, as such, EdTech represents a marketplace with an assured and fast-growing demand for products and services. Iowa already has many of the assets for success in place; and via coordinating implementation of targeted strategies and actions, it may leverage these assets and further build-upon them, ultimately realizing its full EdTech sector growth potential.

I. INTRODUCTION

A. The Importance of Education

At present, and into the foreseeable future, it is hard to overstate the importance of education to economic and societal progress in the United States. In a modern, knowledge-driven economy, the most valuable asset the nation and its individual states can possess is a well-educated and skilled populace.

Education is associated with large-scale benefits for individuals and society. For individuals, the achievement of education credentials is found to bring financial benefits in terms of significantly enhanced income and employment benefit levels, and additional personal benefits including enhanced job satisfaction and health. Government, industry, and society similarly benefit directly from education through enhanced economic productivity of an educated workforce, associated economic growth and increased government revenues, and through reductions in public assistance costs and negative externalities. Society also benefits by having a more highly educated populace in terms of higher levels of civic engagement, volunteerism, improved child welfare, and a broad variety of other factors. The evidence is extremely strong that an investment in education has a strong return—for individuals, for the economy, and for society overall.

B. The Digitalization of Education and the Rise of EdTech

Education is a sector of the economy that is fundamental to the performance of all other sectors of the economy. It is also a sector that stands on its own as a distinct market—consuming products, technologies, content, and intellectual assets to enable its work. Increasingly, technology has become a key component of the education sector. The education technology, or "EdTech," market space has emerged as a large, fast-growing, and important domestic and global sector.

EdTech represents a dynamic technology development sector. Covering technology used in pre-K, K–12, higher education, continuing education, and job skills training activities, it combines three core subsectors:

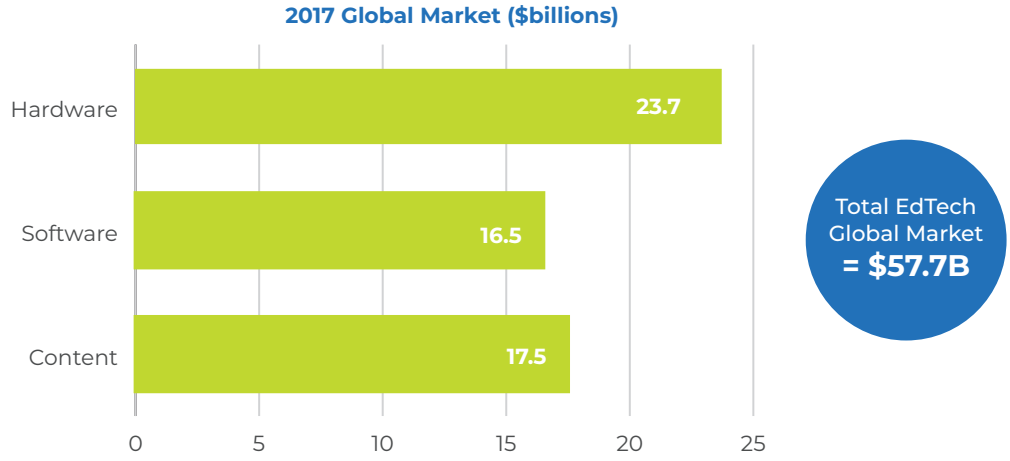
1. **Hardware**—including, for example, interactive white boards, displays and tablets, student response systems, laptops, desktops, tablets, stylus pens, wireless slates, classroom wearables, wrist-worn equipment, head gear, projectors, and sound systems.
2. **Software**—including Learning Management Systems (LMS), Learning Content Management Systems (LCMS), adaptive learning platforms, and assessment systems.
3. **Content**—including audio-based content, video-based content, text content, and multimedia content.

At its heart, EdTech is part of the ongoing digital technology revolution, combining pedagogy and digital technologies to provide new and better ways to provide enhanced learning for students and efficiencies in education, training delivery, and assessment.

C. The Market for EdTech

The EdTech market is highly attractive in terms of its size and growth rate. As shown in Figure 1, the global market is estimated for 2017 to be $57.7 billion, comprising $23.7 billion in hardware, $16.5 billion in software, and $17.5 billion in content development. Overall, between 2017 and 2022, the EdTech market is projected to grow at a strong five-year compound annual growth rate (CAGR) of 14 percent. This would increase the projected size of the global EdTech market to $110.9 billion by 2022.[1]

Figure 1: Size of the Global EdTech Market



Source: BCC Research.

As would be expected, given the size of the U.S. education sector in general, and the strong technological and digital economy in the United States, North America is the largest market for EdTech, currently comprising almost 41 percent of the global market.[2]

D. EdTech as an Innovation Industry

Considering the types of technologies engaged in the sector (hardware, software, and content), it is clearly evident that research and development (R&D) and innovation play an important role in the sector. EdTech represents an advanced industry, high in technological content. It also requires a specialized workforce, with expertise not only in the typical technology-oriented science, technology, engineering, and mathematics (STEM) fields prevalent in digital sectors, but also in creative and artistic skills relative to content, and expertise in pedagogy, psychometrics, and performance assessment. Assembling a workforce with requisite digital/technological skills, creative skills, pedagogical skills, and assessment expertise is no small task.

1 *BCC Research. October 2017. Educational Equipment and Software: Global Markets. BCC Report Code IAS118A.*
2 *Ibid.*

At a time when the economic competitiveness of this nation and its individual states is recognized to be strongly rooted in the capacity to advance innovation-based industries, EdTech is a potentially attractive target for further development—if the requisite assets and skills can be assembled, accessed, and coordinated.

Adding to the complexity of EdTech is the fact that companies engaged in the sector are diverse, including major global technology multinationals (such as Cisco Systems, IBM, HP, Microsoft, etc.), large education companies (such as Blackboard, McGraw-Hill Education, Kaplan Test Prep, Pearson, ACT, etc.), together with midsized and small-business enterprises. As a fast-growing technology sector, it shares characteristics with other digital tech sectors in terms of being favorable to new entrepreneurial business entrants, the attraction of venture capital (VC) and other risk capital, and high-value wealth creating liquidity events. In other words, it has most of the defining characteristics looked for in a technology-based economic development (TBED) sector.

E. EdTech and Iowa

With Iowa being home to ACT, founded in 1959 in Iowa City, the state has a long-standing presence in the commercial side of the sector. Other major companies also are based in, or have a significant presence in Iowa, such as Kendall Hunt (publishing/content), McGraw-Hill Education (publishing/content), and Pearson (publishing/content/assessment). There has also been notable EdTech start-up activity in Iowa, with an expanding base of EdTech entrepreneurial ventures founded and successfully growing within Iowa. The University of Iowa, Iowa State University, and the University of Northern Iowa each have research programs focused around or highly related to educational technology, instructional technology, psychometrics and assessment; and there is work in associated specialized hardware and software spaces such as virtual reality and augmented reality (VR/AR).

F. About This Report

In conversation with representatives of the EdTech sector in Iowa, the Iowa Economic Development Authority (IEDA) determined that the specialized assets and industry base in the state may warrant consideration of EdTech as a strategic sector for furthering Iowa's economic growth. Furthermore, given the strong projected growth in EdTech markets, the Iowa assets in EdTech potentially represent a pathway toward expanded business output and employment growth for Iowa in a dynamic, advanced-industry TBED sector. It was hypothesized that EdTech may thus present a strategic opportunity cluster for Iowa to pursue—along the same lines of Biosciences and Advanced Manufacturing.

TEConomy Partners, LLC (TEConomy) was selected to conduct an evaluation of the EdTech sector in Iowa as an industry "cluster" for future growth. Under guidance of a project advisory committee, the EdTech Workgroup, consisting of Iowa industry and university leaders with expertise in EdTech, TEConomy designed a program of work to meet the following evaluation objectives:

- Define the Educational Technology (EdTech) sector and its core subsectors.
- Evaluate Iowa's current business position in the sector and associated subsectors.
- Assess Iowa's R&D core competencies relevant to the sector.
- Develop an overview of the strengths, weaknesses, opportunities, and threats for the sector in Iowa.
- Benchmark Iowa's position versus selected regions that are considered leaders in this technology space.

- Identify opportunities, including strategies and actions, for expanding the sector's presence in Iowa to spur further economic development in the state.

The following report summarizes TEConomy's findings from this complete program of work, together with recommended strategies and actions for Iowa to pursue in realizing development opportunities from its existing and emerging EdTech assets.

Note: This document focuses on opportunities for growing Iowa's EdTech industry and associated R&D activity (particularly the base of companies developing technologies, products, and solutions for application in education and training nationally and internationally). It is important to note that this is not a strategy for the deployment of EdTech or digital learning in Iowa's education systems. TEConomy directs readers who are interested in Iowa's recent progress and plans for digital learning to the detailed Iowa Digital Learning Plan (which is the result of collaborative work between the Iowa Department of Education, Iowa Area Education Agencies, Local Education Agencies, the American Institute for Research, and multiple additional stakeholders). The Iowa Digital Learning Plan is available online at: http://www.iowaaea.org/wp-content/uploads/2018/12/Iowa-Digital-Learning-Plan.pdf.

II. EDTECH IN IOWA
INDUSTRY & UNIVERSITY ASSESSMENT

A. Business Environment—Industry Overview, Subsectors, and Recent Industry Performance

While Iowa's large and leading corporate anchors in EdTech, such as ACT, have a lengthy and well-established history in the state, developing a full inventory of companies and organizations in the sector today is challenging. The task is relatively difficult as EdTech companies span a range of activities and industry classifications that include computer software, hardware and electronics, publishing, educational support activities, and others. With no single industry classification fully capturing EdTech, and with sector companies embedded within broader sectors and difficult to isolate, the project team used a bottom-up approach to identify companies and the extent of the sector in Iowa. These approaches included leveraging the following data and information sources to develop a micro-firm database of Iowa companies:

- Iowa City–Cedar Rapids website featuring the cluster in the regional corridor;
- PitchBook VC database;
- Hoovers Dun & Bradstreet corporate database;
- EdTech Workgroup member organizations;
- Federal Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) database;
- Patent analyses; and
- Industry and university interviews and meetings with the EdTech Workgroup and the Iowa Innovation Council.

The research identified 28 EdTech companies/organizations across Iowa (Table 1)—most of whom are directly engaged in providing EdTech products and services with a few additional software development companies acting as key "enabling" entities developing applications. These companies, listed below, employed 3,126 individuals in 2018, according to employment data prepared by Iowa Workforce Development (Figure

Iowa EdTech Industry Profile, Key Findings:

- **28 sector companies, employing more than 3,100 in Iowa**
- **Diverse mix of larger, mature companies and numerous recent start-ups**
- **$22.7 million in VC/angel investments raised since 2010; relatively modest totals relative to Iowa's size**
- **14 Federal SBIR/STTR awards for sector companies since 2010 represents 9 percent of all Iowa awards**
- **Clear subsector strengths in three key areas: testing/assessment; STEM content development; and content visualization**

2). Though it is important to note that this represents a moderate undercount of total employment as several newly established companies were not yet included within the state's databases.

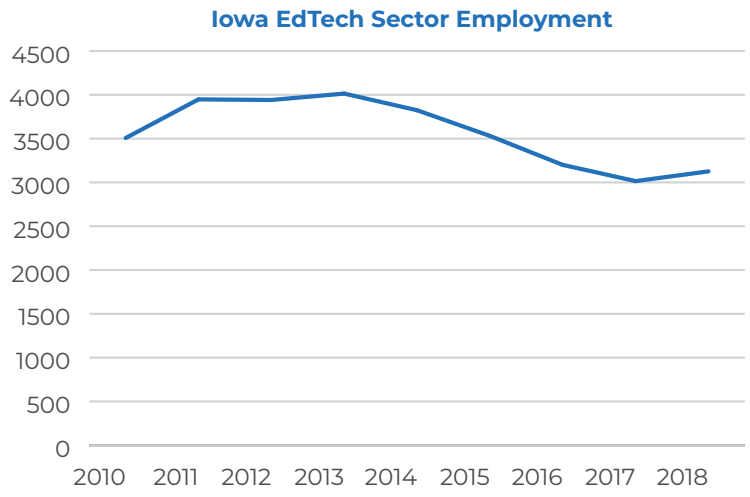
Table 1: Iowa EdTech and Enabling Companies Identified

- ABC Virtual
- ACT, Inc.
- BodyViz
- Budding Biologist
- College Board
- College Raptor
- Complex Computations
- Foundations in Learning
- Higher Learning Technologies
- Iowa Testing Programs
- Kendall Hunt Publishing/Great River Learning
- Launch Deck/Venture Point
- LeepFrog Technologies
- McGraw-Hill Education
- Parametric Studio Inc.
- Pear Deck
- Pearson
- Project BBQ
- Qi Learning Research Group
- Ruffalo Noel Levitz
- Shaking Earth Digital
- Silver Oaks
- Stamats
- StarrMatica
- Substrate Games
- True 360
- Victory VR
- VIVED Learning (formerly Cyber Science 3D)

EdTech industry employment has consistently exceeded 3,000 jobs in Iowa during the current economic expansion, with a peak of just over 4,000 reached in 2013. After rising by 14 percent from 2010 and reaching this peak, the sector has experienced a contraction, shedding jobs through 2017 before seeing a slight increase in 2018. Overall, the sector's employment level is down by nearly 11 percent during the current expansion (since 2010).

Figure 2: Employment in Iowa EdTech Companies and Trends, 2010–2018

Year	Iowa Employment*
2010	3,507
2011	3,948
2012	3,941
2013	4,014
2014	3,824
2015	3,531
2016	3,200
2017	3,015
2018	3,126



**Note: Employment data do not include six companies requested by TEConomy that are not in the IWD database, most likely and primarily due to their young age (recent start-ups).*

Source: Total sector employment provided by Iowa Workforce Development (IWD) based on Quarterly Census of Employment and Wages (QCEW) data; levels and overall trend confirmed in TEConomy interviews.

Based on interview discussions with a majority of the companies, the recent employment declines can be primarily attributed to job cuts at the state's larger, more mature EdTech firms. The EdTech sector, however, has a diversity of firms, not only with respect to products and markets, but also in terms of age and maturity. The largest companies—specifically ACT, Pearson, and McGraw-Hill—are generally older, more mature, and well established in EdTech and in educational testing and assessment and publishing more broadly. As one would expect, these companies account for the majority of sector employment—approximately two-thirds. Beyond these firms are a sizable cadre of relatively new companies and start-ups, a majority of which began business during this economic expansion. So, despite the recent employment losses, the sector in Iowa is characterized by significant business dynamism.

The inability to isolate the EdTech sector into one or a grouping of federal industry North American Industry Classification System (NAICS) codes limits the ability to gauge the industry's concentration in Iowa relative to the nation or other states in a comparable manner. There is one closely aligned industry classification, however, that reveals insights into Iowa's specialization and relatively high wages in the sector—Educational Support Services (NAICS 6117)—where Iowa stands out with a 78 percent greater concentration in employment relative to the national average (a statewide location quotient of 1.78). This high degree of concentration indicates the industry is highly "specialized" in Iowa. This industry classification is, however, not a perfect fit for EdTech. While it includes educational testing services and testing development, a major component of the EdTech sector, it also includes other, unrelated activities including career counseling, study abroad and exchange programs, and a broader array of educational consultants. Still, it yields insights into the state's specializations as well as the relatively high state wages paid in a major component of EdTech, where average annual wages in Iowa were $67,000 compared with $51,000 for the national sector.

The geographic footprint for EdTech in Iowa primarily concentrates around three regional nodes—the Iowa City–Cedar Rapids Corridor, the Des Moines–Ames Corridor, and Dubuque. Iowa City–Cedar Rapids, including Coralville, is home to ACT, College Raptor, Foundations in Learning, Higher Learning Technologies, Leepfrog Technologies, Pear Deck, Pearson, Ruffalo Noel Levitz, Stamats, and others. Included in the Des Moines–Ames Corridor are BodyViz, Qi Learning Research Group, Substrate Games, and others. McGraw-Hill Education and Kendall Hunt Publishing are based in Dubuque and form a sizable employment base there with a content focus.

Identifying Major EdTech Subsectors. Considered as a whole, Iowa's EdTech companies are focused on software and content rather than developing computer/electronics hardware. The companies design products and solutions for both K–12 and postsecondary markets. The concentrations of companies and products, however, do cluster around a few clear primary focus areas or industry "subsectors" (Figures 3 and 4):

- **Assessment:** Iowa is characterized by some in the industry as the "Assessment Capital of the World." This subsector includes companies that are providers of educational assessment (testing and evaluation) solutions for K–12, higher education, and continuing education/workforce training applications. The assessment subsector is the largest in terms of employment and is concentrated in the Iowa City–Cedar Rapids region of the state.

- **Educational Content:** Another concentration of companies in Iowa is focused on producing and providing educational content—the body of knowledge and information that teachers teach and that students are expected to learn in a given subject area. EdTech is enabling digital content to be delivered in new, dynamic ways including written, visual, and auditory. The Iowa companies identified in the content subsector have a particular focus on STEM subject matter.

- **Visualization:** Advanced visualization technologies are enabling innovation in content delivery and enhancing the educational experience for both students and teachers including the application of VR and AR. The technologies are enabling, for instance, a medical student to visualize anatomy in three dimensions, a history student to walk beside the Wright Flyer, or an architecture student to stroll through a building design. While still nascent in their development stages, EdTech companies are seizing on these advanced technologies for the classroom. In Iowa, the companies in this subsector are leveraging others' hardware as a platform for new software development to enhance the educational experience. And while still emerging as a subsector, the market potential for these applications is very large.

- **Software/Applications Development:** Several Iowa software companies are enabling the development and growth of EdTech through strategic partnerships or customer relationships. EdTech companies, particularly new start-ups, often have the experience and know-how in educational content or assessment or pedagogy but do not have the technical capabilities to deliver complex software, so the companies in this subsector are providing custom software and app development and IT support.

Established companies are also developing software and application program interface (API). While a portion of these software development efforts are aimed to update existing/ legacy platforms and for internal use, more and more large assessment companies are offering SaaS (software as a service).

- **Other EdTech:** An additional set of Iowa companies is operating in the EdTech sector serving separate market needs and niches, almost fully in the college and university space. Stamats has a more than six-decade history in Iowa working with higher education institutions across the United States in integrated marketing and communications and branding campaigns, which today are primarily digital in nature. Leepfrog Technologies has developed software for university registrar offices and online course catalogues. College Raptor is leveraging big data to provide more accurate assessment of the actual costs for college. And Ruffalo Noel Levitz has worked with thousands of higher education and other nonprofit institutions over its lengthy history to target enrollees and raise funding.

These industry subsectors are explored and profiled in much further depth in Chapter V of the report in the context of identified EdTech development "platforms" for Iowa to pursue.

Figure 3: EdTech Subsector Areas, Concentrations for Iowa Companies, Innovation[3]

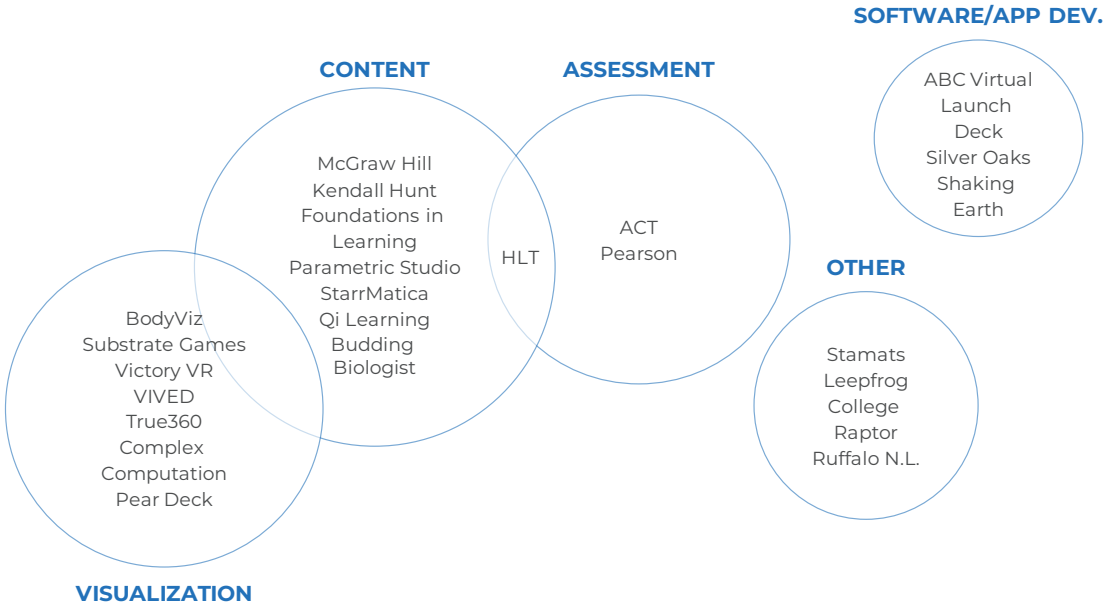
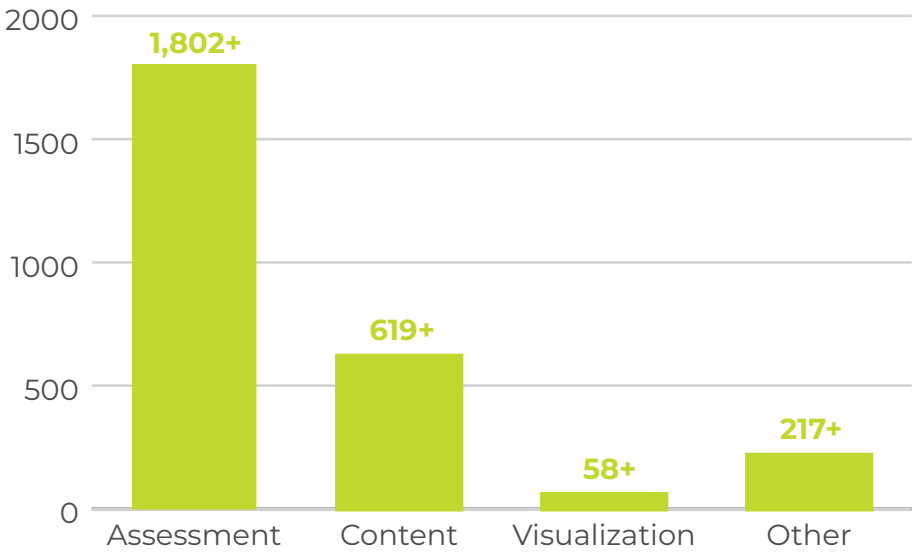


Figure 4: Current Employment Levels by EdTech Industry Subsector



Source: Based on TEConomy's company-specific data collection, employment levels not available for all companies; hence the "+" to indicate additional employment that is not captured.

3 *A significant number of companies identified in Figure 3 offer products/services, or possess core competencies, that cover multiple EdTech subsector areas. The classifications made here are based on judgment regarding their primary line of business.*

Access to Innovation Capital. Iowa's EdTech companies have attracted modest amounts of private equity investment in the form of angel financing and/or venture capital. According to the PitchBook VC database, from 2010 through 2018, six Iowa EdTech companies received $22.7 million in investments across nine individual deals (Table 2). Higher Learning Technologies' nearly $15 million in funding across three deals stands out, and this mobile learning solutions company has developed postsecondary study tool apps with more than 50,000 daily users and reports 10 million downloads. Pear Deck, based in Iowa City, secured $5.2 million in venture funding. The company has commercialized a web-based presentation platform for active engagement and learning between teachers and students, and formative assessment in K–12 classrooms.

Table 2: VC and Angel Investments in Iowa EdTech Companies, 2010–2018

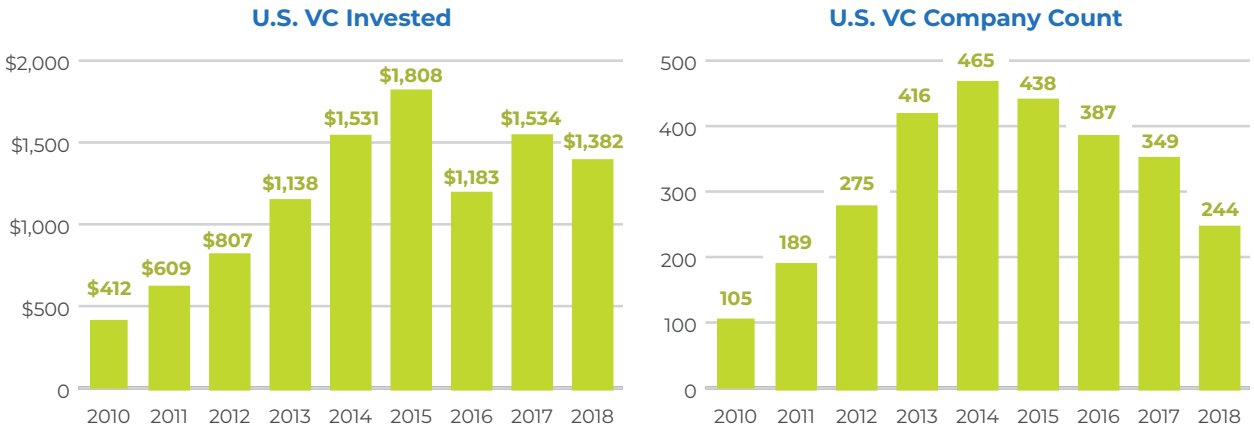
Company	VC Deals (#)	Deal Years	VC Invested ($ in Millions)
Higher Learning Technologies	3	2014 (2), 2017	$14.76
Pear Deck	1	2017	$5.20
Foundations in Learning	1	2013	$1.91
Victory VR	1	2018	$0.78
Budding Biologist	2	2013, 2014	$0.04
Project BBQ	1	2018	$0.02
Total	**9**		**$22.71**

Source: TEConomy's analysis of PitchBook Database.

The investment totals for Iowa's EdTech companies are modest relative to Iowa's shares of population and overall economy. During this nine-year period, Iowa's $22.7 million accounts for just 0.22 percent of national EdTech investments while Iowa represents 0.96 percent of the U.S. population and 0.99 percent of national Gross Domestic Product (GDP). This indicates room for improvement in the sector with respect to attracting innovation capital.

Nationally, the EdTech sector has attracted significant amounts of venture funding—a cumulative $10.4 billion invested in U.S. EdTech companies from 2010 through 2018 (Figure 5). The sector saw a steady rise in investments from 2010 through 2015, before experiencing some recent leveling off. Since 2013, investments in U.S. EdTech companies have averaged more than $1.4 billion annually.

Figure 5: VC and Angel Investments in U.S. EdTech Companies, 2010–2018 ($ in Millions)



Source: TEConomy's analysis of PitchBook Database.

Federal SBIR and STTR awards represent additional sources of early-stage capital for small, emerging innovative firms. Six Iowa EdTech companies have successfully secured 14 of these federal awards since 2010, accounting for 9 percent of all Iowa SBIR/STTR awards during this period (Table 3). Three companies have received three or more awards in recent years:

- Parametric Studio (four awards) specializes in engineering-centric and project-based STEM games, software, kits, and curricula for grades K–12.
- Complex Computation (three awards) is a data analytics and visualization company started by an Iowa State University faculty member in Ames and originally conceived to solve complex biological problems.
- Foundations in Learning (three awards) has developed an online digital platform for building foundational literacy skills for students in upper elementary and middle school. The platform utilizes personalized instruction and has an accompanying screener and literacy diagnostic tool.

Table 3: Federal SBIR/STTR Awards to Iowa EdTech Companies, 2010–2018

Company	Number of Awards	Award/ Phase(s)	Year(s)	Agency
Budding Biologist	1	SBIR Phase I	2013	NSF
Complex Computation	3	SBIR Phase I	2015, 2017, 2018	Depts. of Energy, Defense
Foundations in Learning	3	SBIR Phase I, II	2014, 2015	Dept. of Education
Parametric Studio	4	SBIR Phase I, II; STTR Phase I	2016, 2017, 2018	Dept. of Education, NSF
StarrMatica Learning Systems	1	SBIR Phase I	2017	Dept. of Agriculture
Substrate Games	2	SBIR Phase I	2016, 2017	Dept. of HHS, NSF

Source: SBIR.gov database.

B. Academic Research Strengths, Assets, and Core Competencies Related to EdTech

Iowa's research universities are a key component of the state's EdTech activities and capabilities, and anchor many of the core competencies that enable ongoing translational research and industry interaction. Iowa universities have a long-standing reputation for excellence in education research that is being leveraged by the educational product development industry as well as emerging areas of strength in digital technology applications that are spinning out new EdTech products and services.

This report section examines data on the current position and recent trends of academic R&D activities in areas most closely related to EdTech and then highlights specific key assets and strengths identified at each institution based, in part, on interview discussions with university faculty and research leadership.

Capacity in EdTech research is enabled by university R&D activity in two key intersecting discipline areas: education research and computer and information sciences. Iowa's university R&D expenditures highlight a relatively strong position in education research activity with more than $17 million in R&D expenditures in 2017 (Table 4) and a high growth trajectory of increased activity since 2010 of almost 162 percent. Although still a more emerging area of activity relative to larger benchmark university systems, Iowa's university R&D spending in computer and information sciences topped $10 million in 2017 and has grown at a rate of 15 percent.

Table 4: University R&D Expenditures in Education Research and Computer and Information Sciences for State of Iowa and Individual Public Universities, 2017 ($ in Thousands)

University	Education Research	Computer and Information Sciences
State of Iowa, Total	$17,404	$10,505
Iowa State University	$6,045	$7,731
University of Iowa	$10,578	$2,327
University of Northern Iowa	$55	$7

Source: National Science Foundation (NSF), Higher Education R&D Survey.

As shown in Table 4, the state's public research universities comprise the vast majority of overall research activity in these spaces, making them the key drivers of education technology innovation (along with companies). Each institution has specific strengths at the intersections of the two research areas encompassed by specialized programs and centers that help support the research environment for educational technology.

1. IOWA STATE UNIVERSITY

The strengths of Iowa State University (ISU) in technology and computer science, which it should be noted overlap with strengths in engineering research as well, are reflected in the technology integration focus of its education research activities that align strongly with EdTech themes. Several key centers and research institutes at ISU aligned with the EdTech space include the following:

EdTech-Related Start-Ups Associated with ISU:

- **BodyViz**
- **Complex Computations**
- **Parametric Studio**
- **Qi Learning**

- **The Virtual Reality Applications Center (VRAC)**—VRAC is an interdisciplinary research center focused on human-technology interaction areas such as virtual reality (VR), augmented reality (AR), and mixed reality (MR), mobile computing, developmental robotics, haptics interaction and user interfaces, and human-centric design. The center supports several EdTech applications areas such as MR training and intelligent tutoring systems. Additionally, the VRAC houses the interdisciplinary Human Computer Interaction program that enrolls over 200 students and includes curriculum focused on digital learning environments.

- **The Center for Technology in Learning and Teaching (CTLT)**—Housed within the School of Education, this center provides spaces for exploration and evaluation of technologies within the instructional environment. Focus areas include use of mobile devices and social networking within the classroom as well as integration and evaluation of instructional technology, and the center supports a specialization in curriculum and instructional technology.

- **Center for Excellence in Learning and Teaching (CELT)**—This center provides resources for teachers and instructors to further professional development and skills related to education. Several of the focus areas of the center include areas aligned with building EdTech capacity such as best practices in digital and online teaching, exploring technology options for teaching, and innovative teaching methods incorporating new technologies.

Several other notable areas of university research that are aligned with the EdTech space include the following:

- Games and simulation-based learning, spanning a cluster of faculty;
- Applications of machine learning and data analytics for computer-assisted language learning, research writing, computational linguistics products and services; and
- Technology integration and evaluation, including development of proprietary technology platforms for learning and instruction.

In interviews with Iowa EdTech companies, two specific research and technology areas were cited regarding partnerships or collaborations with ISU faculty: curriculum development and educational testing in terms of advising and implementing in the classroom.

Cybersecurity also must be integrated into the majority of connected EdTech programs and applications. This is an area of long-standing core competency at ISU, consolidated under several programs and initiatives at the university, including the Information Assurance Center, Information

Systems Security Laboratory (training IT employees in Iowa and testing products for companies), and Internet-Scale Event and Attack Generation Environment (ISEAGE) (a virtual laboratory used by K–12 and college students across Iowa for cyber defense competitions and research). ISU also leads the Iowa Cyber Alliance, a consortium of schools, businesses, and government bodies that works to improve cybersecurity education and training within the state. In terms of educational programs ISU has a new Cybersecurity Engineering major starting fall 2019 and offers a Master of Engineering degree in Information Assurance.

2. UNIVERSITY OF IOWA

The University of Iowa anchors an internationally recognized College of Education that has a long history of excellence in educational measurement and assessment as well as content development. Several university assets that are particularly aligned with development of EdTech capacity include the following:

EdTech-Related Start-Ups Associated with the University of Iowa:

- **Higher Learning Technologies**
- **Leepfrog Technologies**
- **Foundations in Learning**
- **VIVED**

- **The Baker Teacher Leader Center**—This comprehensive education research center is focused on teacher professional development and certification as well as modernizing the teaching workforce to incorporate innovative and technology-based approaches. The center serves both pre-service teachers as well as in-service professionals obtaining renewal units. The center also leverages the latest technology, providing devices for each teacher and certifying teachers as Certified Level 1 Google Educators.

- **Center for Advanced Studies in Measurement and Assessment (CASMA)**—An internationally renowned university asset, CASMA is focused on the methodology and practice of educational measurement and assessment. The interdisciplinary focus of the center helps it conduct research across a wide variety of areas, including educational measurement fields such as psychometrics, advancement of testing instruments, and assessment analytics models. Several ongoing engagements with testing companies and other private industries are focused in EdTech-related applications.

- **The Center for Evaluation and Assessment**—This center designs and implements various program evaluations, with particular focus on measurement and assessment of applied educational initiatives. The center also develops professional training tools to help aid the use of assessment in education-related policy and curriculum, which are critical to evaluation of EdTech efficacy.

- **Iowa Testing Programs**—Also internationally recognized in the testing and measurement space, the program provides standardized tests to schools that measure student strengths and weaknesses, conduct screening for targeted interventions, assess preparedness levels, and predict future student performance. Maintained by the College of Education, the testing programs are administered to almost all schools in Iowa as well as many other districts nationally with the results being used to conduct further research and test development.

- **Iowa Reading Research Center**—This center provides a variety of literacy research and evaluation services, including specialized literacy analytics modeling and professional development resources.

- **Development and Learning from Theory to Application ("DeLTA") Center**—This collaborative center is focused on supporting interdisciplinary research, with a significant body of research activity around child development and learning. Specifically, the center houses the shared-use CHild Imaging Laboratory in Developmental Science (CHILDS) facility focused on detailed measurement of brain and behavioral development changes using vision tracking, VR, and neurological diagnostics.

Several other specific areas of university research activity that are aligned with the EdTech space include the following:

- Play-based/game-based learning in STEM fields, associated with a new graduate-level degree offering in Learning Sciences;
- Iowa Informatics Initiative activities that boost capacity related to big data analysis in education and information science topics;
- Development and testing of computerized education systems and software; and
- Social and emotional learning assessment and cognition sciences.

Several interviews identified the close working relationships/partnerships the university and its faculty maintain with testing companies including both ACT and Pearson. In interviews with Iowa EdTech companies, numerous specific research and technology areas were cited regarding partnerships or collaborations with University of Iowa faculty, including psychometrics, machine learning, brain and behavioral sciences and cognition, software prototyping and testing, literacy research, social/emotional learning, and the business school.

3. UNIVERSITY OF NORTHERN IOWA

The University of Northern Iowa (UNI) houses a comprehensive set of research programs focused on educational content creation and professional development as well as a variety of other centers and programs that are exploring EdTech applications. Several key university research assets in this space include the following:

- **Center for Educational Transformation (CET)**—This center supports and conducts research related to specific critical and emerging issues of interest in education including education and immigrant populations, rural and distance education, STEM education access, and mental health in schools.

- **Center for Early Education in Science, Technology, Engineering, and Mathematics (CEESTEM)**—This center, which supports integration of STEM topics into early childhood education as well as redesigned learning environments and supporting education technology toolkits, is focused on development of research-based programs and educational technology, particularly around STEM topics, and also houses an integrative classroom studio for demonstration and evaluation.

- **National Program for Playground Safety**—This research center is focused on field observation and evaluation of playground environments, injury prevention and playground materials, strategies for playground engagement, and models for play supervision. The center participates in outreach and collaboration that incorporates biomedical engineering, materials testing, instrumentation technology for assessment, and injury surveillance data collection as part of its broad focus on developing protocols and policies.

Other activities that could be leveraged toward broader EdTech opportunities include the following:

- Educational content creation and assessment across a variety of subject areas;
- Iowa Teacher Quality Partnership (ITQP) program and its work developing online platforms and teacher quality assessment; and
- Individual faculty and programs pioneering or incorporating content creation and education technology solutions in specific subject matter spaces such as computer-aided design, mathematics, textiles and apparel, distance education, and geospatial analytics training.

In interviews with Iowa EdTech companies, educational content creation was cited regarding partnerships/collaborations with UNI faculty.

C. Positioning of University Core Competencies to Support EdTech Industry Development

When viewed collectively, the breadth of specialties across the public research universities and their various innovation-driven assets presents a strong anchoring foundation for technology development and commercialization in EdTech. Most critically, the universities' set of core competencies spans the spectrum of intersecting capabilities required to support a holistic EdTech ecosystem: high-quality content generation, integration of digital platforms and technologies, and measurement and assessment of outcomes.

Based on indicators of research activity in publications and R&D expenditures as well as qualitative interviews with university and private industry collaborators, the overall core competency set for Iowa universities in the EdTech space could be summarized across six segments:

- **High-quality educational content generation and curriculum development,** present across a variety of fields but with particular strength in STEM content and developmental learning leveraging the availability of education research subject matter experts within Iowa institutions.

- **Student-technology interaction**, particularly with respect to integration of education technologies into experiential learning and evaluation of outcomes.

- **Psychometrics**, a differentiated area of unique expertise for Iowa's education research programs that can be leveraged to support new EdTech products and services.

- **Social/Emotional Learning (SEL)**. Again as a strength within research programs.

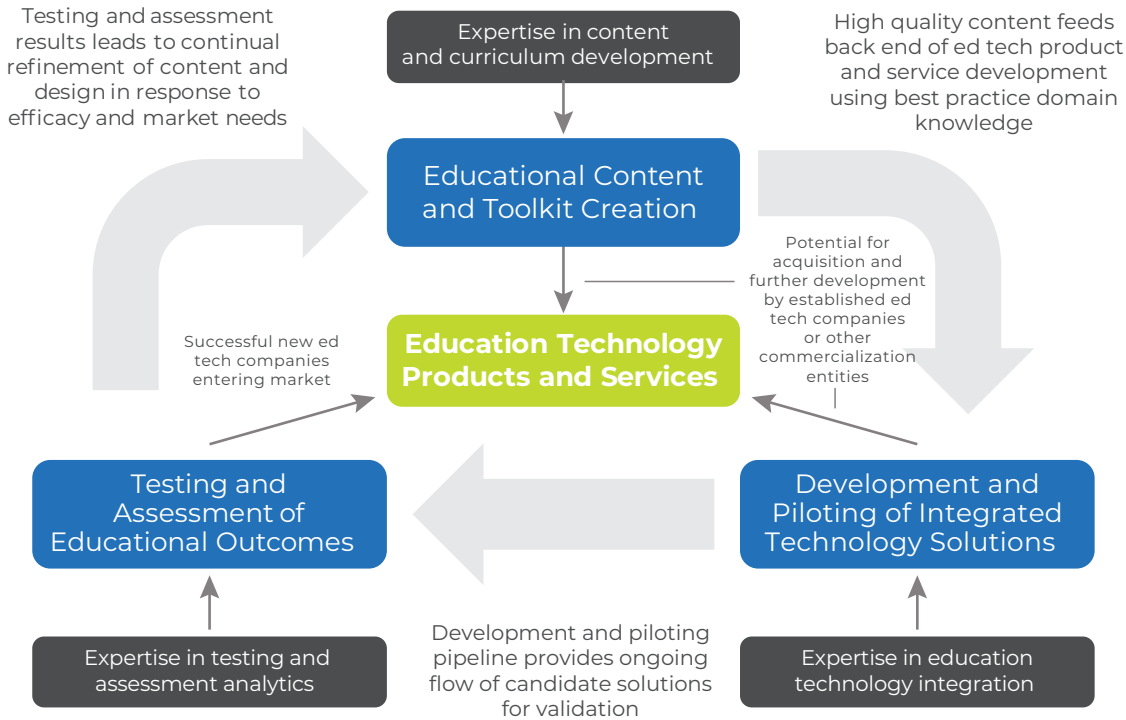
- **Testing and assessment analytics**, a capacity anchored by the universities' deep subject matter expertise and long-standing collaboration efforts with public institutions and private industry.

- **Virtual/Augmented/Mixed reality (VR/AR/MR) applications**, an emerging area of activity that leverages existing centers of excellence in computer science, human-computer interaction, and visualization to support EdTech solutions.

It should be noted that the Iowa EdTech Workgroup and the Iowa Innovation Council have both raised an additional need for EdTech supporting lifelong learning and workforce upskilling. It is not just about K–12 and higher education applications, EdTech provides benefits across the full learning spectrum.

Strengthening connectivity and collaboration across Iowa institutions will be critical to the long-term success of an EdTech innovation ecosystem and industry cluster. Coordination efforts can augment existing core competencies across the institutions, but more importantly can aim to create an integrated environment that generates a "feedback loop" for continual development of new EdTech opportunities as shown in Figure 6. Creating a robust university collaboration ecosystem within Iowa in the EdTech space can then allow for accelerated scaling of the overall industry and more potential for successful commercialization off-ramps for developing solutions.

Figure 6: University Core Competencies Form the Foundation for "Outer Ring" of EdTech Commercialization Cycles



Source: TEConomy Partners, LLC.

III. STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND THREATS ASSESSMENT

SWOT (strengths, weaknesses, opportunities, and threats) analysis is a frequently used framework for conducting a situational analysis of a sector, industry, company, or organization. Assessing both internal and external factors, and providing both current and future perspectives, SWOT analysis provides a structured method for summarizing the overall EdTech operating environment in Iowa via drawing-together the intelligence gained through analytical work and interviews with key sector stakeholders, industry representatives, and educational professionals. The SWOT analysis provides a useful summation tool for feeding information, in a structured fashion, into the strategic plan development process.

A. Strengths

As highlighted in previous chapters, Iowa benefits from significant assets in EdTech within industry and academe. Companies interviewed noted that there are several strengths in the Iowa operating environment that are favorable to EdTech sector development. The following are chief among those identified.

Iowa's workforce, especially in terms of work ethic, is a distinct advantage.

This has been a constant positive refrain in TEConomy's (and, previously, Battelle's) work across Iowa's business sectors. In information and communications technologies, biosciences, advanced manufacturing, and energy industries, companies have consistently praised the quality of Iowa's workers and their dedication to their employers. This is no different in the EdTech space, where companies noted that the employees they have in Iowa operations are a significant asset for their respective firms. That is not to say that it is easy to find employees, especially in the current full-employment economy, or to attract personnel from outside of the state to come to Iowa—but, once employees are found and brought onboard, there are highly positive characteristics demonstrated.

The Iowa Regent universities have multiple programs producing graduates with education and skills relevant to the needs of the sector.

Iowa's universities operate multiple programs directly relevant to educating the talent required for development and application of EdTech solutions. At the University of Northern Iowa, for example, the College of Education's Instructional Technology Division provides undergraduate teaching majors the opportunity to specialize in this program with a minor in Educational Technology, and the College also offers an Instructional Technology MA degree. At Iowa State University, courses are available all the way through to a PhD with an emphasis in instructional technology (IT) offered through the

School of Education and Division of Teaching, Learning, Leadership, and Policy. The school also offers an M.Ed. and M.S. in Education with an emphasis in IT. The University of Iowa operates graduate programs specifically focused in assessment and evaluation, with the Educational Measurement and Statistics program, for example, focused on preparing students for careers in educational measurement, evaluation, research, and statistical/quantitative analysis. The program offers both MA and PhD degrees in Educational Measurement and Statistics. The above represent just some of the educational program assets of relevance to developing the workforce required for the EdTech sector. Many other programs are directly relevant including programs in advanced visualization technologies, human-computer interaction, software engineering and computer sciences, etc.

Iowa's EdTech sector contains a mix of small and large companies.

Iowa's EdTech environment has proven itself suitable for the operation of large companies, such as McGraw-Hill, ACT, and Pearson, as well as a favorable environment for the development of start-up and entrepreneurial EdTech business ventures. These companies are also, increasingly, interfacing with each other, and the large Iowa EdTech companies have been actively investing in Iowa's new ventures or forming strategic partnerships with the entrepreneurial business sector.

The quality of life in Iowa's EdTech hub regions is favorable.

With short commutes, a relatively low cost of living, good school choice, and the generally favorable atmosphere of small-town and college-town America, Iowa's EdTech hub regions present appealing places to live, work, and raise a family.

A business-friendly operating environment exists in the state.

Iowa frequently ranks well in terms of having a business-friendly operating environment, and this was similarly highlighted in interviews with EdTech companies in the state. In terms of "business cost," Forbes ranks Iowa 4th and its "regulatory environment" 10th in the nation.[4]

There is state support via early-stage funding.

The State of Iowa has been innovative in development of multiple funding programs to support commercial R&D and innovation commercialization. This is recognized by the early-stage companies interviewed in the EdTech sector in Iowa. Notable programs and funds include the following:

- **The Proof of Commercial Relevance (POCR) program.** It is designed to assist in market validation of products/services and the business model prior to commercial launch. The program awards up to $25,000 in low-interest loans with a 1:2 (private:public) match.

- **Demonstration Fund.** This fund is designed to provide assistance to companies with market-ready innovative technologies or products that have a clear potential for commercial viability. It assists companies with marketing and business development activities and helps businesses with high-growth potential reach a position to attract follow-on private sector funding. Awards are up to $100,000 and are primarily loans or royalty arrangements with a 1:2 (private:public) match.

4 *https://www.forbes.com/best-states-for-business/list/#tab:overall.*

- **Iowa Innovation Acceleration Fund.** It provides funds to Iowa-based companies (with <500 employees) with innovative technology solution(s) and is focused toward companies in advanced manufacturing, bioscience, or information technology industries. Funds seek to accelerate market development and result in significant leveraged capital investment. The fund is split into two programs: (1) PROPEL awards up to $300,000 to accelerate market development for companies that have critical management in place, have a validated business model and an established customer base that's generating substantive revenue; and (2) INNOVATION EXPANSION awards up to $500,000 to encourage expansion of product lines in companies that have a complete management infrastructure, a demonstrated historical profitability, and an established customer base; funding provides assistance for product refinement and market expansion activities for unique, innovative, and competitive products.

- **SBIR/STTR Outreach Program.** This program assists Iowa companies by reviewing SBIR/STTR grant proposal applications and providing commitments to matching grant funds for Phase I SBIR/STTR awards.

In addition, Iowa offers supporting policies and programs designed to encourage private-sector risk capital investment in early-stage companies. Examples of programs here include the following:

- **Angel Investor Tax Credits** are offered to increase the availability and accessibility of VC, particularly for ventures at the seed capital investment stage. The total amount of tax credits available per fiscal year (July 1–June 30) is $2 million. Investors can receive a maximum of $100,000 in tax credits per calendar year for a household, and the investors in any one business can be issued a maximum amount of $500,000 in tax credits per calendar year. The tax credit is equal to 25 percent of an investor's equity investment and refundable to investors who file personal net income tax.

- **The Innovation Fund Tax Credit** was created to stimulate VC investment in innovative Iowa businesses. Individual investors receive tax credits equal to 25 percent of an equity investment in a certified Innovation Fund. In turn, those certified Innovation Funds make investments in promising early-stage companies that have a principal place of business in Iowa. Innovative businesses include, but are not limited to, businesses engaged in advanced manufacturing, biosciences, and information technology.

There is state support for commercial R&D activity.

For larger, established companies, Iowa also provides incentives to support R&D in the state.

- **Refundable Research Activities Credit.** Iowa sets itself apart as being one of the few states to offer a refundable research activities credit. Iowa companies earn refundable tax credits for R&D investments that may be paid directly in cash to the company once its tax liabilities have been met.

- **The High Quality Jobs (HQJ) program.** HQJ provides qualifying businesses assistance to off-set some of the costs incurred to locate, expand, or modernize an Iowa facility. This flexible program includes loans, forgivable loans, tax credits, exemptions and/or refunds. Actual award

amounts are based on the level of need, quality of the jobs, percentage of created or retained jobs defined as high quality, and the project's economic impact.

Major EdTech companies are making investments in smaller firms.
In interviews with major sector firms (such as Kendall Hunt, McGraw-Hill, and ACT), it was noted that these companies have been proactive in forming relationships with smaller Iowa EdTech firms, up to and including formal investment in these companies. Given the importance to early-stage investors (angels and VCs) of an evident pathway to financial exit (liquidity events) with investments in entrepreneurial companies, the presence, within Iowa, of larger sector companies with interests in acquisitions and strategic partnerships is a significant strength.

Companies are open and interested in discussing partnerships and collaborations.
Some sectors are characterized, and limited, by being inward looking, with companies not open to outside ideas, partnerships, or collaborations. This is not the case with Iowa EdTech where the company interviews revealed a sector characterized by a willingness to collaborate, to learn from each other, and to seek strategic partnerships. Companies recognize that EdTech trends are toward convergence—with the integration of software application development, educational content, and assessment needing to occur to realize fully developed products that meet emerging market needs and preferences. Iowa's EdTech companies are starting to find one another to investigate convergence opportunities, but they are also looking outside of the state.

Next Generation Science Standards have been adopted in Iowa.
The Next Generation Science Standards (NGSS) are K–12 science content standards which set the expectations for what students should know and be able to do—they are designed to help improve science education for all students. A goal for developing the NGSS was to create a set of research-based, up-to-date K–12 science standards. These standards give local educators the flexibility to design classroom learning experiences that stimulate students' interests in science and prepare them for college, careers, and citizenship. The Iowa Science Standards as well as the NGSS are based on a "Framework for K-12 Science Education" that was developed by a committee of the National Research Council. NGSS seek to engage students in the scientific process, with open-ended questions and the use of scientific methods to provide evidence for reaching conclusions. This type of education lends itself to the development of novel EdTech applications for experiment simulations, interactive illustrations, etc. The adoption of NGSS also provides companies with more assurance of a standardized national marketplace for their products, and having the standards adopted in Iowa provides Iowa companies with the ability to develop, pilot, and test their products locally.

Iowa hosts a trifecta of capability in assessment, content, and visualization technologies.
As noted previously, and discussed further in this report, demand growth is anticipated in EdTech products that combine high-quality educational content with advanced communication and visualization technologies to enhance student learning. Ideally, advanced EdTech applications will also incorporate assessment that monitors student performance and allows the educational content delivery to be adapted to the individual learning characteristics of the student. Iowa has a base of companies in each of these areas and is starting to experience the development of convergence-based companies bringing together content and assessment to provide adaptive learning systems.

Iowa has a base of major content companies.

Iowa benefits from having a long-standing base of expertise in high-quality educational content publishing, most notably through the presence of Kendall Hunt and McGraw-Hill. These companies sustain strong linkages to a large network of content creators, providing "reach-in" to skilled content developers potentially able to assist Iowa companies in their EdTech content development.

There is expertise in advanced visualization technologies in Iowa.

One of the advantages of digital technology is the ability to create advanced 3-D models, simulated environments, and complex digital simulations of natural and human-made environments and structures. Such technology is used in a wide variety of engineering, scientific, and other applications, and is increasingly viewed as a robust tool for application in education and training. Iowa has a long-standing base of academic expertise in advanced visualization and VR and simulation environment development, testing, and design—with significant R&D centers at both the University of Iowa and Iowa State University. The academic base of expertise in visualization technologies has already led to the development of multiple start-up companies, with several finding application in the EdTech market space.

There is cybersecurity expertise in Iowa.

As students use EdTech applications, their use will accumulate data on their academic performance and their strengths and weaknesses. Analysis of these data will be useful to enhancing student educational performance, but it may also be used or misused for other purposes. Just as it is important to maintain the privacy of individuals' health data, it will be similarly important (in a knowledge economy) to maintain the privacy of academic performance data. Because performance data are inherently sensitive, Iowa's strong presence in assessment has led to a matched expertise in assessment data cybersecurity and information privacy—an important core competency for the development of new EdTech applications.

B. Weaknesses

There is no "perfect" environment for technology companies. Each location has its strengths and weaknesses. Even Silicon Valley, for all its start-up venture success, sees weaknesses in terms of high business operating costs, high labor turnover rates, and difficulty in attracting personnel based on high real estate prices. Iowa, similarly, has weaknesses that should be recognized in formulating strategies and actions to enhance EdTech sector development in the state. Based on interviews, committee input, and other resources accessed during the EdTech project, TEConomy identified the following as areas of weakness for Iowa to be aware of, to work to offset, or to adjust to.

The state has limited access to skilled talent in coding, software engineering, and applications development.

This is far from being unique to Iowa—indeed, in almost every region of the nation, there is considerable concern being expressed over access to personnel with required digital technology skills. IT skills are fundamental to the "digitalization of everything" trend within most sectors of the economy, and EdTech is certainly among the leading sectors requiring access to these skills. Iowa's companies note that they experience significant challenges in finding the skilled talent they need in digital technologies especially talent with prior work experience. Even in terms of talent fresh out of university, Iowa's overall output of students is comparatively small. This is a challenge similarly

shared and noted in the bioscience strategy for Iowa where it is noted that "access to adequate numbers of trained data scientists, programmers and software engineers is likely to be the primary rate limiting factor for the growth of the platform in the state and must be considered a high strategic priority."[5] The same holds true for EdTech as a platform.

The state has limited access to skilled talent in the management of fast-growth start-up EdTech ventures.

Again, this is not a weakness unique to Iowa. It is a challenge for most places. Iowa benefits from having skilled and experienced management in large companies who have considerable knowledge of educational content, education markets, and organizational management. The main area of weakness is in finding personnel who have that experience combined with the development of entrepreneurial start-up ventures. It was also noted by companies that it can be challenging to find sales and business development personnel with experience in educational markets and EdTech.

Iowa has limited airline service.

With a population of circa 3.2 million, Iowa ranks 31st among U.S. states in population. This comparatively small population size inevitably impacts market demand for specific services, and air travel is one of those services. The result is that Iowa's airports do not represent significant hubs for major airlines, and most air travelers need to connect from an Iowa airport to another hub airport outside of the state for onward travel to most domestic and international destinations. For companies trying to develop national business presence, limited air travel options represent an inconvenience (and therefore increased cost of doing business). It is also more challenging for companies to attract out-of-state venture funding, as capital providers generally seek to have ready access to the ventures in which they invest.

Iowa generally lacks an external perception as a leading technology state.

Companies in the EdTech sector noted that Iowa's external image still remains rooted in "rural" and "agricultural." Even though manufacturing is the state's largest macro industry sector, the persistent external image is agricultural, and "technology leadership" is far from being well-recognized as an Iowa industry strength. EdTech companies mentioned this as a challenge as they seek to expand into markets outside of the state. The challenge is mitigated somewhat by smaller companies being able to point to the presence of major market leaders like ACT, Pearson, and McGraw-Hill in Iowa. ACTNext's annual Education Technology and Computational Psychometrics Symposium (ETCPS) is no doubt also helping in terms of bringing a national and international audience to Iowa for conference participation.

The state has limited access to scale-up capital.

Scaling technology companies requires access to capital. As early-stage companies develop and refine their product in their pre-revenue stage, they will need to leverage capital assets to fund operations. Even when products are launched and revenue flows begin, tech companies typically will continue to require significant injections of investment capital to fund marketing operations, build their sales and customer service enterprise, and gain and then retain market share. As was found in the recent assessment of the Iowa Biosciences sector, EdTech companies noted that the challenge in Iowa is less-one of accessing very early-stage capital and more one of gaining access

5 *TEConomy Partners. January 2018. Phase II Report: Strategies and Actions for Iowa Bioscience Development. Crosscutting and Platform Specific Strategies and Actions. Produced for the Iowa Economic Development Authority.*

An Alternative Perspective on Capital Availability

It should be noted that, in performing the Venture Capital Status Report (see separate document for IEDA), TEConomy interviewed multiple VC firms investing in, or familiar with, Iowa ventures. The overall conclusion reached was that Iowa is not lacking in available "A Round" capital for promising qualified ventures—but rather the issue is with earlier-stage seed funding supporting a steady flow of high-quality new ventures that can later scale to seek venture capital. There are evidently quite a few, and an expanding base of, VC firms willing and able to focus in Midwestern business ventures, the gap was felt to be in pre-seed and seed capital required to accelerate the formation and growth of entrepreneurial technology companies in the early stages of their life cycle—prior to them achieving revenue. This is not a challenge unique to Iowa, but the fact that Iowa ranks last among its adjacent states in VC funding suggests that there is a definite problem in Iowa in getting companies to scale to the VC application stage.

to the larger tranches of investment required to scale an enterprise post proof-of-concept. It was noted in recent work for the IEDA that Iowa's performance in attracting venture capital places it at the bottom of performance among surrounding Midwestern states.

EdTech adoption and access for piloting and testing of new EdTech solutions are challenges in Iowa.

Multiple companies noted that they have experienced significant challenges in terms of gaining access to educational environments (particularly K–12 environments) to pilot and test their products in Iowa. Without having successful case-studies of their products in-use, companies have an extremely difficult marketing challenge. Leadership at individual school districts are, understandably, cautious in allowing new products to be piloted with students. This was noted to be less of a problem for products targeted toward the higher education market, where individual faculty have more leeway in terms of the EdTech products they adopt for their classes. Companies also noted that Iowa is generally not on the leading-edge of EdTech product adoption and many teachers have limited exposure or education themselves in the application of EdTech and its benefits to student performance.

K–12 education environments experience long product sales cycles and highly fragmented markets.

The K–12 education market in the United States comprises 98,277 public and 34,576 private schools, for a total of 132,853 schools nationwide.[6] The postsecondary (Title IV) market comprises 7,021 institutions.[7] This large market is fragmented in terms of decision makers and those with the power to make purchasing decisions. Further, the decision to adopt an educational product or service, particularly in K–12 environments, does not typically reside with a single individual, but is the result of a process requiring multiple review and decision-making steps. This has the effect of greatly complicating the marketing and sales of EdTech products and generating rather lengthy sales processes. Educational curricula and standards also vary from state-to-state, and school district to school district—making one-size-fits-all solutions difficult. The adoption of national standards, such as the NGSS, may be helpful in somewhat mitigating this challenge.

6 *National Center for Educational Statistics. 2015–2016 data. Accessed at: https://nces.ed.gov/fastfacts/display.asp?id=84.*
7 *Ibid.*

Most education markets have tight budgets.

It is not uncommon to read news reports of teachers having to pay for books or supplies themselves, teachers being underpaid, or school districts having budget crises. When schools have highly constrained funds, the ability to purchase new educational technologies (even if they are proven to have significant beneficial outcomes for students' performance) is very much limited. Budget constraints are not only impacting K–12 schools, but are also impacting the postsecondary market where declining enrollments and high operational costs are creating campus budget concerns across the nation.

Iowa does not have an organized EdTech cluster development organization or forum.

A consistent comment received from participants in TEConomy interviews and group meetings was that, despite there being clusters of expertise in EdTech in terms of academe and industry in Iowa, there is not a "connective-tissue" organization that regularly brings practitioners in EdTech together to exchange ideas and to drive the cluster forward in a collaborative way. Best practice in cluster-based economic development is to facilitate regular and diverse interactions between key stakeholders to identify joint opportunities and any gaps in the cluster ecosystem that should be addressed. Development of such a collaborative organization is likely to be successful in Iowa because TEConomy did find multiple instances of companies collaborating one-to-one with each other and some having university relationships. A willingness to work-together was expressed in interviews and apparent in the reality of collaborations already happening on the ground in Iowa.

Access to technology is inequitable.

Nationally, education is not a level playing field. There are well-funded school districts and significantly underfunded districts. There are postsecondary institutions with endowments running into hundreds of millions (and, in some cases, billions) of dollars, and some colleges closing their doors. The result is geographic inequalities in the ability of schools to access and deploy modern EdTech solutions. Many schools (especially in rural/small-town areas) lack basic broadband infrastructure or are unable to fund IT infrastructure needed to deploy certain EdTech solutions. Some schools can provide good access to computers and tablet devices for their students, others cannot afford textbooks. The result is a highly variable landscape for EdTech adoption across the United States, together with a very real "have" and "have not" divide in terms of the ability of schools to access proven EdTech solutions. It should be noted that Iowa displays more equity from school district to school district across the state and has been paying attention to digital EdTech readiness and resources, from the Iowa Department of Education down to individual school districts. The market is, however, national (and international) and where equity challenges are very much evident.

C. Opportunities

Despite some of the challenges identified above, leading market research firms predict very robust growth rates for EdTech in the future (see Chapter V). Iowa has a meaningful footprint in the sector and an opportunity for further growth and development of EdTech as a TBED engine for the state. Multiple opportunities for positively impacting the development of the sector in Iowa were identified over the course of the project.

Iowa could be leveraging a fast-growth market.

Markets of relevance to EdTech present substantial growth opportunities. BCC Research, a preferred provider of market research data to TEConomy, anticipates a compound annual growth rate (CAGR) for 2017–2022 in digital education content of 8.86 percent, in assessment a CAGR of 17.6 percent, and in educational applications of VR/AR a CAGR of 77.8 percent. Further details of market projections are provided in Chapter V. These are exceptionally strong CAGRs overall.

Iowa could become the hub for personalized/adaptive learning systems, with assessment at the core.

Having ACT, Pearson, College Board, and Iowa Testing Programs each with presence in the state, in combination with the University of Iowa's robust academic expertise related to psychometrics and assessment, positions the state well to advance a convergence opportunity between content and assessment (and visualization technologies) in Adaptive Learning Systems (ALS)—an emerging sector anticipated to experience substantial growth (discussed further in Chapter V). In many respects, the fast-growing Iowa company, Higher Learning Technologies (HLT), is an example of an ALS company, providing content and testing within a single suite of apps. ACT has formed ACTNext as an in-house "skunk works" with a definite focus in ALS and associated advanced EdTech platforms. Several large and small Iowa companies have formed collaborations in new product development for this burgeoning market, and larger Iowa educational sector companies have been early investors in innovative Iowa-based EdTech ventures with ALS focus. There is an opportunity not only for developing new start-up enterprises in ALS based on Iowa assessment expertise, but also for repositioning existing Iowa companies for growth through integrating assessment into their EdTech solutions, and for potentially attracting business to the state to be able to connect to the world-class assessment expertise base.

Iowa companies are building connectivity across the EdTech spectrum.

Some business sectors are very "closed-off" and uncollaborative, but this does not appear to be the case in EdTech, at least not in Iowa. In Iowa, EdTech companies both large and small express a willingness to pursue collaborations and partnerships (and there is an emerging track record in doing so). Given the convergence opportunity in ALS (noted above), a collaborative environment in Iowa will position the state well for advancement in a fast-growth EdTech sector. It was clear that the companies interviewed in Iowa see benefits in joining forces, investing in one another, and collaborating to gain access to expertise and business synergies. What is needed is an organized approach to facilitating the connections between entities to facilitate realization of synergistic opportunities and address shared challenges.

The increasing experience base among EdTech entrepreneurs could be leveraged.

There is a small, but growing, base of entrepreneurial EdTech companies in Iowa that have successfully navigated the start-up phase, raised capital, and introduced products and services into

education markets. There is thus a small base of people with direct experience in successful EdTech entrepreneurship, and they represent an extremely valuable resource for mentoring and advice of other start-ups and for provision of advice to those in economic development concerned with improving the TBED/EdTech start-up ecosystem.

The state could be leveraging its large companies to help Iowa entrepreneurial ventures to scale.

Iowa benefits from having major companies and market leaders operating in educational markets. Companies such as ACT and McGraw-Hill have national and international reach, large-scale business networks, and world-class reputations that can be leveraged by smaller companies working collaboratively. Furthermore, these large companies recognize the changing dynamics of the education marketplace and the changes to the market likely to occur through EdTech adoption. The companies recognize that, though they may be large, they do not necessarily have all of the in-house expertise or flexibility necessary to address all EdTech market opportunities and threats—and thus are willing to collaborate with and invest in new EdTech start-up ventures. With a demonstrated willingness to collaborate, Iowa's large educational-sector companies represent a rich resource of expertise, market access, and capital resources. What is needed is an organized program in the state to raise the awareness of each organization with one-another in terms of capabilities and interests, not only in business sectors but also between business and academic research environments, and within Iowa's education provider base.

The state could be leveraging learning from the Iowa Central Rivers Area Education Agency study that has recently examined technology use in instruction and has also examined teacher perceptions of their school supports and technology readiness.

This report provides an excellent overview of Iowa-centric learning in this space. In terms of topline results, the study found the following:[8]

- 44–51 percent of teachers asked students to use technology for collaboration and critical thinking, while 22–27 percent asked students to use technology for communication and creativity.
- Math teachers were among the least likely to ask students to use technology for collaboration, communication, and creativity.
- 78 percent of teachers agreed that technology enhances student learning and that they have the ability to integrate technology with instruction.
- 93 percent of teachers reported having access to computers for student use, and 64 percent reported that technical support is above average or excellent.
- 36 percent of teachers rated the quality of technology-focused professional development as above average or excellent.

It can be seen from the results of this report that there is opportunity to enhance the use and penetration of EdTech within Iowa and to increase the amount and quality of technology-focused professional development.

8 *Jonathan Margolin, Jingtong Pan, and Rui Yang. June 2019. Technology use in instruction and teacher perceptions of school support for technology use in Iowa high schools. REL Midwest (Regional Educational Laboratory at American Institutes for Research) and the National Center for Educational Evaluation and Regional Assistance.*

ACTNext is a significant asset for Iowa.

While TEConomy does not usually single out an individual company as a basis for cluster opportunity, ACT is a special case. ACT has recognized the forces of change impacting its traditional assessment business and has made a significant investment of resources in forming ACTNext as an in-house "skunk works" for examining opportunities in EdTech and the integration of ACT core expertise in assessment into EdTech markets. Having a market leading commercial company stand up a think tank to investigate and understand potential education futures and start the development process of advanced technology solutions to meet future market needs is a significant asset for Iowa. Furthermore, the management of ACTNext appears to be unusually open in terms of wanting to engage with outside entities in considering educational futures and associated opportunities and has even extended a preliminary invitation to the Iowa EdTech cluster to leverage its well-attended annual conference to help market the state and its EdTech sector.

Iowa has a well-rounded base of EdTech companies upon which to build.

Rather than being one-dimensional, Iowa has an interesting mix of companies to build from in content (especially STEM content), assessment, applications and interactive media development, artificial intelligence (AI), and visualization technology. While these multiple capability areas are certainly not equal in terms of their current business size, they each contain active R&D assets and are producing new venture developments. Having this diversity of companies and associated research programs across key areas of EdTech helps position Iowa well for realizing potential EdTech convergence opportunities (see Chapter V).

Iowa could be coordinating efforts to develop a "quantified" school system.

Data—rigorously collected and methodologically sound—are a key need in improving education and educational outcomes. EdTech, as an inherently digital technology, both uses and generates data. As such, both the development of EdTech solutions, and the evaluation of the success of EdTech in enhancing educational outcomes, will require collection, analysis, and access to data. Iowa could, potentially, become a go-to location of EdTech cluster development if it solves the challenge for researchers and for companies of data collection and data access. It is hard to say what this would look like, and it would take specific study to determine a preferred structure for a "quantified" school or school district—but, it is likely that the first place to do so will become a magnet for EdTech activity. It is likely that a trusted third party, such as one of Iowa's universities, would be needed to help design and structure a quantified school system to realize this opportunity. Having a school district of the future suitable to the testing, piloting, and new model development and evaluation would have significant market value. Doing the same at higher education and career/tech education levels would also be a logical progression.

It should be noted that the Iowa Department of Education has been rolling out a statewide multitiered system of support for school district digital readiness. The state has contracted with Panorama (of Boston, MA) to coordinate the roll-out of the statewide digital platform. As districts across the state adopt and load data into the platform, it will become a valuable data resource.

D. Threats

All business sectors face threats—both foreseeable and unforeseeable. Threats from disruptive technologies, changing consumer market preferences, changes in the regulatory environment, or trade disputes, for example, can impact markets substantially. In performing the evaluation of the EdTech sector for Iowa, several potential threats were identified.

Demand for standardized testing is declining.

In Iowa itself, K–12 schools are highly active in the use of standardized testing, but, on a national level, this trend is showing some reversal. Iowa companies have already felt the impact of this threat becoming reality. ACT and Pearson have made cuts to their workforce in Iowa as a result of reductions in demand for standardized testing. The decline in market size in traditional standardized testing is being driven along two pathways—one being a reduction in the number of high school students nationally (those typically taking standardized tests) and the second being a small, but expanding, number of higher education institutions choosing to no longer require standardized test scores for their applicants. It should be noted, however, that a decline in traditional standardized tests may be more than offset by growth in the integration of assessment into ALS EdTech applications.

In a heavily digital business sector such as EdTech, outsourcing may be frequently deployed.

The demand for digital talent in the United States has been outstripping supply. High talent demands have also increased the cost of labor in digital skills across the nation. In response to this labor challenge, companies have increasingly chosen to outsource some of their product and applications development work, with the tendency being toward overseas outsourcing. It cannot, therefore, be assumed that the growth in EdTech companies in Iowa would result in all jobs being created in Iowa. Indeed, existing Iowa companies could theoretically continue to grow their businesses in terms of revenues, but do so using primarily external labor in digital areas.

Competition for talent may cause in-state "cannibalization" of skilled personnel.

Competition for talent is a sign of a healthy and growing economy, but it can place serious restrictions on the growth of individual sectors and businesses within that economy. As noted above, digital skills (especially in software engineering, coding, and applications development) are in very high demand, and most companies are experiencing quite substantial challenges in recruiting the talent they need in these areas. Many digital skills are portable across sectors, so EdTech companies are not only competing against EdTech companies for personnel with these skills, they are also competing against many other sectors in the state (in financial services, precision agricultural technology, advanced manufacturing, etc.). The net result in a tight labor market can be an in-state battle between companies to poach talent from one another. Iowa will need to provide solutions to this challenge through education, workforce development, and workforce attraction pathways.

While content has been valuable, it is becoming increasingly commoditized and harder to monetize.

Companies in the content space note that margins are being squeezed and traditional models of business disrupted by an emerging trend toward Open Educational Resources (OER). OER comprises openly licensed documents and media (content) that is useful for teaching, learning, and assessment. There is a large and rapidly expanding online "library" of courses, textbooks,

educational resources, illustrations, reading lists, and annotated bibliographies that are now freely accessible by anyone and available through hundreds of different online repositories. As these open resources become more and more populated and curated, they rise as viable competition to traditional paid-for content from established content companies. In this environment, companies note that it will become increasingly difficult to monetize content alone—rather, it will need to be packaged within more holistic educational solutions (such as ALS).

Iowa is not alone in paying attention to EdTech as an existing and potentially fast-growth tech cluster.

Input received, from EdTech companies and experts consulted over the course of this project, suggests that there is no single location that has emerged as the leading location for EdTech. As a sector with large-scale digital elements, Silicon Valley is certainly a hotbed in the sector, but the growth there is organic and not particularly organized (it does not have to be). Outside of Silicon Valley, there are locations, as highlighted in this report, that demonstrate clustering of VC investment in EdTech, and some of these locations are trying to develop this as a formal growth cluster. The market size is large and attractive, and Iowa cannot assume that it will be alone in trying to realize EdTech growth.

The large number of EdTech products causes market confusion.

The EdSurge Product Index, a community-driven database of EdTech products, currently lists 2,550 EdTech products,[9] and it is likely an incomplete list. In its "curriculum products" category alone, EdSurge lists 646 products. Educators are already, therefore, faced with a large variety of EdTech products to consider, and persons interviewed noted that there is considerable confusion in the marketplace as to which are the best products in each application or educational setting. The threat in this market environment is that companies launching new products can get lost in the noise, even when they have a groundbreaking product. It becomes expensive to market, cut through the noise, and gain market traction.

Capital access issues might cause companies to relocate.

As noted in the Weaknesses section of this report, concern was expressed regarding access to venture capital and other capital resources in Iowa, or from Midwest-based VC firms, required for major company growth. If companies instead must seek capital in major VC hotspots on the coasts, the risk increases for companies being asked to relocate to be proximate to their major investment capital providers.

Potential growth in EdTech may be restrained by inequality concerns.

Many schools, teachers, and students in this country face subpar access to technology and internet bandwidth. In rural areas, access to broadband limits the use of many online resources and applications, while resource-poor schools may lack technology and lower-income student families lack the funds necessary to purchase laptops or tablets for their children's use. A situation may exist where a well-resourced school district can have a makerspace with robots, 3-D printers, and tablets for student use, whereas an adjacent inner-city or rural district may not even have a basic computer lab. A conclusion has not yet been reached as to whether EdTech will be a solution to, or an exacerbator, of this digital divide.

9 *https://www.edsurge.com/product-reviews.*

IV. COMPETITIVE POSITIONING AND BENCHMARKING

Four regions were selected for regional benchmarking by members of the EdTech Workgroup to provide competitive insights on other EdTech hubs and their respective organizations and initiatives. The regions were known by EdTech Workgroup members to be dynamic hubs for EdTech activity, but also regions that were not so incredibly outsized, such as Silicon Valley or New York City, to be useful comparisons for Iowa. The comparison regions selected include the following:

- Pittsburgh, PA
- Madison, WI
- Chicago, IL
- Denver, CO.

While, as with Iowa, EdTech industry data and activities are challenging to identify and to isolate, the benchmarking analysis presented in this section includes the following:

- Current data and recent trends related to academic R&D expenditures in the key fields of education and computer and information sciences;
- Current data and recent trends for EdTech-related VC and angel investment activity in each region; and
- A qualitative inventory of EdTech-related activities based on a scan of key organizations, policies, programs, and initiatives most relevant to EdTech in each region.

A. EdTech Ecosystem Overview: Summary Comparisons

A thriving ecosystem for EdTech industry development requires innovation, talent, and access to capital. The situation for the first two of these components is related here via university-related R&D expenditures in the most relevant fields of education and computer/information sciences. University strengths in these fields signal not only a concentration of activity that might lead to new EdTech solutions and commercial opportunities, but also as a proxy for talent development in these key fields.

In university R&D related to education, Iowa stands out among the comparison regions as one of the most highly concentrated and the fastest growing (Table 5 and Figure 7). Iowa's research institutions have combined to grow the R&D base in the discipline from nearly $6.7 million in 2010 to $17.4 million in 2017. The University of Iowa, as established in Chapter II, accounts for the majority of this current total ($10.6 million) with ISU also contributing a sizable figure ($6.0 million).

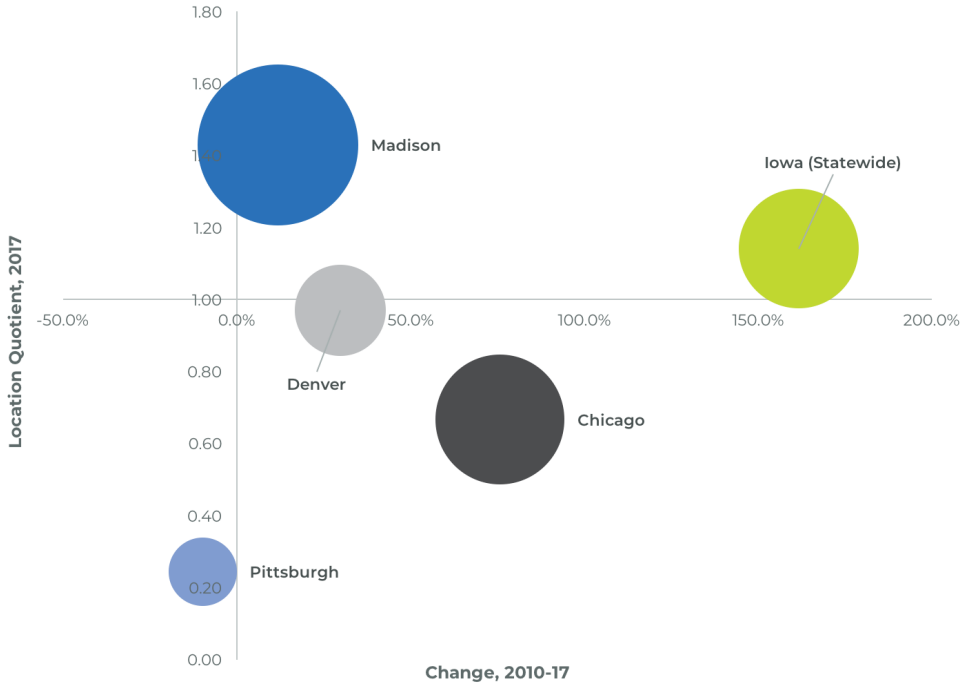
The bubble chart presented in Figure 7 shows the strong position of Iowa relative to the comparison regions with a rapidly growing R&D base and strong relative concentration (location quotient or LQ) upon which to continue to build. Madison, home to the University of Wisconsin's main campus, is also highly concentrated in education research with an R&D base reaching $31.3 million in 2017 and a specialized concentration 43 percent greater than the national average (LQ of 1.43). Chicago's sizable research base is driven by R&D activity at two institutions—Northwestern ($10.1 million) and University of Illinois, Chicago (UIC) ($8.7 million).

Table 5: University R&D Expenditures in Education for Iowa and Comparison Regions, 2017

Region/State	2017 ($ Thousands)	% Change, 2010-17	2017 R&D LQ
Chicago	$20,287	75.6%	0.67
Denver	$10,012	29.7%	0.97
Iowa (Statewide)	**$17,404**	**161.7%**	**1.14**
Madison	$31,325	11.8%	1.43
Pittsburgh	$5,658	-9.8%	0.24
U.S.	**$1,380,221**	**38.9%**	**1.00**

Source: TEConomy's analysis of NSF, Higher Education R&D Survey data.

Figure 7: University R&D Expenditures in Education: Level, Concentration (LQ), and Recent Trend



Source: TEConomy's analysis of NSF, Higher Education R&D Survey data.

Iowa has grown its academic R&D expenditure base in computer and information sciences by nearly 15 percent since 2010 to reach $10.5 million in 2017 (Table 6 and Figure 8). While this growth is a bright spot, it is based on a relatively modest base of overall activity, and the state remains well behind most of the comparison set in computer science R&D. Pittsburgh is home to world-leading Carnegie Mellon University (CMU) where, in this discipline, the university spent $136.9 million in research in 2017 alone. Combined with the University of Pittsburgh ($9 million), the region is a major powerhouse in computer science R&D with an extremely high concentration (LQ of 3.95). Even with its very large base of activity, Pittsburgh continues to grow at an impressive rate. Chicago, at $47.5 million in activity in 2017, gets sizable R&D contributions from the University of Chicago ($25.0 million) and UIC ($12.7 million).

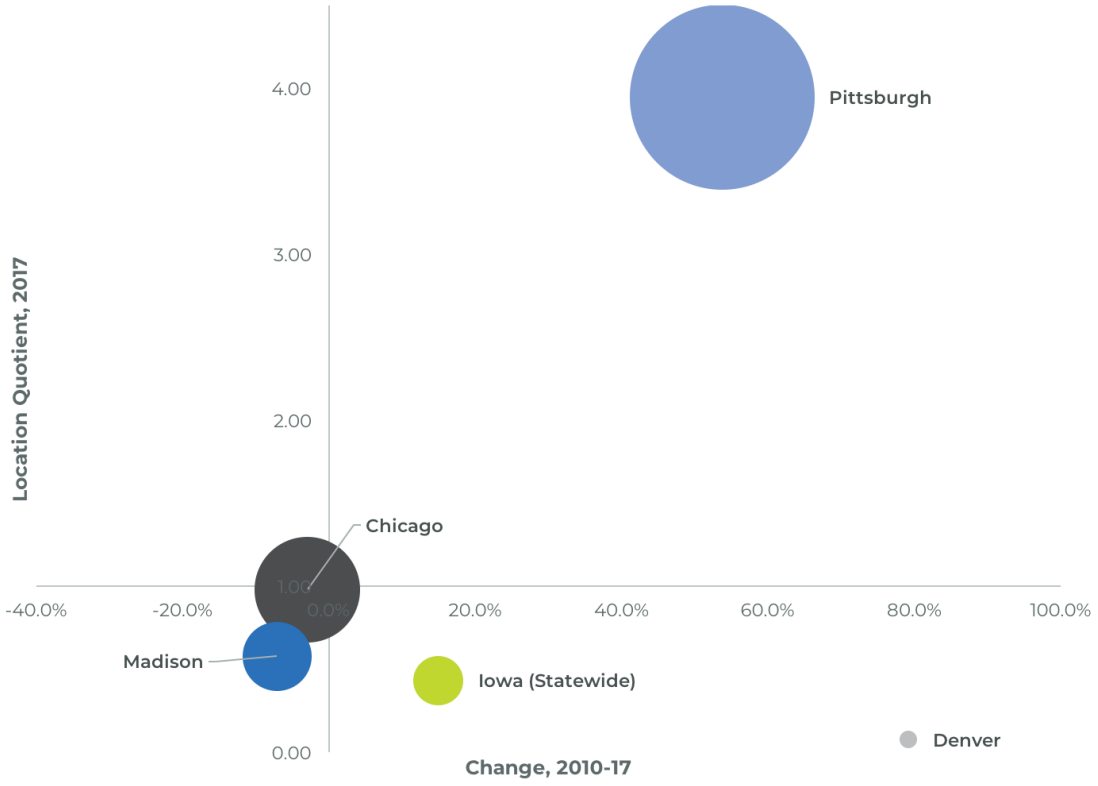
While not all of this academic research is focused in educational technology, these fields represent the capabilities and potential sources for new innovation and commercialization in EdTech.

Table 6: University R&D Expenditures in Computer and Information Sciences for Iowa and Comparison Regions, 2017

Region/State	2017 ($ Thousands)	% Change, 2010-17	2017 R&D LQ
Chicago	$47,497	-2.9%	0.98
Denver	$1,285	79.2%	0.08
Iowa (Statewide)	**$10,505**	**14.9%**	**0.43**
Madison	$20,155	-7.1%	0.58
Pittsburgh	$145,960	53.7%	3.95
U.S.	**$2,191,762**	**33.8%**	**1.00**

Source: TEConomy's analysis of NSF, Higher Education R&D Survey data.

Figure 8: University R&D Expenditures in Computer and Information Sciences: Level, Concentration (LQ), and Recent Trend

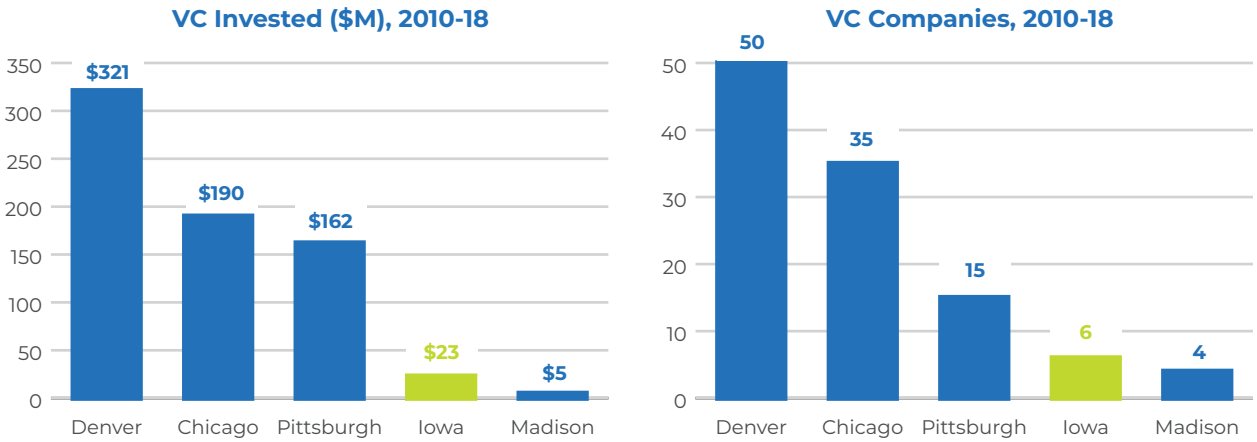


Source: TEConomy's analysis of NSF, Higher Education R&D Survey data.

In EdTech-related VC and angel investments, Iowa has lagged the majority of the other regions. The nearly $23 million invested across six Iowa companies is well behind the totals for three of the four comparison regions. Denver has seen the largest investments among the comparison set with $321

million invested since 2010 across 35 EdTech companies (Figure 9). The comparisons reveal the need for Iowa to continue to focus on how better to attract private equity investments in the industry.

Figure 9: VC and Angel Investments in EdTech-Related Companies, 2010–2018 ($ in Millions)



Source: TEConomy's analysis of PitchBook Database.

The following profiles summarize the qualitative information and inventory of EdTech-related organizations, initiatives, events, etc., compiled for each of the four comparison regions. EdTech-related activities, organizations, and initiatives take on many flavors in these communities and vary considerably in their depth and context.

B. Pittsburgh, PA: A Top University and Private Organizations Lead in Collaborative Approaches to EdTech

Pittsburgh stands out for its leadership in EdTech, not only with respect to notable start-ups generated in the city, but also with respect to educational and technological leadership at CMU. The city and broader region are characterized by a collaborative spirit in the EdTech space, led by the efforts of both private entities such as the Remake Learning Network and the Sprout Fund, but also CMU and its partnerships with local school districts.

Private Organizations, Initiatives & Events Identified Related to EdTech

Remake Learning is a network of more than 500 schools, libraries, museums, nonprofits, private companies, and others extending across the Greater Pittsburgh region that recognizes youth in today's digital age are pursuing knowledge and support differently; and it is working to re-think modern teaching and learning. The network, established in 2007, has brought together thousands of children and hundreds of practitioners across dozens of projects. The following examples include initiatives which leverage EdTech:

"Pittsburgh has this incredible collaborative environment. There are a lot of education technology companies, like Duolingo. But it's so much a larger conversation than that."

– Sunanna Chand, Director of Remake Learning.

Frank Catalano. "What makes Pittsburgh different as an edtech hub? Collaboration — and Mister Rogers." GeekWire. January 30, 2018.

- CSforPGH: ensuring equitable access to high-quality computer science education and digital literacy as an economic development imperative.
- Maker Learning Collaborative: advancing a hub for the "maker movement"; Pittsburgh has become a national hub.
- Organizational Impacts: Remake Learning Network members have established more than 170 makerspaces including more than 100 in public schools, have formed the Pittsburgh Regional STEM Ecosystem, and are operating 7 mobile "fab labs" that move across the region. Also, more than 900 educators have participated in professional development "innovation intensives" since 2013.[10]

EdTech PGH is a local meetup group that connects individuals working at the intersection of education and technology.

The Sprout Fund's Ed-Tech Refinery (2001–2018) has supported partnerships between emerging EdTech entrepreneurs and educators at schools, libraries, and museums in the Pittsburgh region.

Pennsylvania Association for Educational Communications and Technology is a statewide, nonprofit, volunteer-led organization supporting and speaking for EdTech in the Commonwealth of Pennsylvania.

10 *Impacts reported by Remake Learning Network in Learning Together: A Decade of Collaboration and Innovation Across Greater Pittsburgh and West Virginia, available at: https://remakelearning.org/wp-content/uploads/2017/10/Learning-Together_digital.pdf.*

The Pennsylvania Educational Technology Expo and Conference is a statewide event that provides programs focused on technology in the educational field. Each year, hundreds of exhibitors showcase their latest technology products and services to a large audience of teachers, administrators, technology directors, school board members, and others.

University Excellence in EdTech: Carnegie Mellon University

Carnegie Mellon University is a global leader in numerous disciplines that meet at the unique intersections and competencies crucial to EdTech, including in computer science research, learning science, artificial intelligence, EdTech talent development and commercialization. CMU has several academic programs, assets, and initiatives directly related to EdTech, including the following:

- **CMU's Master of Educational Technology and Applied Learning Science (METALS) Program**—This one-year interdisciplinary master's program is jointly taught by leading researchers in learning analytics, curriculum design and educational data mining in the Human-Computer Interaction Institute and the Psychology Department. The program culminates with a seven-month, team-based capstone project for an external client. Students emerge as EdTech designers, developers, consultants, entrepreneurs, policy makers, or evaluators.
- **LearnLab**—Working directly with local school districts in Greater Pittsburgh, LearnLab strives to learn more about technology-enhanced education.
- **Entertainment Technology Center's Educational Technology Community**—The network focuses on exploring and developing experimental educational initiatives in Western Pennsylvania, West Virginia, and Eastern Ohio through collaboration.... The ETC extends education beyond the university's halls into classrooms, after-school environments, museums, libraries, and nonprofit entities through offering community building events, engaging projects, and professional development.[11]
- **CMU Educational Technology Club**
- **University ties to highly successful EdTech start-ups**, including Duolingo and Carnegie Learning.

CMU, Remake Learning Network, and the region more broadly have placed a major emphasis on "collaboration" across a series of EdTech and innovative education initiatives. A primary emphasis on partnerships between researchers and local K–12 schools, for example, among Digital Promise's League of Innovative Schools, include the following:

- South Fayette School District partnered with Carnegie Mellon to pioneer the development and pilot testing of the nation's first coherent **K–12 curriculum on computational thinking**.
- Montour School District and Carnegie Mellon created a research consortium with three other area districts called the LearnLab which brings together K–12 teachers and university researchers for research collaborations, **introducing evidence-based education technologies into the classroom.**
- Montour's first-grade teachers are also working with a team of researchers from St. Vincent College's Fred Rogers Center for Early Learning and Children's Media to s**tudy interactions between teachers and students through the use of technology.** [12]

11 https://www.etc.cmu.edu/edtech/.
12 https://www.edsurge.com/news/2018-02-07-what-every-city-can-learn-from-pittsburgh-s-pioneering-k-12-research-partnerships.

C. Madison, WI (and Wisconsin Statewide): State Leadership in EdTech with a Rural Emphasis

At a statewide level, Wisconsin has put in place formal structures for vetting and distributing digital coursework in both fully online and "blended" learning (mix of online and classroom instruction). The state has placed a particular emphasis on ensuring that rural districts, which make up a majority of the state, have access to high-quality digital learning. The state has funded EdTech in its schools and libraries through a specific set of grant programs for more than 20 years. Madison and Wisconsin Dells host annual EdTech-related conferences.

State Policy and Programmatic Focus on EdTech

The Technology for Educational Achievement (TEACH) Wisconsin Program was created in 1997 and administered by the Wisconsin Department of Administration, Division of Enterprise Technology, to administer EdTech-related grants to schools, libraries, and other educational institutions. The program includes the following:

- Technology Training Grants: providing training support for teachers and librarians prioritizing rural districts to build EdTech-related IT knowledge and capacity. $1.5 million is available annually for the grants. Since 2016, 587 grants have been awarded to rural schools totaling nearly $4.5 million.
- Curriculum Grants: $25,000 awarded each fiscal year (FY) to a consortium of districts to develop and implement technology-enhanced high school curriculum. Winners must provide 100 percent matching funds.
- IT Infrastructure Grants: provide technology infrastructure to improve the capacity of rural districts, libraries. $7.5 million available for FY 2016, 2017, and 2019; $15 million for FY 2018.
- Telecommunications Access Program: provides access to data lines and video links.

Wisconsin Department of Public Instruction's Digital Learning and Technology Team provides information and support to administrators, educators, and others to support digital learning. The department has introduced tools for districts to develop Digital Learning Action Plans built around Wisconsin's Digital Learning Plan assessing the "Future Readiness" of students annually with respect to EdTech.

Organizations, Initiatives, and Events

The Wisconsin Digital Learning Collaborative (WDLC) was established by legislation to be the "statewide web academy" to provide equitable access to high-quality online learning via two collaborating organizations:

- The Wisconsin Virtual School; and
- The Wisconsin eSchool Network.

The WDLC and its partners vet digital courses and content for quality and allow students flexibility in accessing online and blended learning for credit. A majority of state districts are in rural areas, and an emphasis is placed on leveraging EdTech for equitable access across the state.

Wisconsin Education Technology Leaders (WETL) is the state's chapter of the national Consortium for School Networking (CoSN), which provides training, advocacy, professional development for teachers, chief technology officers, etc. Clinics are held annually on key topics (e.g., this year is focused on cybersecurity).

Wisconsin Educational Media & Technology Association (WEMTA) provides awards and grants to librarians/educators and administrators who excel in EdTech use.

Madison and other Wisconsin cities host annual EdTech-related conferences and events, including the following:

- **Distance Teaching & Learning Conference** hosted annually by UW-Madison for 35 years; the professional development experience emphasizes "evidence-based practice, educational innovation, and practical applications of theories and research findings in the field of distance education and online learning."[13] The conference is attended by more than 700 college faculty, teachers, thought leaders, administrators, instructional designers, tech support staff, corporate trainers, and military educators.
- **School Leaders Advancing Technology in Education (SLATE)** hosts its annual convention in Wisconsin Dells.
- **BrainStorm Conferences** gather educational technologists from around the country to connect, inform, and inspire. One conference is in Wisconsin Dells this year.

13 https://dtlconference.wisc.edu/why-attend/.

D. Chicago, IL: Home to an EdTech-Related VC Fund and a Leading Nonprofit Advancing Personalized Learning

Chicago was formerly home to a specific EdTech incubator and accelerator, which are now defunct; but, its digital start-up incubator/accelerator 1871 houses EdTech companies and a nonprofit collaborating with schools, school districts, and EdTech companies to advance personalized learning. The city is also home to EVC Ventures, a $50 million VC fund focused in EdTech-related investments; and EdTech investment specialists GSV Advisors also has major operations in Chicago.

State Policy and Programmatic Focus on EdTech

The Learning Technology Center (LTC) is an Illinois State Board of Education program that supports all public K–12 districts, schools, and educators with activities in the following areas:

- Digital Teaching, Learning, and Leadership (personalized learning, webinars, summits, EdTech initiatives)
- Network and Technology Infrastructure
- Data Security and Safety
- Access and Equity.

The School Technology Revolving Loan Program is a three-year, low-interest loan (2 percent interest rate) for school districts to acquire technology. Since the inception of the program in FY 1999, more than $87 million has been loaned to qualified or approved school districts in Illinois.

Organizations, Initiatives, and Events

EdTech Chicago Meetup Group holds regular meetings and acts as a hub for keynotes, panel discussions, and hands-on learning experiences that inspire teachers, entrepreneurs, technologists, education reformers, and EdTech enthusiasts to connect, collaborate, and innovate.

LEAP Innovations, a nonprofit organization located at 1871 (Chicago's digital start-up incubator/accelerator/coworking space) is collaborating with schools, districts, EdTech companies, and thought leaders to make personalized learning a reality in every classroom by bridging the gap between education and innovation. LEAP recently received a major grant ($14 million with Chicago Public Schools) from the Chan Zuckerberg Initiative to support personalized learning programs. The organization's activities include the following:

- Curating EdTech products/technologies for schools with rigorous annual evaluations
- The Leap Pilot Network, an 18-month program to implement, including working to refine use of EdTech products
- Whole-School Redesign
- Teacher Professional Development.

EVC Ventures is a $50 million Chicago-based VC fund with a strong focus in EdTech, particularly for higher education. For example, EVC has funded companies helping campuses to digitize and those engaged in cyber solutions for colleges and universities.

Chicago was home to EdTech-specific incubators and accelerators in partnership with 1871, and while 1871 continues to house EdTech companies, the following incubator and accelerator now appear to be defunct:

- DeVry EdTech Incubator at 1871 (DV X Labs)
- Pearson Catalyst for Education.

E. Denver, CO: A Region Seeing Sizable VC Investments, but with Little Formalized EdTech Structure

While the city and broader region have seen strong venture funding for EdTech-related companies, TEConomy's scan revealed little formal cluster-centric or industry-specific cohesion. The city has hosted several EdTech conferences and events in recent years, though it is not apparent whether these have taken place due to the strength of the EdTech industry or thought-leadership, or because Denver is well suited for hosting large events.

Organizations, Initiatives, and Events

EdTech Meetup Denver/Colorado is a means for outreach and notification on local EdTech-related events including investing, "Founders Panels," speakers, happy hours, etc.

Colorado Association of Leaders in Educational Technology is a group of school executives from across the state focused on professional development, influencing decision-making on EdTech, sharing knowledge, networking, and other related activities.

Denver has hosted several EdTech conferences and events, in recent years (or upcoming). These have included the following:

- InnEdCO, which organizes a statewide conference helping teachers integrate technological tools with 21st Century skills, including technology and information literacy standards, into all content areas.
- Online Learning Consortium (OLC) held its "OLC Innovate 2019" in Denver in April.
- EDUCAUSE, focused on higher education IT, held its 2018 Conference in the city.
- International Society for Technology in Education (ISTE) 2016 Conference was held in the city.

V. IOWA EDTECH

RECOMMENDED PLATFORMS AND MARKET OPPORTUNITY

A. The Concept of Development Platforms

While Iowa demonstrates a variety of research core competencies (as discussed in Chapter II), it should be noted that not all research core competencies are created equal in terms of their overall scale, their associated commercialization potential, or their line-of-sight to large markets. Several factors need to be taken into account when moving from core competencies to consideration of actual development platforms (core programmatic themes with the potential to generate innovations, relationships, or clusters of R&D activity that may generate significant growth within the Iowa economy).

Ideally, a PLATFORM for science- and technology-based economic development should meet several key threshold criteria:

- Be built on a cluster of competencies with a significant base of R&D and established clusters of scientists, faculty, or centers upon which to build.
- Contain a clustering of existing businesses and institutions with interests in similar R&D areas, products, or technologies.
- Represent a platform around which public/private partnerships may be developed to promote shared interests and encourage the development of a favorable operating environment for platform growth.
- Be associated with a significant potential market with strong growth prospects and an achievable line-of-sight for bringing new products and technologies to serve market demands.

B. Iowa's EdTech Platforms

The assessment of Iowa core competencies and assets in EdTech clearly show expertise to be centered in EdTech applications (primarily software based) as opposed to EdTech hardware. Iowa's EdTech industry predominantly groups into three main clusters of activity:

- **Assessment**—This platform includes providers of educational testing solutions for K–12, higher education, and continuing education/workforce training applications. A well-established and long-standing area of expertise and business development for the state, it comprises university-based and industry R&D through to leading high-profile companies

in the assessment industry (including ACT, Pearson, College Board, and Iowa Testing Programs). While paper testing in examination settings is still a component of this sector, it is increasingly a platform driven by advanced software applications. This is a platform in which there is considerable know-how and research expertise in Iowa ranging from the basic science underpinnings of psychometrics and evaluation, through to advanced development of integrated learning and assessment systems enabled by advanced digital technologies. This is the largest of the three existing EdTech platforms identified for Iowa in terms of employment.

- **Content**—Iowa's position in content is rooted in a historical presence of an academic publishing industry in Iowa, particularly in the Dubuque area. Kendall Hunt and McGraw-Hill Education have large-scale Iowa operations in the production and distribution of textbooks, courseware, and other educational content—content that is increasingly delivered over electronic platforms (in addition to traditional print). Pearson is also engaged in content development and distribution, as are multiple smaller business ventures focused in delivering specific content and filling niche needs for digital educational content delivery in the market. Iowa's expertise in content is particularly robust, from both a research and industry perspective in STEM content. This is the second largest of the three existing EdTech platforms identified for Iowa in terms of employment.

- **Content Visualization and VR Systems**—The digitalization of content is enabling educational materials to be viewed in ways that enhance understanding and the educational experience. Using VR and other advanced visualization technologies, students can manipulate and understand 3-D illustrations and fly-through models of biological structures, anatomy, chemical compounds, engineering designs, and a host of other content. Students can take virtual field trips, perform virtual dissections, and build and experiment with structures and components in a safe, nondestructive environment. Currently, this is a relatively small cluster in terms of employment in Iowa; but, deep academic R&D expertise, in combination with a small but growing entrepreneurial business base, illustrate that Iowa is capable of emerging as a notable hub for the development of visualization applications in education, especially in the area of STEM education.

Convergence

The phenomenon of technology convergence is not new. Many products contain multiple components that have had unique development pathways prior to converging into a novel product (for example, the global positioning system (GPS), mobile telephony, camera, and Internet browser converging into a smart phone). What is perhaps more of a current phenomenon is convergence that is of a larger scale in terms of distinct industry sectors, which originally operated largely independent of one another, starting to merge together. In this new convergence paradigm, technologies and companies from one sector converge with those from another (or several others) to provide a combined solution to market needs and opportunities. Convergence is largely being driven by the "digitalization of everything" whereby advanced and emerging disruptive cyber/digital technologies (AI, Internet of Things [IoT], VR/AR, big data, cloud computing, etc.) make possible the automation of processes, the analysis and management of highly complex systems and decisions, and greater customization of solutions.

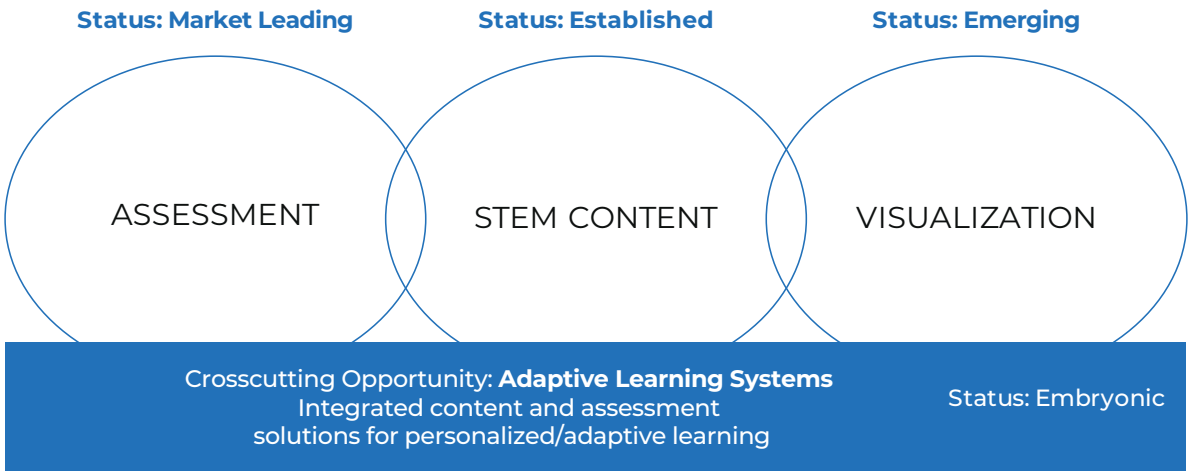
The EdTech environment in Iowa is further supported by additional companies located in adjacent technology spaces that may support the growth of the sector. This is particularly evident in the presence of several companies that specialize in custom software development, app development, and visual design services that can be readily applied to EdTech applications.

The phenomenon of "convergence" (see sidebar) is driving the development of an Iowa position in a fourth platform—a platform focused in the development of Adaptive Learning Systems (ALS). Adaptive learning, also known as adaptive teaching, is an educational method that uses computer algorithms to manage the interaction with the learner and deliver customized resources and learning activities to address the unique needs of each learner. ALS use the convergence of expertise from pedagogy, content, and assessment to develop learning systems that adapt, potentially in real-time, to the knowledge level of the student, their progress through content, and their understanding of the content as measured through built-in assessment tools.

Because of the demonstrated expertise in Iowa within assessment and content platforms, and emerging capabilities in the visualization platform, Iowa may be relatively well positioned for innovation and business growth in ALS. In many respects, the fast-growing Iowa company, Higher Learning Technologies (HLT), is an example of an ALS, providing content and testing within a single suite of apps. ACT has formed ACTNext as an in-house "skunk works" with a definite focus in ALS and associated advanced EdTech platforms. Several large and small Iowa companies have formed collaborations in new product development for this burgeoning market, and larger Iowa educational sector companies have been early investors in innovative Iowa-based EdTech ventures.

What is seen in Iowa is thus the opportunity to advanced EdTech through a focus on four platforms as illustrated in Figure 10. Each of these opportunity platforms is discussed in further detail below.

Figure 10: Four Primary Opportunity Platforms for EdTech Development in Iowa



Source: TEConomy Partners, LLC.

C. Assessment Platform

Description	This platform contains companies that are providers of educational assessment (testing and evaluation) solutions for K–12, higher education, and continuing education/workforce training applications.
Status	☐ Emerging R&D (core competency in research only, need to build industry) ☐ Emerging R&D Plus (R&D core competency and small base of industry) ■ Established Growth (R&D and significant base of industry with expansion potential)
Market Size	BCC Research reports that assessment represented a global market of $2,364.2 million in 2017 and is projected to reach $5,185.8 million in 2022 (representing a robust 2017–2022 CAGR of 17 percent). BCC Research also reports that assessment integrated with learning content within ALS had a market size of $3,372.8 million in 2017, projected to increase to $7,464.7 million globally by 2022 (a CAGR of 17.2 percent). Assessment, both in terms of stand-alone solutions and as a component of ALS, thus are projected to experience significant global market growth in the next several years. For the North American market, growth is projected to be similarly strong. BCC Research reports the 2017 North American Assessment Systems market as being $836.4 million (35.4 percent of the global assessment systems market). This is projected to grow to $1,881.7 million in 2022 (a CACG of 17.6 percent). ALS is reported by BCC Research as a $1,408.3 million market for assessment in 2017, growing to a projected $2,848.7 million market in 2022 (a 15.1 percent CAGR). IBIS World, another provider of market research to TEConomy, quantifies the assessment market as being significantly larger than the BCC Research projections. IBIS World projections, just for the U.S. market, show a larger, but much slower-growing market. For 2017, IBIS World reports a U.S. assessment market size of $2,730.7 million and projects this to rise to $3,178.1 million in 2022 (a CAGR of 3.1 percent). TEConomy expects that the difference between BCC Research and IBIS World market projections is definitional (i.e., what is being measured), with BCC Research examining just the “tech” component (therefore assessment systems software), versus IBIS World examining the entire assessment sector (which would also include testing services). From overall market size and growth perspectives, it is clear that assessment tech and ALS applications of assessment absolutely meet the platform definition need in terms of being large in scale and fast growing.
Iowa Industry Profile	Iowa enjoys a very strong market position in assessment, with a distinctive cluster of operations in the Iowa City region. With ACT headquartered in Iowa, the state benefits from the presence of one of the leading providers of assessment services. Well known for the ACT Test administered to millions of students each year, ACT (a nonprofit) provides a much broader suite of assessment solutions ranging across markets in elementary education all the way through career skills. ACT thus provides assessment expertise across the lifelong learning continuum. Also located in the Iowa City region is a significant operation of Pearson Education. Pearson Education is a British-owned education publishing and assessment service provider to schools and corporations, as well as directly to students. Pearson also owns several educational media/content brands including Addison-Wesley, Peachpit, Prentice Hall, eCollege, Longman, Scott Foresman, and others. The Iowa City region also has a moderately sized presence of the College Board assessment company (which administers the SAT) and Iowa Testing Programs (operating at the University of Iowa) that provides educational testing for Iowa schools.

	It should be noted that in recent months both ACT and Pearson have experienced strategic reductions in their workforce. Some of this is the result of outsourcing (for example, ACT is now outsourcing certain aspects of customer service), while other job reductions reflect the shifting market in the United States with reductions in student enrollments in higher education and an increase in the number of higher education institutions that are no longer requiring standardized test scores for applications. Because of these employment trends, TEConomy believes only moderate growth in assessment employment should be anticipated for Iowa. Iowa is well positioned in the marketplace currently, but should not expect to see large-scale growth (and may even experience moderate decline) in the sector along traditional pathways. Moving to a higher growth trajectory is likely to come via the crosscutting integrated opportunity of assessment integrated with content delivery systems as ALS.
Iowa Academic Research Assets	Iowa's Regent universities are uniquely positioned alongside private industry and the state public education system to continue to develop their capacity in the assessment space. Research activities incorporating assessment as part of the life cycle of educational content development exist across all the major universities with a heavy emphasis on best practice validation methods. In particular, the University of Iowa has a well-established, internationally recognized reputation in specialized psychometrics and socioemotional assessment methods and ongoing industry and public education system relationships centered around its excellence in assessment capabilities. Several key centers and programs support this capacity, including the following: • The Center for Evaluation and Assessment • Center for Advanced Studies in Measurement and Assessment (CASMA) • Iowa Testing Programs.
Business Start-Up Potential	Assessment as a stand-alone platform likely has relatively limited prospects for generating significant start-up activity. Assessment is a marketplace that is characterized by a few large players that have long-standing, established reputations in assessment. These companies, such as ACT, Pearson, and College Board, have their assessment products strongly rooted in the market and trusted as standard measures of performance. Start-up potential is more likely in the convergence of assessment with content delivery in the crosscutting ALS platform.
Business Expansion Potential	Expansion of existing companies and service providers in assessment in Iowa is likely to be relatively limited along traditional assessment service provision pathways. Indeed, moderate declines may continue in employment in traditional testing areas such as college admission tests. Expansion is likely to occur, however, in digital testing applications and the integration of testing with content into ALS. This is evident at ACT, for example, with the growth of ACTNext—a subset of the organization that is very much focused on ALS opportunities and the evolution of the organization in areas including Computational Psychometrics, Adaptive Learning Experiences, Artificial Intelligence, Machine Learning, Multimodal Analytics, and Innovative Assessments.

Business Attraction Potential	There is a potentially strong environment for business attraction that would leverage Iowa assessment capabilities. The robust Iowa cluster of expertise around assessment may well be a substantial attractor for companies in ALS and in other areas requiring expertise in assessment and evaluation for integration into their EdTech products. Success in this regard will depend, particularly, on the Iowa City region facilitating an open-innovation environment that supports collaborations between established assessment organizations and emerging and existing companies seeking that expertise for their ALS EdTech ventures.
Strategic Imperatives	• Building continued interest and momentum with universities to advance innovations along a commercialization pathway and to engage with commercial ventures in the EdTech assessment space. • Connecting entrepreneurs and ventures interested in applications requiring an assessment component to assessment expertise in major Iowa assessment companies and academic programs.

D. STEM Content Platform

The term "content knowledge" describes the body of knowledge and information that teachers teach and that students are expected to learn in a given subject area, such as mathematics, social studies, or biology. Content knowledge generally refers to the facts, concepts, theories, and principles that are taught and learned in specific academic courses, rather than to related skills—such as reading, writing, or researching—that students also learn in school. In EdTech, the term "content" is somewhat different in its application. In EdTech, content refers to the educational information contained within a digital platform and may comprise written, visual, and auditory content. A beneficial characteristic of digital EdTech systems is that they can use mixed-media approaches, combining all three types of content to best impart understanding or knowledge to the student. Digital content may span a range of sophistication-levels, ranging from a basic online PDF of a textbook through to highly sophisticated and immersive VR content and advanced 3-D visualizations and adaptable simulations.

The complexity of STEM subjects particularly lends itself to the use of digital education content. Being able to, for example, visualize complex anatomy, engineering structures, molecules, etc., in 3-D and via virtual fly-throughs brings content to life for the student in ways that a traditional textbook cannot. Digital dissections can be performed without having to access real frogs, digital field trips can be conducted to environments inaccessible or nonaffordable for real field trips, processes can be animated to show change over time, etc. Digital content opens-up new horizons for education, plus it has the advantage of being able to be distributed at a relatively low cost, rather than the cost of traditional publishing and distribution of textbooks, and be updated relatively inexpensively as curriculum and subject knowledge requirements evolve.

Description	This platform incorporates organizations and companies involved in the creation, publishing, and distribution of educational content, which may be text, video, audio based, or multimedia. STEM content is a particular emphasis area for the platform because of the profile of the existing base of Iowa companies engaged in content and because of the demand for such content.
Status	☐ Emerging R&D (core competency in research only, need to build industry) ☐ Emerging R&D Plus (R&D core competency and small base of industry) ■ Established Growth (R&D and significant base of industry with expansion potential)
Market Size	BCC Research reports that education and training digital content represented a global market of $17,498.3 million in 2017 and is projected to reach $26,543.8 million in 2022 (representing a 2017–2022 CAGR of 8.7 percent). For the North American market, growth is projected to be similar to that of the global marketplace. BCC Research places the 2017 North American market at $7,791.6 million (44.5 percent of the global content market). This is projected to grow to $11,910.1 million in 2022 (a CAGR of 8.86 percent). From both overall market size and growth perspectives, it is clear that digital educational content meets the platform definition need in terms of being large in scale and relatively fast growing. While the CAGR of 8.86 percent is lower than the Assessment Platform CAGR of 17.6 percent, the content market is significant larger overall (at a projected $11,910.1 million in content for 2022, versus $1,881.7 million—i.e., digital educational content represents a North American market that is 6.3 times larger than that of assessment).

	It should be noted that, while market research projections continue to be quite positive for digital education content, several major content companies that were interviewed for the Iowa EdTech project note that content is increasingly becoming "commoditized" and available from free or low-cost providers over the Internet. Companies are starting to question the long-term viability of "content only" business models and are increasingly developing in house, or in collaboration with partners, more holistic education solutions incorporating content and assessment into ALS. This points to a likely market evolution whereby Iowa's observed strengths in STEM content development and publishing can combine with Iowa's world-class assessment cluster to produce growth in ALS solutions.
Iowa Industry Profile	TEConomy's review of companies currently operating in Iowa shows that most educational technology companies in Iowa today are in the content space and aligned with this platform area. This includes both established content companies such as McGraw-Hill and Kendall Hunt, as well as a growing pipeline of emerging companies focused on digital content management and delivery solutions (including companies such as Foundations in Learning, Parametric Studio, StarrMatica, and Budding Biologist). STEM content is the focus for most of these companies. Digital content is a sector for Iowa where there is a proven, albeit small, track-record in development of successful start-ups. This success has occurred through innovation by entrepreneurs combined with support from IEDA, SBIR, private angel and VC funders, and other funding sources.
Iowa Academic Research Assets	High-quality STEM content is dependent upon applied domain expertise to produce new materials to be adapted into curriculum, digital tools, and demonstration EdTech systems. Many of Iowa's universities are highly specialized around evidence-based content creation and subsequent outcomes validation, which is particularly important for establishing the value proposition to education systems in the adoption of new tools in STEM education. Iowa's Regent universities have a respected reputation in educational curriculum creation as well as specialized education and research centers focused around high-quality educational content creation and evaluation that are already being leveraged toward STEM content creation. Examples include the following: • ISU's Center for Excellence in Teaching and Learning (CELT), Center for Technology in Learning and Teaching (CTLT) • U of I's Baker Teacher Leader Center • UNI's Regents' Center for Early Developmental Education. Within these programs there is an evident focus on creation of STEM learning materials and tools across a number of initiatives and research projects, including digital courseware, AR physics content, and physical sciences learning toolkits for early childhood education.
Business Start-Up Potential	Digital content as a platform generally sees greater freedom to operate (lower barriers to entry) than assessment. The content segment of EdTech has seen a relatively significant number of start-up enterprises formed across the nation, and these start-ups being able to attract capital. In part the opportunity is large because there is considerable variability in curriculum across K–12 systems from one state to another, and, in higher education, professors are generally free to choose any content they wish in the formulation of their courses. This variability in curricula across geographies and market segments does however place an upside limit on the market potential for any one content product (since a one-size-fits-all product is unlikely to get traction without customization to specific markets). Into the future, it is anticipated that start-up content-focused ventures will need to incorporate assessment components into their products.

Business Expansion Potential	As with assessment, employment at content companies has seen recent reductions. Companies are adapting to changing market conditions, and major companies like Kendall Hunt and McGraw-Hill are investing in entrepreneurial ventures that deliver content in new multimedia applications or that also include assessment and other features (as ALS). Expansion along a traditional "content only" model is likely to be limited, but those content companies that successfully navigate changing market dynamics could experience growth.
Business Attraction Potential	Attraction of major content companies to come to Iowa simply to operate as traditional content-only companies is unlikely to happen. There is potential, however, for companies to be attracted to Iowa to build capacity in integration of content with the strong assessment core competencies in Iowa in order to produce ALS solutions.
Strategic Imperatives	• Connecting content companies to Iowa core competencies in advanced visualization technologies to create differentiated content.· • Connecting content companies in Iowa to core competencies in assessment for the development of ALS solutions.

E. Content Visualization and VR Platform

In STEM education, and in other fields of education, the content that needs to be relayed to a student is often complex. Enhanced understanding of complex content (especially complex three-dimensional constructs) may be significantly enhanced through the use of advanced visualization technologies and applications—such as VR or AR. Leveraging advances in display technology and advanced high-speed 3-D model rendering VR, for example, can enable a medical student to visually study anatomical structures, a chemistry student to rotate and visualize complex molecular structures, engineering and architecture students to "fly through" 3-D renderings of structures, and trainee surgeons to perform practice operations. The integration of visual content, auditory content, and text content into multimedia education platforms can help enhance the learning of students—adapting to their individual preferred modes of learning. Content can become more engaging and more readily understood. Using advanced visualization platforms in training applications can enable professionals such as surgeons, veterinarians, pilots, etc., to train in simulated environments. Surgeons can train for procedures that may be very rarely encountered or can practice a complex procedure in a safe simulated environment. A pilot, or other operator of complex machinery, can be put through specific training procedures for hazardous events. Advanced visualization systems can also enable the "gamification" of content, producing engaging applications that teach in an entertaining way that is appealing to today's student. It should be noted that visualization of learning content, and game-based learning and assessment, are broader than only AR and VR.

Although visual aids have always played a key role in educational materials, new technologies offer potentially disruptive advances in the way students interact with content:

- Fully immersive VR environments ranging from static 360-degree video to interactive virtual environments. Examples of applications include virtual "field trips" to various locations and interactive virtual labs and design spaces.

- MR and AR products and technologies that allow students to interact with digital content using their body in the physical classroom environment. Examples of applications include projected "interactive whiteboards" for physics and spatial-based learning or interactive AR "notecards" that allow students to manipulate digital models of objects via touch.

A challenge for development of this market, especially for cash-strapped school districts, is that it currently requires investment in hardware infrastructure to support capabilities, whether VR headsets for students or projector/camera systems for AR/MR applications. It is a nascent area of development for educational content with only a few established players, but there are early indications that it may represent a large market and significant adoption could be driven as a cost-effective way for students to have immersive interactions with educational content.

Description	Includes hardware and software systems (primarily in Iowa it is software) that enable enhanced visualization of 3-D structures or that display multimedia educational content to enhance learning.
Status	☐ Emerging R&D (core competency in research only, need to build industry) ■ Emerging R&D Plus (R&D core competency and small base of industry) ☐ Established Growth (R&D and significant base of industry with expansion potential)
Market Size	VR and AR technologies already represent a large global market (projected at $3,700 million for 2017), but educational applications of the technology represent just a small fraction of this market. BCC Research places the education market for these technologies at $116.7 million for 2017 globally, but its research anticipates extremely fast growth, with a CAGR between 2017 and 2022 of 76.6 percent (resulting in a projected global market size for educational VR/AR technologies and applications of $2,007 million). BCC Research's estimate for the North American market for educational applications of VR/AR stood at $39.9 million for 2017 ($25.1 million or 65.3 percent in hardware, and $13.8 million or 34.7 percent in software). As with the global market, substantial growth is anticipated in the North American market, with the total educational VR/AR market projected to be $708.4 million in 2022 (a CAGR of 77.8 percent for 2017–20022). For 2022 it is projected that software will be the largest part of this market, comprising 54.7 percent of the market ($387.5 million in sales).
Iowa Industry Profile	This is the smallest of the three existing clusters in Iowa EdTech currently. Several emerging companies in the AR/VR space such as Victory VR have potential to generate significant market attention with novel educational content offerings, but still it is a very nascent space with larger education content companies still waiting on validated technology applications to invest.
Iowa Academic Research Assets	Iowa benefits from having significant academic assets and a reputation for R&D in VR and advanced visualization technologies. These are not primarily directed at EdTech applications of VR, but certainly do contain significant research and training programs of direct relevance. • A key university center is ISU's Virtual Reality Applications Center (VRAC) focused on research in AR/VR space, although not solely in education technology space. • The Iowa State University has a current interdepartmental graduate degree program in human-computer interaction. • Other faculty and centers at the University of Iowa and the University of Northern Iowa are beginning integration of AR/VR with education research programs and piloting technology evaluation initiatives. • UI National Advanced Driving Simulator (NADS), Virtual Soldier, Center for Computer-Aided Design (CCAD).

Business Start-Up Potential	The best start-up potential is likely to be in the software and applications side of visualization, rather than in the development and production of hardware. It is anticipated that the hardware component of the market will be dominated by a few very large players with large R&D budgets and the ability to conduct large-scale marketing campaigns to build market share. For 2016, for example, the VR/AR hardware market was dominated by Samsung 28 percent, HTC 22.6 percent, Sony 18.8 percent, Oculus 9 percent, and others 21.6 percent (with others also comprising large companies including Google, Zeiss, Nintendo, Nvidia, and Qualcomm). Software, however, is likely to be far more open to market penetration by smaller companies (much as it has been across most digital markets). From a software standpoint, development of applications for VR is an extension of the skill sets found in software engineering, programming, and code development that apply to multiple sectors.
Business Expansion Potential	Given the projected growth rates for visualization application, it is likely that the small base of Iowa companies using visualization for education as a core component of their business currently (BodyViz, Substrate Games, Victory VR, VIVED, True360, Complex Computation, and Pear Deck) operate in a favorable market for expansion. If the companies are able to continue to access growth capital and skilled talent, and produce successful products, their growth potential is strong.
Business Attraction Potential	Digital companies have the advantage of being able to operate from most locations. The main limiting factor for attracting growth businesses in this sector tend to be access to risk capital (especially mid-level tranches of VC) and the ability to transfer personnel into the new environment and attract new talent to the firm. The R&D assets and nascent group of companies in visualization and EdTech present a potentially compelling message for business attraction, made all the stronger by the related presence of major content and assessment companies in Iowa also. The limitations for attraction, especially for more entrepreneurially oriented growth ventures, would be a lack of access to growth VC and a relatively small talent base to draw from. Scalability of training programs within the Regent universities in Iowa will be important to this latter aspect.
Strategic Imperatives	Promoting the small but notable and concentrated base of R&D assets and entrepreneurial businesses in EdTech visualization to the specialized subset of EdTech companies nationally and internationally. It will be important to raise the profile of the Iowa cluster quickly in this small, but potentially fast-growing, space. • Ensuring that a pipeline of skilled talent is developed within Iowa's Regent universities. • Raising the profile of Iowa as a hub for this niche business sector with risk capital providers/VC firms with interests in the space. • Networking Iowa's larger STEM content and assessment EdTech clusters with visualization cluster companies for pursuit of joint opportunities and the build-out of novel platforms for ALS integrating advanced visualization components.

The market opportunity for Iowa, from the above three platforms (assessment, content, and visualization) is significant. Table 7 summarizes the projected market size in each platform for North America based on the presented market research data and the CAGR projections through 2022. These results suggest that these markets, combined, will grow from between $9,840 million and $10,340 million in 2017 to between $15,100 million and $15,600 million in 2022 (equivalent to a combined CACG of 8.57 percent).

Table 7: Summary of North American Market Size for Three EdTech Platforms

Platform	2017 ($ in Millions)	2022 ($ in Millions)
Assessment	$2,000–$2,500	$2,500–$3,000
Content (Digital)	$7,800	$11,900
Visualization (VR)	$40	$700
Total	$9,840–$10,340	$15,100–$15,600

With employment standing at approximately 3,126 across these EdTech sectors in Iowa, a basic estimate can be made of the potential employment gains that could occur if Iowa sustains growth at the projected national rate of 8.57 percent. Were this to occur, the sector would be anticipated to employ circa 4,716 personnel in 2022 across Iowa (a new job gain of 1,590 jobs). It should be noted, however, that the nondigital, more traditional components of content and assessment have experienced moderate employment reductions in recent years at Iowa's major companies in these sectors. As such, further declines in this employment might occur that would offset some of the gains on the digital side of the equation.

F. ALS, a New Platform Driven by Convergence

As noted previously, the phenomenon of "convergence" (described in sidebar on page 44) is driving the development of an Iowa position in a fourth platform—a platform focused in the development of Adaptive Learning Systems (ALS). Adaptive learning is an educational method that uses computer algorithms to manage the interaction with the learner and deliver customized resources and learning activities to address the unique needs of each learner. ALS use the convergence of expertise from pedagogy, content, and assessment to develop learning systems that adapt, potentially in real-time, to the knowledge level of the student, their progress through content, and their understanding of the content as measured through built-in assessment.

For Iowa, the powerful concentration of assessment platform expertise is a key "attractor" for convergence opportunities in ALS. Assessment is a highly specialized and sophisticated field, and Iowa is a hub for multiple leading companies in the space and has an active track record in academic research and graduate training relevant to the sector. The presence of a significant base of STEM content companies in Iowa, and advanced visualization companies with interests in education, provides a potentially dynamic opportunity for an ALS platform to be pursued via facilitated convergence in the state.

BCC Research projections for development of the ALS market in North America are shown on Table 8. By 2022, the market for these system is projected to be larger than that for assessment alone.

Table 8: BCC Research Projections for Size and Growth of the North American ALS Market

	2017 ($ in Millions)	2022 ($ in Millions)	CAGR% 2017–2022
ALS	$1,408.3	$2,848.7	15.1

Were this type of market growth to actually be experienced, relative to the other sectors, then the potential for Iowa employment gains in the development of ALS products (on a fair share basis) would be as shown on Table 9.

Table 9: Projections for Fair Share Gains in ALS Platform Development Based on Iowa's Share in Existing EdTech Platforms

	2017	2022
ALS as additional % to platforms	--	+15.4%
ALS additional jobs projection	--	+726 jobs

As Table 9 illustrates, if Iowa could achieve a share in a new ALS platform that is equivalent to its share in the other combined platforms, the state could potentially see an additional 726 jobs by 2022. It should be anticipated, however, that the opportunity for Iowa to perform well in ALS is strongly rooted in the existing strengths in assessment (and the presence of significant activity in the other platforms); thus, the actual market opportunity for Iowa is potentially higher. Were Iowa to be able to outperform natural fair share gains by two times, the opportunity would be for creation of 1,452 jobs (three times would be a 2,178 job potential, and four times would be 2,904 jobs).

Overall, the four platforms combined may present a relatively conservative opportunity to have employment in Iowa in 2022 totaling 4,716 jobs in the existing three platforms, plus 726 jobs in a new ALS platform, for a total of 5,442 jobs in 2022 (a net gain of 2,316 jobs over 2018 levels). This is a possibility; but, again, TEConomy would temper this projection with an understanding that nondigital jobs in traditional content and assessment sectors in education may decline moderately. Still, job gains within the range of 1,000 to 2,000 jobs over the next five years would appear to be a reasonable projection if Iowa is able to realize its promise in EdTech platform development.

G. Solutions for Rural School Districts

Over the course of the project, it was noted by persons interviewed and by members of the project advisory committee that certain characteristics of Iowa's educational landscape should be leveraged for development of EdTech solutions. Chief among these is the presence of multiple small and rural school districts that present distinct educational challenges. EdTech may be a solution to the challenge of recruiting teachers with degrees in STEM subjects into rural districts, with ALS, for example, presenting a robust supporting tool for teachers for whom STEM subjects may not be their primary discipline. EdTech may also present opportunities for delivering specialized content via remote education applications and provide means for students to take "virtual" field trips and take part in other simulated activities that would not be practical given scarce resources. EdTech may provide opportunities for leveling the playing field between school districts of all types across the state, helping to ensure that students in all Iowa communities have access to proven tools and technologies.

It was noted by the project advisory committee that consideration should be given to the Iowa EdTech strategy incorporating a subsidiary platform in EdTech for small and rural school districts.

VI. STRATEGIES AND ACTIONS FOR GROWING IOWA EDTECH PLATFORMS

Based on the complete program of quantitative and qualitative research, and review of the work by the project advisory committee, a series of four primary strategic imperatives were developed for advancing EdTech sector growth in Iowa. These imperatives are shown on Figure 11 and form the basis for four strategies (and a series of associated actions) summarized in Table 10.

Figure 11: Crosscutting Strategies for Iowa EdTech Platforms

Table 10: Crosscutting Strategies and Associated Action Recommendations for Iowa EdTech Platforms

Strategy 1: Collaboration Facilitation and Cluster Networking	Strategy 2: Piloting and Adoption Environment	Strategy 3: Entrepreneurial Ecosystem Development	Strategy 4: Workforce Development and Access
Action 1.1: Form EdTech Iowa collaborative cluster organization within an existing Iowa TBED organization (ICAD Group recommended).	**Action 2.1:** Identify existing cadre of K–12 and higher education institutions that have collaborated with Iowa companies for testing and piloting. Plus, target a selection of underperforming schools.	**Action 3.1:** Promote regional incubator and coworking space for EdTech within existing spaces/organizations.	**Action 4.1:** Develop a transdisciplinary EdTech graduate degree program (Education, Comp. Science, Business Studies, etc.).
Action 1.2: Fund initial EdTech Iowa operations with membership dues, potentially supplemented by funds from EDA if current application successful.	**Action 2.2:** Develop a mobile EdTech Iowa Demonstration Lab.	**Action 3.2:** Form EdTech Iowa mentoring network.	**Action 4.2:** Connect rising IT software talent with EdTech companies pregraduation.
Action 1.3: Review opportunities for strategic collaborations with existing complementary Iowa organizations (for example, TAI).	**Action 2.3:** Assess/ consider nonschool environments for piloting and testing.	**Action 3.3:** Develop "Pitch Panel" for annual conference.	**Action 4.3:** Promote connectivity between EdTech firms and Iowa software and app development firms.
Action 1.4: Develop and host annual EdTech Iowa Conference. Start initially with a half-day add-on to existing ACT conference and build from there.	**Action 2.4:** Develop training and exposure program in EdTech for teachers and superintendents.	**Action 3.4:** Build relationships with VC firms and early-stage investors with proven interests in EdTech. Identify investors in Midwest ventures.	**Action 4.4:** Integrate EdTech needs into existing IT workforce development plans.
Action 1.5: Research API platforms as "best fit" for Iowa company connectivity and path to market access.	**Action 2.5:** Conduct needs assessment surveys of K–12 leaders and industry workforce skills leaders. Identify pain points and needs requiring EdTech to address.	**Action 3.5:** Develop an "Assessment Integration Lab" in Iowa City.	**Action 4.5:** Attract and recruit management talent with EdTech experience.

Strategy 1: Collaboration Facilitation and Cluster Networking	Strategy 2: Piloting and Adoption Environment	Strategy 3: Entrepreneurial Ecosystem Development	Strategy 4: Workforce Development and Access
		Action 3.6: Promote EdTech entrepreneurship within Iowa research universities.	**Action 4.6:** Develop EdTech Iowa website for linking employers to job candidates. Also develop "why Iowa" case-making and marketing materials.
			Action 4.7: Conduct occupational needs assessment and demand projections study for the sector in Iowa.

Details on the rationale for these suggested strategies and associated actions for consideration are presented below.

It should be noted that TEConomy believes it will be critically important for the success of an EdTech Iowa advancement organization that it be actively engaged in strategic planning and action formulation and implementation. The strategies and actions recommended herein, built on a base of knowledge and input gained over the course of the cluster evaluation project, represent a starting point—a series of potential strategies and actions for consideration by the organization that is formed. It will be important that the organization itself set direction, and the strategies and actions herein are proffered as a starting point for discussion and final action decision-making, rather than a formally stipulated course of action.

A. Strategy 1: Collaboration Facilitation and Cluster Networking

RATIONALE:

- Iowa has a good base of EdTech assets across companies and within universities, but the connectivity between actors in this cluster is relatively limited. There is no statewide organization representing the cluster currently.
- Realizing opportunities in the convergence-based ALS platform requires connecting key organizations across the existing platforms (assessment, STEM content, visualization).
- Best practice in TBED is for clusters to be represented by an active collaboration organization that facilitates interactions between regional assets and identifies shared programs and projects to work on to advance the clusters. There is no such organization in Iowa currently.
- Individual companies cannot design the ecosystem in which they operate; it takes collective effort to steer change, prioritize actions, address shared issues, and promote Iowa as a recognized hub for EdTech development and business operations.
- A collaborative organization can ensure that strategies and actions are implemented.

Strategy 1 Potential Actions and Activities:

Strategy 1, Action 1.1 Form EdTech Iowa collaborative cluster organization within an existing Iowa TBED organization (ICAD Group recommended).	**Potential Activities** • On the recommendation of TEConomy, consider the Iowa City Area Development (ICAD) Group as the preliminary organization entity for forming/hosting EdTech Iowa. The assessment cluster, based in the Iowa City region, represents the largest cluster in Iowa EdTech; and ICAD Group has already developed expertise in the sector and is pursuing federal grants, in partnership with UI, in support of EdTech development that may be leveraged for supporting organizational development. • Appoint a Board of Directors for EdTech Iowa of between 8 to 10 members. • Develop platform focused subcommittees, with crosscutting membership in an ALS platform development subcommittee. • Review benchmark organizations to learn from programs and content already deployed successfully by other cluster-promoting organizations and networks in the United States. • As may be logical, in time as EdTech Iowa develops, consider having three primary regional hubs for the organization with subchapters, leveraging existing regional economic development organizations to help facilitate in Iowa City–Cedar Rapids Corridor, Ames–Des Moines Corridor, and the Dubuque region.
Strategy 1, Action 1.2 Fund initial EdTech Iowa operations with membership dues, potentially supplemented by funds from EDA if current application successful.	**Potential Activities** • Fund the organization using a membership model for corporate and higher education members, with representatives of K–12 sector able to join for free. Set tiered membership-fee structure based on size of organization (number of personnel in Iowa). • If the current application for funding from the EDA is successful, leverage this to provide support for EdTech Iowa consistent with the grant's requirements and scope. • In addition to EdTech companies, allow membership by companies and organizations in associated sectors such as information and communications technologies and software and applications development and design.

Strategy 1, Action 1.3 Review opportunities for strategic collaborations with existing complementary Iowa organizations (for example, TAI).	**Potential Activities** • Seek to engage existing programs and initiatives across the state (especially in STEM education) in EdTech Iowa to coordinate and support existing programs and provide means to optimize existing program support for EdTech Iowa initiatives. • With EdTech Iowa having a digital technology focus, examine opportunities for collaborations or strategic partnership with the Technology Association of Iowa (TAI) and other relevant organizations.
Strategy 1, Action 1.4 Develop and host annual EdTech Iowa Conference. Start initially with a half-day add-on to existing ACT conference and build from there.	**Potential Activities** • Start initially with the conference being a half-day add-on to existing ACT conference and build from there as interest and resources allow. • Consider the first conference as a launch platform to announce the strategy. • Make presentations on each of the platforms and their key assets in Iowa, together with presentations on the future of EdTech by invited speakers. • Allow for brief presentations on Iowa's companies operating in each platform and booth space for open areas at event. • Ensure that a presentation is made on university capabilities and interests. • Allow lots of conference time dedicated to breaks for casual networking. • Develop an attached special track focused on the needs and challenges in EdTech evaluation and implementation for small and rural school districts.
Strategy 1, Action 1.5 Research application programming interface (API) platforms as "best fit" for Iowa company connectivity and path to market access.	**Potential Activities** An application programming interface (API) comprises a set of routines, protocols, and tools for building software applications. Basically, an API specifies how software components should interact. Additionally, APIs are used when programming graphical user interface (GUI) components. Multiple APIs are used in EdTech applications, and the project advisory committee noted that an action should be pursued to identify which APIs are well positioned for the future and a match to the types of products being produced by Iowa EdTech firms.

B. Strategy 2: Piloting and Adoption Environment

RATIONALE:

- Technologies need to be tested with the target consumer; but, companies note that access to students, especially K–12 students, for the testing and piloting of EdTech products can be challenging.
- Layers of decision makers are engaged in EdTech adoption, including school boards, school superintendents, and individual teachers in the K–12 system. There is more flexibility for adoption by higher education faculty.
- Start-ups and entrepreneurial ventures in EdTech have limited cash resources; and it is expensive to pilot and test programs, and time consuming to find cooperative districts or teachers willing to collaborate.
- Iowa can leverage its well-developed program of Technology Integrationists in K–12 systems—professional positions focused on integrating technology into the classroom. The State of Iowa has invested heavily in these positions and associated infrastructure, and the Technology Integrationists represent a defined point of contact with which companies can engage.

Strategy 2 Potential Actions and Activities:

Strategy 2, Action 2.1 Identify existing cadre of K–12 and higher education institutions that have collaborated with Iowa companies for testing and piloting. Plus, target a selection of underperforming schools.	**Potential Activities** • Survey each EdTech company in Iowa to request information of school districts and individual school personnel who have participated in piloting of products, facilitated testing, etc. • Similarly request identity of university faculty in Iowa who have participated in piloting and testing programs. • Seek to identify at least10 schools to form a collaboration with EdTech Iowa, whereby these schools, as a group, may provide access to vetted applications and products from Iowa EdTech companies most likely to elevate the performance of these schools. Perform case studies and track outcomes.
Strategy 2, Action 2.2 Develop a mobile EdTech Iowa Demonstration Lab.	**Potential Activities** • Fund and develop a Mobile EdTech Iowa Lab able to travel to schools and colleges across the state to demonstrate technologies developed by Iowa EdTech companies. • Fund via soliciting investment in the mobile lab by private foundations and Iowa EdTech companies, their investors, and leading higher education institutions. • Incorporate a range of options from basic app demonstration through to immersive AR technologies. • Incorporate testimonies into exhibits from teachers successfully deploying EdTech in Iowa and achieving improved student outcomes. • Showcase grant programs and other incentives designed to encourage engagement in piloting, testing, and early adoption of Iowa EdTech products and solutions.

Strategy 2, Action 2.3 Assess/consider nonschool environments for piloting and testing.	**Potential Activities** • Examine opportunities to gain access to piloting and testing populations through nonschool locations such as libraries, 4-H and youth groups, churches, summer camps, and community colleges. • While K–12 schools may be the primary market for many educational technologies, consider alternative locations where youth can be accessed in a less "restrictive" environment for the testing and piloting of new technologies. • Canvas a range of organizational types to test openness to the concept. • Leverage the Mobile EdTech Iowa Lab to provide a teaching and demonstration resource at these alternative locations to raise levels of interest and promote participation in a piloting and testing network.
Strategy 2, Action 2.4 Develop training and exposure program in EdTech for teachers and superintendents.	**Potential Activities** • Provide small training grants to encourage teacher participation in EdTech exposure and training events. • Leverage the Mobile EdTech Iowa Lab to provide a teaching resource for use with teachers and superintendents and raise their exposure to Iowa-developed solutions. • Consider establishing EdTech curriculum development grants for schools (as deployed in Wisconsin). • Establish a one-day full-immersion program in EdTech, with content developed by the Regent universities and industry to provide school superintendents with a robust understanding of EdTech, its benefits in terms of student performance, and EdTech options available through collaboration with EdTech Iowa and member companies.
Strategy 2, Action 2.5 Conduct needs assessment surveys of K–12 leaders and industry workforce skills leaders. Identify pain points and needs requiring EdTech to address.	**Potential Activities** • Design a survey, with the assistance of the Regent universities, to identify pain points and needs requiring EdTech to address. • Distribute surveys to Technology Integrationists at Iowa K–12 schools and human resource leadership within leading Iowa companies. • Relay results of the survey in a white paper brief to EdTech Iowa companies. • Relay results back to the participating schools and businesses and provide connections to Iowa EdTech solutions to identified challenges where solutions are already developed or in development.

C. Strategy 3: Entrepreneurial Ecosystem Development

RATIONALE:

Cluster-based economic development requires that attention be paid to creating a complete ecosystem spanning the R&D through business start-up and business growth continuum. Any gaps in such an ecosystem can place significant constraints on sector growth. Several gaps are observable in the current EdTech entrepreneurial ecosystem that need to be addressed, primarily in the areas of: business incubation; mentoring and advisory networks; and capital access.

As noted under Strategy 1, individual companies cannot design the ecosystem in which they operate; it takes collective effort to steer change, prioritize actions, address shared issues, and promote Iowa as a recognized hub for EdTech development and business operations.

Strategy 3 Potential Actions and Activities:

Strategy 3, Action 3.1 Promote regional incubator and coworking space for EdTech within existing spaces/ organizations.	**Potential Activities** • Because Iowa already benefits from the operations of multiple incubators, accelerators, and coworking spaces, consider having EdTech Iowa approach each to assess their interest in participating as an EdTech incubator in collaboration with EdTech Iowa. • First, pay attention to securing incubator space in the three regions of Iowa with the greatest concentration of EdTech assets: the Cedar Rapids–Iowa City corridor, Dubuque, and the Ames–Des Moines corridor.
Strategy 3, Action 3.2 Form EdTech Iowa mentoring network.	**Potential Activities** • Use to advantage Iowa's burgeoning base of experienced EdTech entrepreneurs and experienced EdTech executives with the relevant skills for mentoring new entrants to the sector. • Establish a "Founders Panel" of EdTech entrepreneurs to speak at regional tech events and economic development events.
Strategy 3, Action 3.3 Develop "Pitch Panel" for annual conference.	**Potential Activities** • Develop a "Pitch Panel" for the annual EdTech Iowa conference, comprising experienced EdTech entrepreneurs and business executives to provide a panel-based review of "Shark Tank"–like pitches around EdTech venture concepts. • Establish a single panel initially and then, depending on observed demand, establish subsidiary panels in each of the three Iowa EdTech regional hub locations. • Examine options for securing a base of early-stage proof-of-concept grants, or other types of early seed funding to which the Pitch Panel would have access. This would encourage new ventures to make pitches more so that simplify the provision of advice and feedback.

Strategy 3, Action 3.4 Build relationships with VC firms and early-stage investors with proven interests in EdTech. Identify investors in Midwest ventures.	**Potential Activities** • Since several major Iowa EdTech companies have already engaged in start-up venture funding, consider establishing a small shared-venture fund to pool company resources to invest in promising Iowa ventures. • Coordinate a meeting of major Iowa VC and angel stakeholders to outline the strategic opportunity in EdTech as well as special characteristics of the education products market that differentiate it from typical investment spaces. Arrange for several "success stories" to be presented as well as outlining Iowa's strategic advantage in this space to increase awareness among investment capital stakeholders of this opportunity and to help network with emerging companies. • Review Pitchbook data to identify VC investors nationwide that place an emphasis on EdTech investments. Consider approaching firms in the Midwest, or that have made multiple Midwest firm investments, to introduce EdTech Iowa and solicit their interest in receiving/reviewing EdTech Iowa vetted–investment pitches. If pitches are shown to have been reviewed/vetted by major Iowa EdTech companies and experienced business development professionals, they are likely to receive increased interest among potential investors. • Ensure that the options of state matching funds are understood by potential investors in EdTech ventures. • Leverage existing relationships and connections.
Strategy 3, Action 3.5 Develop an "Assessment Integration Lab" in Iowa City.	**Potential Activities** • Develop an "Assessment Integration Lab," comprising representatives of the major Iowa assessment companies and key faculty at the University of Iowa, to provide professional advice on the development of ALS that require assessment as a component of the product/solution. • Tap the experience of ACTNext, which is already this type of organization, in considering the feasibility of the Assessment Integration Lab concept. • Use ACT, Pearson, College Board, and Iowa Testing Programs in the Iowa City region as a unique cluster of organizations, and multiple perspectives on assessment, to provide advice. It is likely that such an organization would not only have significant value for Iowa EdTech ventures to interact with, but would also provide a significant attractor for companies located outside of the state—thereby substantially raising the profile of Iowa as a leading EdTech hub, especially in the fast-growing ALS field. • Consider adopting a similar organizational approach to Iowa's expertise in advanced visualization and VR for coordination with content-focused companies and organizations.

Strategy 3, Action 3.6 Promote EdTech entrepreneurship within Iowa research universities.	**Potential Activities** • Advance the commercialization of EdTech thought leaders in Iowa universities. The universities in Iowa are home to good ideas, faculty who have worked hard to develop an EdTech product or solution but are facing challenges to commercialization or hesitation. • Have the office of tech transfer work to "mine" the colleges of education at key universities to learn more about products, curriculum, etc., that have potential. • Hold brown-bag lunch events or speaker events for the college of education with local EdTech companies to promote/encourage company development, opportunities among university faculty. • Provide access to commercialization "mentors" from in-state EdTech companies or from office of tech transfer for low-stakes conversations/ meetings or brainstorming sessions with faculty.

D. Strategy 4: Workforce Development and Access

RATIONALE:

EdTech companies, like others in Iowa, face challenges in sourcing and/or retaining technical talent for software development, systems architecture, general technology, and related skill sets. Firms are having difficulties hiring EdTech sales reps. Cluster companies have niche market needs and know-how that includes selling to universities around the country and need for "pilot" reps in Iowa that have experience interfacing with higher education and other education administrators. EdTech also requires senior managerial talent within a "sweet spot" of knowledge, skills, and experiences where the need is for a unique combination of technology, education, and subject matter expertise, as well as business acumen. Finding these candidates has been described as akin to "finding a needle in a haystack."

It is important to recognize Iowa's ongoing efforts and assets in developing talent and rooting it firmly in Iowa. Key initiatives and strengths include the Governor's STEM Advisory Council; key academic programs cited at the University of Iowa, Iowa State University, the University of Northern Iowa, and the state's community colleges as important sources of talent for EdTech; and participation by EdTech companies in the state's well-regarded internship program.

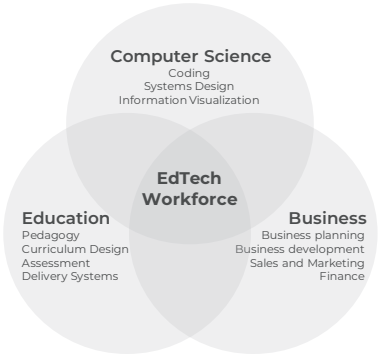
Strategy 4 Potential Actions and Activities:

Strategy 4, Action 4.1

Develop a transdisciplinary EdTech graduate degree program (Education, Comp. Science, Business Studies, etc.).

Potential Activities

- Develop top talent in holistic, EdTech-specific graduate programming at the state's postsecondary institutions. The sector requires business leaders with unique expertise at the intersection of education/learning sciences, computer science, and business acumen; and this can be holistically addressed only in cross-disciplinary courses and/or degree programs designed specifically for EdTech. One example is found at Carnegie Mellon University in its Master of Educational Technology and Applied Learning Science (METALS) program—a one-year interdisciplinary master's program that culminates with a seven-month, team-based capstone project for an external client.



- Consider adding an applied master-level degree program at one of the state's leading universities. The program should be interdisciplinary and multidisciplinary in structure spanning areas such as learning and data sciences, curriculum design, human-computer interaction, information visualization, psychology, pedagogy, cybersecurity, etc. In addition, the program should have a distinct "applied" focus with a capstone or internship requirement(s) that not only develop experience with real projects and clients, but further solidify student relationships with Iowa EdTech companies.

Strategy 4, Action 4.2 Connect rising IT software talent with EdTech companies pregraduation.	**Potential Activities** • Connect rising IT and software development talent with EdTech companies through experiential learning opportunities and school-to-career transitions. • Through senior/capstone projects, bring in EdTech companies to classrooms (MBA/business schools, engineering, IT, education programs) for case studies, solving real-world tech challenges. • Through internships, systematically connect cluster companies with career placement offices at Iowa colleges and universities and community colleges. • Promote broader cluster career awareness and branding as an opportunity for workforce attraction—brown-bag lunch events at colleges of education and computer sciences, attending job fairs, meeting with key faculty. • Promote/advance "cross-college" connections at key institutions such as University of Iowa and Iowa State to connect students at the colleges of education and computer science and even business schools interested in technology commercialization and/or entrepreneurship.
Strategy 4, Action 4.3 Promote connectivity between EdTech firms and Iowa software and app development firms.	**Potential Activities** • Further bolster B2B connections and partnerships between EdTech firms and Iowa-based software development firms. Several examples of long-term in-state partnerships/collaborations already exist. Ensure that state IT firms are aware of the cluster and business development potential. • Hold "demo days," "pitch days," or "partnering lunches" for EdTech companies to connect with Iowa software development firms and learn more about tech needs and capabilities to solve.
Strategy 4, Action 4.4 Integrate EdTech needs into existing IT workforce development plans.	**Potential Activities** • Ensure that statewide strategies for developing and growing Iowa's IT workforce are inclusive of and coordinated with the EdTech sector and its demands. TEConomy, having been involved with numerous TBED strategies across Iowa, understands the strong demand and immediate need for this workforce and these skill sets across a host of major state industry clusters including insurance, biosciences, advanced manufacturing, precision agriculture, etc. This EdTech cluster study has broadly reinforced these needs. • As Iowa's IT-related workforce development programs and initiatives are pursued and considered, involve EdTech companies in these conversations. • In general, continue to advance broad, core statewide efforts related to coding, data sciences, and other key areas.
Strategy 4, Action 4.5 Attract and recruit management talent with EdTech experience.	**Potential Activities** • Recognize that this is very challenging, but forums exist for networking and reaching out to these individuals and ensuring that they are aware of the strong and varied career opportunities across the Iowa cluster. • Coordinate on cluster "delegations" and state representation to key national and international EdTech conferences.

	• Participate in regional and national membership organizations related to EdTech. • Cohost top executives for multifirm interview days in Iowa's regional EdTech hubs.
Strategy 4, Action 4.6 Develop EdTech Iowa website for linking employers to job candidates. Also develop "why Iowa" case-making and marketing materials.	**Potential Activities** • Develop an EdTech-specific Job Posting Board or Career Center to highlight job and career opportunities in the industry across Iowa; this can be an EdTech Iowa role. • In branding and promoting EdTech in Iowa, develop promotional materials that form a crisp marketing piece and message that strongly communicates a "Why Iowa?" message. Leverage information from this study to communicate the breadth of the industry, including geographically, and the varied niche strengths of the industry. • Leverage promotional materials for delegations to national or international conferences and/or for individual companies to use in recruitment to show the breadth of career opportunities in Iowa.
Strategy 4, Action 4.7 Conduct occupational needs assessment and demand projections study for the sector in Iowa	**Potential Activities** • Be aware that EdTech-specific data and related intelligence are virtually nonexistent with respect to industry and occupational analysis. There exist no NAICS industry classifications nor Standard Occupational Classification System (SOC) codes that specifically isolate EdTech. • Therefore, as suggested by the EdTech Workgroup, regularly take stock of the industry situation and measure/project the outlook for EdTech jobs and careers in Iowa. It is important to have these data to demonstrate the industry demand to individuals thinking about pursuing a career in EdTech and to attract skilled talent into the state.

In addition to the above, it was noted by members of the project advisory committee that two additional areas of opportunity be investigated for integration into the final strategy of EdTech Iowa. These include the following:

- Using Iowa's deep expertise in assessment, in combination with university capabilities in program evaluation and efficacy assessment, to develop a testing and certification program for EdTech solutions. In effect, this would comprise an evaluation service that would assist in efficacy testing of EdTech and provide an "Iowa Efficacy" seal of approval for products and technologies verified as enhancing student performance or promoting other positive outcomes. Such a program could elevate Iowa's profile in the EdTech marketspace and increase interaction between the growing EdTech sector nationally and EdTech Iowa.

- Integrating the cybersecurity expertise contained within Iowa's universities and within industry leaders (such as ACT). It was noted that there is concern expressed by parents and educators regarding the security of student performance data that, unless resolved through security technology applications (and potentially policies for data protection), will restrain market growth and EdTech implementation. Having EdTech Iowa draw together Iowa assets for work to ensure information security and privacy compliance could be a differentiator for the state.

E. Conclusion

Building upon existing assets, Iowa has an opportunity to further advance its economy through EdTech as a TBED sector. A key advantage for Iowa is that the EdTech sector in the state contains strengths across multiple platforms—in assessment, in educational content (especially STEM content), and in advanced visualization. A key emerging opportunity for Iowa is rooted in the potential for convergence of these existing platforms to form a new platform in ALS. ALS represents a fast-growing EdTech space and one in which Iowa's deep assessment expertise is a clear differentiator and very much a necessary component.

Currently, EdTech does not represent an "organized" cluster in Iowa—i.e., there is no development organization that is focused on bringing the assets and components of the sector together for mutual advancement and to address needs and opportunities across the associated ecosystem. Still, companies have been finding one-another, and university resources, and developing collaborations—so characteristics of the sector in Iowa point to a favorable environment for strategic coordination. Based on projected growth rates in EdTech (see Chapter V), TEConomy anticipates that Iowa has the potential to add upward of 1,000 jobs in EdTech over the next five years—but, realizing this opportunity will require a strategic focus on connecting ecosystem organizations and companies, enhancing the piloting and demonstration environment for EdTech in the state, improving the entrepreneurial ecosystem, and creating and encouraging workforce development activities.

Long term, the upside potential of investing in EdTech is significant. In a knowledge-based advanced economy, education and human capital skills will be a crucial determinant of economic performance and, as such, EdTech represents a marketplace with an assured and fast-growing demand for products and services. Iowa already has many of the assets for success in place, and now needs to coordinate implementation of targeted strategies and actions to leverage these assets and build upon them further to realize its full EdTech-sector growth potential.

APPENDIX:

IOWA EDTECH WORKGROUP PARTICIPANTS

The Iowa Economic Development Authority and TEConomy Partners, LLC extend their thanks to the following individuals who participated in the EdTech Workgroup for this project. Their significant time commitment and professional guidance are gratefully acknowledged.

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- Ada Woo, Senior Director of Strategy Implementation and Operations, ACTNext

EdTech Workgroup Members

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- Dan Clay, Dean of the College of Education, University of Iowa
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