Towards a Roadmap for Scalable Advanced Learning Ecosystems (SALEs)

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Abstract

Fifty-five educators from around the country convened on the Georgia Tech campus in November 2018 to discuss the concept of "Scalable Advanced Learning Ecosystems" (SALEs).The purpose was to identify the overarching issues that would need to be addressed in creating a system of learning that was both highly personalized and scalable. Five themes emerged from the summit: 1) enhanced learner agency; 2) transformation of instruction, assessment, and the faculty role; 3) rethinking accreditation, financial aid, and the credit hour; 4) moving towards a complex and interconnected technical infrastructure; and 5) affordability and determining return on educational investment. This paper illuminates these five themes.

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Changes are visible on the horizon that have potential to transform the nature of teaching and learning in the twenty-first century. To name just one example, recent developments in artificial intelligence have the potential for scaling up education, increasing personalization, and harnessing learning data and analytics in meaningful ways. Of course, possibly useful technologies still need to be refined or even invented. To accommodate the rapidity of innovation, certain institutional incentives, policies and structures need to be revised, adopted, and put in place. Significant investments of effort and/or money will be needed to ensure cost-effectiveness and affordability in the long term. Proposed solutions to educational challenges will require consensus building and institutional will. The continuous churn of knowledge and shifting demands on students and the workforce has created an ever-growing need for professional development and re-skilling. As a result, the number of people needing some form of higher education will increase significantly beyond the population of 18-24-year olds that form the bulk of higher education students today. Yet already, higher education systems are unaffordable and un-accessible to many potential students. Current models seem unlikely to suffice for a student population that may come to include every working adult. Advances in learning and educational theories coupled with advances in information communications technologies, have already made possible great strides in increasing the affordability and accessibility of a high quality education. However, to date there has yet to be an overarching blueprint guiding the creation of the most complete state-of-the-art scalable educational environment. While there have been numerous isolated introductions of possible components of this environment (e.g. MOOCS, intelligent tutoring systems, etc.), a unified vision has yet to be created that incorporates everything known to be effective in one system. The Scalable Advanced Learning Ecosystems (SALE) summit sought to begin the creation of this vision.

Kadel (2018) introduced the notion of “Scalable Advanced Learning Ecosystems” or SALEs. A scalable advanced online learning ecosystem is a network of platforms and tools that need to work seamlessly in order to provide a consistent learner experience. A SALE provides instructors and administrators flexibility in considering the tools they need to deliver learning effectively. The Kadel article was also a preview of the summit, sponsored by the National Science Foundation, that convened educators from around the country to collaborate on ideas for SALEs.

Fifty-five attendees came together on the Georgia Tech campus on November 29 and 30, 2018 to create a roadmap for creating SALEs.[1] Envisioned as laying the foundations for next generation learning ecosystems, workshop organizers brought together experts in the field to imagine the blueprints of what SALE would look like. This conference was conceived of as an outgrowth of Georgia Tech’s educational think tank, the Center for 21st Century Universities (C21U), Georgia Tech Professional Education (GTPE), and the provost’s Commission on Creating the Next in Education (CNE), a Georgia Tech-wide initiative which imagines education in the not so distant future. It was also a logical follow up to the Affordable Degrees at Scale conference hosted each year by Georgia Tech. The workshop featured several invited speakers, who lead conversations around the core topics[2]. These plenary talks were followed by deep-dive interactive sessions in which participants focused on particular issues and domains and develop action plans in four

[1] A copy of the SALE Summit program is included in the Appendix.
[2] The recordings of these plenary talks are available at: https://mediaspace.gatech.edu/channel/NSF%2BScalable%2BAdvanced%2BLearning%2BEcosystems%2B%2528SALE%2529%2BSummit/107094871

tracks: Learning Design and Technologies; Business Models and Sustainability; Faculty Roles, Student Services and Student Engagement; Research, Assessment, and Compliance. Within these tracks participants examined learning and organizational goals, affordances of new and emerging technologies, institutional strengths, and societal drivers of change that coalesce in the creation of SALE. They also considered project scale, scope, costs, potential impact, and possible return on educational investment. The authors would like to express our sincere thanks for the facilitators of the deep-dive sessions[3] and the summit participants[4] who laid the groundwork for this white paper.

The need for this gathering was clear – contrary to the concept of an educational ecosystem, many current learning technologies, tools, and platforms function like silos. In particular, they are often proprietary in nature instead of being open source and integrative. Demarcations between technologies and lack of integration can make it difficult for universities to customize learning environments and choose from an a la carte menu of platforms and technologies to meet their needs. They face issues of compatibility, maintenance, and support. As a result, it is difficult to create a learning ecosystem – ecosystem in this case defined as an adaptive learning environment that personalizes content, instruction, and program administration for the learner. Yet, learning ecosystems are the wave of the future as more and more students use educational technologies, move online and to hybrid classrooms, and as education increasingly scales-up.

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These new models are replacing older paradigms for learning. While the apprenticeship model of learning through one-on-one or small group interactions with a teacher works for almost any competency, it has become rare in post-secondary education (except for research labs) because the model is neither easily scalable nor financially affordable. With class sizes at many universities reaching as many as few hundred students (even for some graduate classes), the interaction between the teacher and the students can be limited with few opportunities to personalize or adapt instruction. The Holy Grail, then, for future pedagogies is to find ways to adapt instruction individually for all students at scale. Advances in computing, artificial intelligence and data analytics bring with them the potential to reproduce personalized interactions at scale. And the real-time data collection and interpretation, and the pedagogical responses found in one on one learning interactions, can lead to the creation of an ecosystem that works for all learners.

Educators are closer to this ecosystem than ever before. Those who teach, design, and administrate learning understand the cognitive, social and cultural processes of learning better than they did a generation ago. For example, educators now have better understanding of the role of metacognition and the importance of formative assessment and feedback in learning. Further, the role of context and activity in creating conditions for the transfer of knowledge and skills to different contexts has become more salient. Parallel advances in educational technologies – especially in computing, networking, media, virtual reality, artificial intelligence, machine learning, and data analytics – are making many familiar models of learning scalable and also introducing new models of learning. Georgia Tech’s Online Master of Science in Computer

Science (OMSCS) program illustrates both how new computing technologies make a model of learning scalable and introduces a new transmission model of learning.

Continued re-evaluation and re-imagination of learning environments is sorely needed. As early as 2007, educational technologists noted that the lack of integration of learning systems fostered poor experiences for learners, cost fluctuations, uneven learning outcomes, and disengagement on the part of learners and teachers (Uden, Wangsa, & Damiani, 2007). Subsequent reports have reiterated these findings. Students and educators find multiple technologies daunting (Lee, Miller, & Newnham, 2008), multiple authentications and visiting multiple sites equally frustrating (Suess & Morooney, 2009). In some cases, students may have to access five or more different tools, including a Learning Management System (LMS), outside discussion platform, e-textbook, clicker, presentation tools, etc. Learning Management Systems (LMSs), a ubiquitous tool in higher education, can be limiting. As Jonathan Mott has noted, "usage patterns suggest that the LMS is primarily a tool set for administrative efficiency rather than a platform for substantive teaching and learning activities (Mott, 2010, pg. 1). LMSs create constraints for learners and can foster limited learning (Mott & Wiley, 2009). LMSs are also perceived as resistant to change, outdated, and institutionalized (Garcia-Penalvo, et al 2014). Most stakeholders recognize a clear need for re-imagination of LMSs to take into account new developments in technology as LMSs don't necessarily promote wider ecosystems that integrate rapid developments in educational technology.

Chang and Uden (2008) noted that creating a holistic ecosystem requires providing strategic direction for an institution's learning initiatives, and establishing objectives and support for their completion, risk management, and thoughtful allocation of resources. Next Generation Learning Digital Environments (NGLDE) have the potential to serve this purpose. NGLDEs, on the other hand, rely on a variety of developments in educational technology, including Personalized Learning Environments (PLEs). PLEs allows for learners to create their own learning path and outcomes using a personalized portal that organizes multiple tools. Models for this include social network platforms like Facebook, WordPress, and Twitter (Tu, et al, 2012). Another model is The Bring Your Own Device (BYOD) movement, which encourages students not only to utilize the informal learning that takes place on social networks but to customize and personalize learning on students own portable devices. (Yong & Song, 2015) The main drawback of PLEs is that they require high levels of self-regulation on the part of the learner (Dabbagh & Kitsantas, 2012). When students adopt self-directed learning (SDL), however, students experience increased engagement and improvement in learning outcomes (Kim. et al, 2014). Indeed, PLEs can foster both higher order and lower order skills including time management, metacognition, and critical thinking (Broadbent & Poon, 2015).

One solution for both enabling and maximizing PLEs, is the creation of Open Network Learning Environments (ONLEs). Cloud computing is a promising avenue for exploration and can provide the infrastructure for computation and storage resources that support ONLEs (Dong, et al., 2009). This open learning ecosystem would also further learning research. A successful example of creating such a system is the ASSISTments project (Heffernan and Heffernan, 2014). A customizable, flexible learning platform, it allows teachers and researchers to partner in delivering both content and assessment and allows each group to adapt the platform for their own uses. MOOC researchers have developed a framework, called the MOOClet framework, which better enables personalization of MOOCs agnostic of platform (Williams, et al, 2014). In this framework, MOOClets are modifiable modular components of online courses that can be adapted and improved for learners.

Perhaps the most important work to date on a digital learning environment has been done by EDUCAUSE in partnership with the Gates Foundation (Brown, Dehoney & Millichap, 2015) This study coined the term NGLDE in addition to theorizing what the next step beyond LMSs would look like. In particular, they will require new architecture, integrated IT systems, cloud functionality, and bridges between the individual and institutional levels (p. 3-4). As the authors of the study point out, “Clearly we need to invent new architectures that support a digital confederation. We need to invent a model for technological coherence for the NGLDE, consisting of standards and core services. Other components will also be necessary, such as new standards, tools, and user experience designs” (p. 4). The authors of this study advocate the use of the “Lego approach” where using various components, institutions will customize the NGLDE for their needs.

Overarching Themes for SALEs

This paper, a follow-up to Kadel’s 2018 piece, will illuminate some of the major themes that emerged from the SALE summit. The summit was organized around five working groups: business models; technical infrastructure; immersive learning, such as augmented and virtual reality; artificial intelligence and personalization; and research, assessment, and insights. Each of the groups was tasked with a series of questions to consider and was asked to use those questions to create visions for the future of a SALE in 1-2 years, 3-5 years, and 6-10 years.

In comparing these visions, both during the summit and in subsequent discussions, five major themes emerged that showed the overlap of the groups' work. While each workgroup identified various perspectives and characteristics of SALEs within their own domains, five major themes repeated across all these domains:

1) Enhanced Learner Agency

The most sweeping theme centered on the individual learner, who will have agency over what, how, when, and where he or she learns. For example, artificial intelligence (AI) will continue to develop such that applications driven by AI will move from being a "cognitive primer" to being a "cognitive partner." Whereas most AI applications currently in use are able to deliver information based on algorithms that predict what information a learner needs, AI apps of the future will be able to provide deliberate practice with feedback. For example, the online videos of the Georgia Tech OMSCS 7637 class on Knowledge-Based AI have about 150 fifty problem-solving exercises built into them. Most of these exercises come with tutors who assess the student's answer and provide explanations when it is incorrect (Goel & Joyner 2017). The students have found these exercises and tutors both interesting and useful. Ou, Joyner & Goel (2019) presented a 7-principle model for designing instructional videos abstracted from this course.

In the future, AI apps will also act as a coach that assesses the level of learning, delivers content in ways that are tuned to each learner's needs, and prompts the learner in order to measure competence. As those competencies are demonstrated, the learner's transcript – we use that term loosely here – will reflect not only mastery of content knowledge across multiple learning outcomes, but also mastery of skills in critical thinking, presentation, writing, collaboration, etc. These AI apps will be useful not only for online education but also for blended learning (Madden et al. 2019).

The shift to learner agency, however, is not limited to changes in instructional technology. Business models will also need to adapt. For example, how much will learners need to pay, and how will such monies be aggregated or disaggregated? The standard tuition model will need to be replaced with one that encourages payment according to each learner's individual needs. Likewise, this would necessitate changes in financial aid, such as what counts as "full time" enrollment, or enrollment in professional development courses rather than, or in addition to, credit-bearing activities, when the standard Carnegie unit may face its own set of changes.

Consequently, this could result in changes to revenue models. The logic based on a traditional view of higher education may conclude that if learning is less defined by a specific degree program and more by competencies across a range of subjects then revenue will likely decrease. If Student A would normally pay $40,000 for a four-year degree program, but she can give evidence of prior learning and finish in three years, then the institution only receives $30,000. Bradley, Seidman, and Painchaud (2012) dispelled this myth in their discussion of the Prior Learning Model of competency-based education. The authors stated that revenues would not be negatively affected by changes in such education because the faster a student moves through the program, the sooner another student could be added. In other words, if Student A is given credit for prior learning, she will simply finish her program in three years instead of four. This would open up a spot for Student B to start, ensuring a steady stream of students enrolling at the institution. Further, say the authors, such a model may be more attractive to students with on-the-job experience that can be applied to the program, thus increasing the number of students who would wish to be served by that program. Obviously, online programs with more generous or more nebulous concepts of “available seats” create additional flexibilities for competency-based, competency-oriented, or learner-led educational activities.

This emphasis on learner agency invigorates the domain of heutagogy, the study of self-determined learning. In a heutagogical approach to learning, learners are expected to be highly autonomous, owning the path to learning as well as the processes and the criteria for what will be learned and how (Hase & Kenyon, 2001). Learner agency and autonomy is also a source of caution though (Gazi, 2014), for two major reasons: first, decisions about what to learn and how to learn can lead to gaps in competence which may cause material loss or loss of lives. Hence, there should be multiple levels of accountability built into the learning experience to ensure that, independent of the choices learners make, the result of the learning experience is mastery of the essential learning outcomes. Second, personal autonomy and freedom of choice, foundational characteristics of adult learning as defined by Boyd (1966) and Anderson (2013) are primarily Western and democratic values. Hence, such freedoms need to be carefully examined with an open mind about their utility in a variety of global educational platforms and contexts.

2) Transformation of Instruction, Assessment, and the Faculty Role

As the learner’s experiences and choices dictate more and more of the learning process, it will also be necessary to change instruction to provide the best and most applicable knowledge and skills. One working group at the SALE summit spent considerable time looking at the value of immersive learning – augmented, virtual, and mixed reality. The goal of using such technology should be “to make the unfamiliar familiar,” said this group. Multiple studies have demonstrated the value of experiential learning (see, e.g., Kolb, 2015). However, in-person experiential learning can be costly and is not scalable. Immersive learning provides an avenue to deliver to the learner experiences beyond the classroom, but wholly online in a simulated environment. A prime example would be walking the streets of Berlin during the 1961 construction of the wall versus the destruction of that wall in 1989. Students could learn about the politics, economics, culture, history, and unrest that ultimately brought down one of the greatest symbols of the Cold War.

Currently, virtual and augmented reality headsets are cumbersome and expensive. However, companies from Microsoft to Magic Leap are making great strides in reducing both the size and cost of these headsets, while also harnessing increased processor speed that will allow for better virtual experiences. With 5G networks (Techradar, 2019) and the new WiFi6 standard (WiFi Alliance, 2019) in the near term, it will be easier than ever to stream the tremendous amounts of data needed to render these virtual worlds at home, at school, or on-the-go. This will make AR/VR experiences less dependent on large desktop computers and massive local storage. The end result will be experiential learning that draws on a vast library of experiences and interactions, but with reduced cost and increased availability for learners.

New ways of assessing student learning will work hand-in-hand with the adoption of immersive learning environments. Summative assessments, for example, can be redesigned to take place within a virtual world. These will reflect realistic scenarios and challenges and will provide case studies that are directly related to the careers students will have. As such, assessments will be chunked into smaller parts, evaluating knowledge in an episodic way. On the plus side, this allows for better real-time intervention for struggling learners. However, on the minus side, this process will make for a less holistic measure of learning, which must be addressed at some point in the learning process.

As the landscape of instruction, assessment, and administration changes, so too will employment. Instructors will need to be as flexible as the courses and programs that are being delivered to students. This could result in two significant changes: first, there may be less of a need for traditional instructional tasks. As instruction becomes more scalable, fewer faculty will be needed to deliver that instruction. However, this is not to say that faculty role will become extinct. Faculty will continue to create the curriculum and be the owner of the learning environment; however, as many of the tasks of instruction will become more automated and scaled to larger audiences of students, the faculty role will shift to mentoring and facilitation of learning. Faculty will continue to be the authority on expected outcomes and how those outcomes are demonstrated and assessed. Although, even the most hard-working faculty member would not be able to meet all the needs of a class of 1,000 students. Therefore, and second, schools will need to hire more teaching assistants who can provide the day-to-day contact hours that students will need. As above, such services would be in addition to any automated instruction that the students receive regularly. One question the SALE summit participants asked along these lines is whether this will affect the number of graduate students who go on to earn their Ph.D., rather than taking a full-time job as a teaching assistant. This remains an open question.

3) Rethinking Accreditation, Financial Aid, and the Credit Hour

In the vast and often confusing landscape of post -secondary education it is often difficult for students to know how to assign value to specific educational opportunities. If you think of higher education as an investment from which you later expect a positive return (see the Return on Investment section below) then potential students need a way to evaluate the possible risks associated with that investment. In the world of finance this is done partly through corporate credit ratings, and there are a handful of independent firms (e.g. Moody's and Standard and Poor's) that regularly publish such ratings. In higher education a similar function is accomplished through accreditation. Accreditation is an attempt to guarantee quality and is a shortcut to making an informed decision as to the reputability of an institution. There are twenty-one institutional accreditors recognized by the US department of education at the time of this writing in the United States, and a few dozen programmatic accreditors (US Department of Education, n.d.). The Council for Higher Education Accreditation (CHEA) recognizes seven regional accrediting agencies (CHEA, n.d.) and over 150 additional international organizations. There are at least 191 unrecognized accrediting agencies operating in the U.S (Wikipedia, n.d.). The U.S Department of Education database of accredited campuses contains over 31,000 entries, including multiple campuses belonging to the same institution (US Department of Education, n.d.).

When the accreditation space is overwhelming even to those of us in higher education, how can learners be expected to make sense out of it? Despite the best efforts of policy makers, accrediting agencies, and institutions, accreditation has been, and still very much is, a resource-intensive, administrative activity that repels most higher education faculty. Accreditation's focus on controlling change to maintain the evaluated and certified quality makes it notorious for its rigidity to allow for educational innovation. Having said that, we also see incredible examples of innovation in the higher education space within the restrictions of regional accreditors. For example, Georgia Tech's affordable Master's degrees at scale (in computer science, analytics, and cybersecurity) (McKenzie, 2018), Arizona State University's Global Freshmen Academy (Arizona State University, n.d.), and edX's MicroMasters credentials (edX, n.d.) were launched in partnership with elite institutions that provide pathways from open and free courses to degrees.

One of the biggest challenges to creating SALEs with any sort of flexibility in courses and degrees is the credit hour (Carnegie Unit). The overreliance on the credit hour as a measure of learning has resulted in definitions of courses (3 credit hours), degrees (e.g., 120 credit hours for a bachelor's degree), and so on. Federal financial aid – and many employer-based programs – are tied to the credit hour, where in order to qualify, the learner must be taking at least 12 credit hours per semester. However, if learning and instruction are changed such that students enroll in micro-courses, service-based learning, or competency-based learning (to name just a few examples), the credit hour becomes a limiting definition of learning. For example, a credit hour is supposed to represent one hour of faculty-student contact time per week during a 15-week semester. If courses at the same institution run on 4-, 5-, 10-, and 15-week schedules, the credit hour is not flexible enough to be a measure of learning in all of them. Further, in competency-based programs, where faculty-student contact time may be different for each student depending on their incoming competencies, how does the credit hour apply equally to all?

In late 2018, the Department of Education initiated a rulemaking process that intended to address several issues, including the credit hour (U.S. Department of Education, 2019a). The proposed language for credit hour would replace the existing definition as "defined by an institution and approved by the institution's accreditor and is based upon an amount of work, a unit of time spent engaged in learning activities, and/or a set of clearly defined learning objectives or competencies" (U.S. Department of Education, 2019b, p.2). This new definition removes credit hour/clock hour equivalency and is poised to open a new approach to institutional eligibility for financial aid. While these are initial proposals, they give us an idea on how the

Department of Education intends to change accreditation, providing clarity around the credit hour and regular and substantive interaction, and providing pathways for innovation. The rulemaking process will be open for public comments and ideas.

One possible idea is suggested in the report of the Georgia Tech Commission on Creating the Next in Education (Office of the Provost, 2018). This report proposes a new unit for recording student learning based on achievement instead of a fixed time in which the achievement must happen. Called the “Dewey Unit” after John Dewey, this unit measures experiential learning which may happen in or out of the classroom. Students will be able to get credit for formal classroom accomplishments, but also for more informal learning activities that may happen in small increments and in a wide variety of settings. Switching to credit being experience-based rather than time-based allows students to have much more agency in creating a personalized learning journey that is also more readily amenable to credit transfer and financial aid.

4) Towards a Complex and Interconnected Technical Infrastructure

In 2013, Rob Abel (IMS Global), Malcom Brown (EDUCAUSE), and Jack Suess (University of Maryland Baltimore County) published an article in EDUCAUSE Review titled “A New Architecture for Learning” (Abel et al., 2013). The article served as a “call to action” for information technology managers to collaborate on and adopt a set of standards that would allow for agility, flexibility, and personalization across the range of educational platforms and applications that support learning. The article also served as one of the precursors to terms common in educational ecosystems today, such as Learning Tools Interoperability (LTI) (IMS Global, 2019a) and Next Generation Digital Learning Environments (NGDLE) (Pomerantz et al., 2018). NGDLEs are, in their core, ecosystems; dynamic, interconnected, ever-evolving communities of learners, instructors, tools, and content (Feldstein, 2017).

We view NGDLEs as one major part of the SALE landscape. To a large extent, the NGDLE would address technical infrastructure needs and standards that range from application integration, such as: a) making it easy to ingest data from all platforms by adhering to standards like Caliper or xAPI; b) allowing content to be easily transportable between platforms using Common Cartridge or SCORM; c) enabling instructional teams to expand functionality and tighten integrations using LTI or open APIs; and d) enabling personalized learning through a highly flexible framework that encourages instructors to mix-and-match or plug-and-play components (Lisle & Gazi, 2019).

A major challenge to the idea of demonstrating mastery of both content and skills will be in how that information is shared with employers, other schools, or anyone who has an interest in what a student is able to do. IMS Global has proposed the "Comprehensive Learner Record" (CLR) (IMS Global, 2019b) now making headlines (Shendy et al., 2019). The CLR is envisioned as a collection of skills, experience, abilities, competencies, etc. that provide much more granular detail about what (and how) a student has learned. Technology infrastructure is expected to support a comprehensive learner record, similar to how healthcare systems are investing in electronic health records for patients. So, as a learner swirls in an and out of educational activities throughout their lifetime, no matter how many different institutions touch the learner and the type of credentials and competencies are achieved, there is a coherent and comprehensive record of activity that is owned by the learner. Data would be collected with the student's permission and gathered into a repository that can be shared with anyone the student deems should have access to the information. It would further be customizable so that the student can share *relevant* information depending on the recipient's needs. Georgia Tech is making a push into the CLR where such information would be shared on the Blockchain (Office of the Provost, 2018). Other institutions, such as MIT (Newton, 2018), the Universities of Auckland and Melbourne (Browne & Manahan, 2018), UNESCO (Chakroun, 2018), and the entire nation of Malta (Tonin, 2019) are experimenting with sharing such academic credentials on the Blockchain.

5) Affordability and Determining Return on Educational Investment

Parents, students, companies, the federal government, etc. invest significant resources into post-secondary institutions with the expectation to receive some future benefit. Yet, increasingly, the ability of post-secondary institutions to deliver the expected return on investment has been called into question. For instance, a 2018 Gallup poll indicated that only 48% of U.S. adults expressed "a great deal" or "quite a lot" of confidence in higher education, which represents a 9% drop from the 2015 poll (Jones, 2018). Furthermore, Jones (2018) noted that "No other institution has shown a larger drop in confidence over the past three years than higher education" (p. 2). While studies like this poll can and should alarm post-secondary educators, the results are undergirded by a complex system of expectations and metrics that are not aligned and present an inadequate view of post-secondary return on investment (ROI). Blagg and Blom (2018) emphasized this issue in their conceptual framework for ROI. For example, the first component of their model emphasizes that "the exact returns for an individual are highly uncertain and evolve over the years." (p. 2). The authors go on to emphasize that this uncertainty, in part, can be traced back to things such as variation in financial aid packages, the amount of time to graduation, earning variations by institutions, major, degree level, and earning variation, and variation in earnings by demographics and local economic conditions.

As the post-secondary community considers a future with SALEs, the community must recognize the considerable ROI challenges SALEs present. Considerable debate exists about the ROI of online learning (Protopsaltis and Baum, 2019). Furthermore, creating an ecosystem of platforms and tools represents a sizeable technology investment, with the benefits often not seen by the students whose tuition and fees are being invested. That being said, the investments made in SALEs are investments into the core mission of institutions, namely learning and the learner experience. SALEs strive to allow institutions to more deeply acknowledge the individuality in ROI. SALEs that integrate systematic ROI investigation and reporting provide an opportunity to reshape the ROI debate, with parents, students, legislatures, donors, etc. becoming informed partners.

SALEs can achieve affordability through scale, as evidenced by Georgia Tech's master's degrees in computer science, analytics, and cybersecurity, all offered for under $10,000 for program tuition and fees. These programs collectively have almost 12,000 students as of Spring 2019. Master's tuition at a fraction of the cost of the residential program at a top-ranked university, with essentially unlimited capacity makes a very compelling and exciting case for ROI.

Conclusion

The experts and practitioners from a variety of domains, whom we brought together under the auspices of the National Science Foundation and Georgia Tech, identified the broad themes that will achieve Scalable Advanced Learning Ecosystems (SALEs). It should not be surprising that learners, learning environment, policies, technological infrastructure, and business sense stood up from the rest of the issues and characteristics identified. These are broad themes to address in any digital learning environment. Having said this, the devil is in the details. SALEs pose significant challenges in terms of the rapid pace of technological advances that are promising yet still elusive and resource-intensive. They expose the vulnerabilities in terms of governance (of policy making, data, and faculty role, to name a few). More importantly, not all institutions can achieve scale in all subject areas. Therefore, it will be interesting to see unfold those who will emerge as leaders and establish themselves in certain fields.

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APPENDIX: SALE Summit Program