Transforming doctoral education: Preparing multidimensional and adaptive scholars

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Abstract

Purpose – Concerning trends in graduate education, such as high attrition and underdeveloped skills, drive toward a new doctoral education approach. This paper aims to describe and propose a transformative doctoral education model (TDEM), incorporating elements that potentially address these challenges and expand the current practice. The model envisions discipline-specific knowledge coupled with a broader interdisciplinary perspective and addresses the transferable skills necessary to successfully navigate an ever-changing workforce and global landscape. The overarching goal of TDEM is to transform the doctoral student into a multi-dimensional and adaptive scholar, so the students of today can effectively and meaningfully solve the problems of tomorrow.

Design/methodology/approach – The foundation of TDEM is transformative learning theory, supporting the notion learner transformation occurs throughout the doctoral educational experience.

Findings – Current global doctoral education models and literature were reviewed. These findings informed the new Transformative Doctoral Education Model.

Practical implications – Designed as a customizable framework for learner-centered doctoral education, TDEM promotes a mentor network on and off-campus, interdisciplinarity and agile career scope preparedness.

Social implications – Within the TDEM framework, doctoral students develop valuable knowledge and transferable skills. These developments increase doctoral student career adaptability and preparedness, as well as enable graduates to appropriately respond to global and societal problems.

Originality/value – This proposed doctoral education framework was formulated through a review of the literature and experiences with curricular design and pedagogical practices at a research-intensive university's teaching and learning center. TDEM answers the call to develop frameworks that address issues in doctoral education and present a flexible and more personalized training. TDEM encourages doctoral student transformation into adaptive, forward-thinking scholars and thriving in an ever-changing workforce.

Keywords – Transferable skills, Graduate education, Mentoring, Interdisciplinary, Career planning, Transformative learning theory

Paper type – Conceptual paper

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Concerning trends in graduate education combined with global, complex problems continue to drive toward a new doctoral education approach (Bosque-Perez et al., 2016; Nerad, 2004; Walker et al., 2008; Weisbuch and Cassuto, 2016). Traditional faculty-centric methods lack effectiveness in preparing students for the evolving demands facing graduates, whereas learner-centered processes consider a variety of educational and career goals (Doyle, 2012; Huba and Freed, 1999; Lattuca and Stark, 2011). Although students dedicate years to their doctoral education, graduates unfortunately are often ill-equipped and without the necessary skills required by today's workforce (Bao et al., 2018; Bray and Boon, 2011; Denecke et al., 2017; Weisbuch and Cassuto, 2016). As problems become increasingly complex, overspecialization in graduate school deprives students of the breadth needed to work innovatively and broadly to solve global and societal challenges (Elkana, 2006; Uhlenbrook and Jong, 2012). Moreover, rapid globalization necessitates recognition of a more diverse and inclusive world (Denecke et al., 2017).

Although the number of available faculty jobs is dwindling, global doctoral education continues pointing students toward academic careers (Larson et al., 2014). In the United States, most doctoral graduates are expected to enter jobs outside academia (Cassuto, 2015; National Science Foundation, National Center for Science and Engineering Statistics, 2018; Stephan, 2012). This is a similar trend internationally, as Russell Group universities report (2014) just under half of United Kingdom doctoral graduates enter a career in higher education, and roughly 20% teach. Additionally, international doctoral education purposely integrates career development within doctoral education (Bray and Boon, 2011; Milos, 2018), while programs and universities in the United States often lack information and guidance to educate students of career options (Nerad, 2004; Rudd, et al., 2008).

Given the many factors at play in the attainment of a doctoral degree and subsequent employment (i.e., family responsibilities, financial concerns, globalization and diversity, social challenges, and career goals), an innovative, adaptive, and customizable framework for doctoral education is needed (Baker and Pifer, 2015; Bosque-Pérez et al, 2016; Cassuto, 2015; Powell and Green, 2007; Weidman et al, 2001). Answering the call to provide a learner-centered approach while specifically attempting to address the current shortcomings in United States' doctoral education, pedagogical researchers at Texas A&M University's Center for Teaching Excellence developed the *Transformative Doctoral Education Model.* A thorough review of relevant literature, experiences with a National Science Foundation interdisciplinary training grant, and an on-campus partnership with the Office of Graduate and Professional Studies influenced the creation of this model. The aims of this conceptual paper are to (a) review current global doctoral education models and related literature, (b) advocate for a learning theory foundation, (c) describe the new transformative doctoral education model, and (d) discuss this new model's vision to enhance doctoral education.

Literature Review

Despite these long-standing challenges, few models of doctoral education attempt to address these issues and provide the flexibility or more personalized training necessary to enable scholars to enter a variety of careers (Cassuto, 2015; Powell and Green, 2007; Weidman et al., 2001). This literature review seeks to address two questions: a) what global doctoral education models exist in the literature and b) what themes emerge from those models?

To answer the first literature inquiry, the paper identifies seven current and representative doctoral education models across the globe: Vitae Researcher Development Framework, Chinese Doctoral Education Framework, Russell Group, T-Shaped Competency, Shield-Shaped Competency, Doctorate of Education, and the Transformative Graduate Education Model.

Vitae Researcher Development Framework. Several United Kingdom higher education initiatives prompted the Vitae Researcher Development Framework's (RDF) creation in 2010 (Bray and Boon, 2011; Vitae n.d.). Designed to encourage early career scholarship success, RDF depicts a circle comprising of four domains: knowledge and intellectual abilities, personal effectiveness, research governance and organisation, the engagement, influence and impact (Vitae n.d.). Through self-assessment, doctoral students and early career researchers can determine their research strengths or developmental gaps, while also intentionally fostering career awareness (Bray and Boon, 2011). Two such career awareness tools are the Personal Development Planner (PDP) available with the RDF and utilized in the United Kingdom, while the Research and Employability Skills Training (REST) is present in Australian doctoral education. Researchers Bray and Boon (2011) concluded the PDP is a worthy career development tool because the learner's self-assessment reveals potential career matches with their individual skill development. Flinders University created the REST program for high developing research students (Milos, 2018). When synced with RDF, this particular competency-based self-assessment tool encourages students to further plan, document, and assess their skill development, as well as reflect on their educational experiences (Milos, 2018).

Chinese Doctoral Education Framework. Unlike the United States and United Kingdom, China began doctoral education in the 1980's (Huang, 2017). Since then, global and national factors like competitiveness and labour markets drive a doctoral education boom now estimated to grant the world's second most doctoral degrees (Huang, 2017; UNESCO, 2017). Nearly all of the major Chinese universities provide joint-training and partner institution opportunities for students to develop research skills (Bao et al., 2018). The China Scholarship Council created the National Programme for Postgraduate Study Abroad in 2006, emphasizing the career and educational value for doctoral students studying in other countries (Bao et al., 2018).

Russell Group. Comprised of over twenty leading United Kingdom higher education institutions, Russell Group universities (2014) are committed to research, teaching and learning, while also innovatively collaborating with the workforce. According to the Russell Group's website (2018), this university consortium trains over "80% of the UK's doctors and dentists, and half of mathematics and physical science graduates". The Russell Group seeks to maximize their collective research impact, especially for facility and graduate student funding. In doctoral education, Russell Group universities (2014) encourage research's inclusion in teaching and offer temporary research placement in the workforce.

T-Shaped Competency. Today's multidisciplinary work and doctoral education research requires skills considered absent in traditional single discipline-based pedagogy (August et al., 2010). T-Shaped Competency uses the letter 'T', where the horizontal bar indicates an individual's interdisciplinary breadth while their disciplinary range is depicted down the 'T's vertical bar (August et al., 2010; Reis, 2001; Uhlenbrook and Jong, 2012). The University of Rhode Island's Coastal Institute created a tool to assess student's multidisciplinary training based on the T-Shaped Competency (August et al., 2010). Regular engagement with problem-solving and career development contributed an intellectual community among faculty and students across the disciplines (August et al., 2010). Similarly, the UNESCO-IHE Institute for Water Education in the Netherlands created a doctoral learning environment using a T-Shaped Competency model (Uhlenbrook and Jong, 2012). Although considered a multidisciplinary field, these water education students still specialize (vertical bar) in their doctoral focus and integrate complementary professional competencies across the horizontal bar (Uhlenbrook and Jong, 2012).

Shield-Shaped Competency. An interdisciplinary doctoral program at the University of Idaho moved beyond the T-Shaped Competency framework and developed a Shield-Shaped Competency

because of interdisciplinarity needs (Bosque-Pérez et al., 2016). In this educational model, learner's gain understanding and training across multiple disciplines (indicated by multiple vertical bars of knowledge), rather than a single discipline's depth (Bosque-Pérez et al., 2016). Integral to this team-based learning environment is a student's ability to become well-grounded in the main discipline, advance understanding, and show critical awareness of the learning process (Bosque-Pérez et al., 2016). Students experienced high confidence in their interdisciplinary abilities, while also developing their interdisciplinary teamwork and communication skills (Bosque-Pérez et al., 2016). Two noteworthy aspects of this model are a student's engagement with more than one mentor and the model's customizable intent (Bosque-Pérez et al., 2016).

Doctorate of Education. Within the United States, the education discipline doctoral degrees include Ph.D. (Doctor of Philosophy) and Ed.D. (Doctor of Education). The Carnegie Project on the Education Doctorate (CPED) reimagines professional-practice degrees in school leadership, organizational leadership, or teacher education (Perry, 2016). The CPED framework aims to develop stewards of practice through six principles: signature pedagogy, laboratory of practice, inquiry as practice, problem of practice, scholarly practitioner, and dissertation in practice (Perry, 2016). The CPED initiative now has over one-hundred schools participating, including in Canada and New Zealand (CPED n.d.).

Transformative Graduate Education Model. Virginia Tech University researchers introduced the term Transformative Graduate Education Programs or TGPs (Kniola et al., 2012). According to the researchers, TGPs "are programs that are national in scope and are intended to impact the reformation of graduate education in the United States" (Kniola et al., 2012, p. 473). Focused on professional development and social integration, TGPs also call for interdisciplinarity to meet the demands of a global world (Kniola et al., 2012). Unique to Virginia Tech University's Graduate School is the Transformative Graduate Experience (TGE), an educational framework including credit-bearing courses designed to equip students with societal-focused knowledge and skills, regardless of career interest or academic discipline (Virginia Tech University n.d.).

Six themes emerge from the seven models (Table 1). Further detail encompasses the theme's context within the literature and the new Transformative Doctoral Education Model.

Table 1. Doctoral education model themes

Doctoral Education Model	External Drivers	Learner Development	Image	Uniformity	Interdisciplinarity	Learning Theory
Vitae Researcher Development Framework	YES	YES	YES	YES		
Chinese Doctoral Education Framework	YES	YES		YES		
Russell Group	YES	YES		YES		
T-Shaped Competency	YES	YES	YES		YES	
Shield-Shaped Competency	YES	YES	YES		YES	
Doctorate of Education (Ed.D.)	YES	YES	YES	YES		
Transformative Graduate Education Model	YES	YES	YES		YES	

External drivers. A common theme among these seven models and doctoral education literature is the influence of external drivers. Three notable external drivers for global doctoral education include the "massification and professionalization of doctoral education and the introduction of quality assurance systems" (Crossouard et al., 2015, p. 7). In a doctoral education study across six countries, researchers concluded the national context contributes to the influence of these external drivers (Crossouard et al., 2015). Though external drivers may vary across nations, institutions, and disciplines, the global and societal demands remain constant.

Learner Development. The second theme, also common among all seven models, is learner development. In other words, those doctoral education moments that produce long-lasting and meaningful student impact. Threshold concepts, a theory growing in the higher education literature, represent a transformational and irreversible shift in learner perspective and identity (Meyer and Land, 2003; Mayer et al, 2010). Various threshold concepts have been identified in doctoral education, including "analysis, theory, knowledge creation, research paradigm, framework, argument/thesis, creativity, writing, and doctorateness" (Kiley, 2017, p. 296). In addition to those researcher development concepts, skills such as critical awareness and reflection, project management, and communication are also integral in overall learner development (August et al., 2010; Bray and Boon, 2011; Kniola et al., 2012; Milos, 2018). Student immersion experiences, another higher educational trend, create learner development by linking academia with industry (Bao et al., 2018; Perry, 2016; Russell Group, 2014). Additionally, blending technical and transferable skill development in doctoral education further promotes a student's career awareness and preparation. This, along with an expanded mentorship, counterbalance the institutional career development resources that may be lacking for doctoral education.

Image. The third theme of interest includes the availability of a graphic or framework image identified for the doctoral models. Visualization communicates complex ideas to a variety of audiences (Otten et al., 2015). Five doctoral education models incorporated graphics (Vitae n.d., August et al., 2010; Bosque-Perez et al., 2016; Perry 2016; Virginia Tech University n.d.). The Vitae Researcher Development Framework (n.d.) offers a complex image of several intrinsic circles and layers, whereas others are simply depicted by horizontal and vertical bars (August et al., 2010; Bosque-Perez et al., 2016). The image associated with the Virginia Tech TGE example, also adopted by their graduate school, allows extension to their broader student population (Virginia Tech University n.d.).

Uniformity. A fourth theme, uniformity, describes the doctoral education model's level of replicability across institutions. Model uniformity is distinguished between and across nations, as the majority of Chinese doctoral education programs create similar institutional collaborations (Bao et al., 2018), doctoral education aims are embraced by all twenty-four Russell Group (2014) members, and the Vitae Researcher Development Framework is adopted in countless institutions and multiple countries (Vitae n.d.; Bray and Boon, 2011). Perhaps influenced by the recent charge to re-define their discipline, the doctorate of education is a notable example of uniformity in the United States (Perry, 2016). Each example possesses clear connections and dependable contributions with their national workforce. Conversely, model customizability offers higher education programs an option to apply aspects most appropriately fitting their educational landscape and national context.

Interdisciplinarity. Three models specifically incorporate interdisciplinary education, an increasingly valuable learning outcome and doctoral education trend (August et al., 2010; Bosque-Pérez et al., 2016; Holley, 2015; Jacob, 2015; Kniola, et al., 2012; Uhlenbrook and Jong, 2012;). To achieve an interdisciplinary goal, students and faculty mentors must also develop effective forms of communication and collaboration (Begg et al., 2015; Bosque-Perez et al., 2016). The Shield-Shaped Competency also revealed the hidden interdisciplinary benefit of enhanced mentorship (Bosque-Perez et al., 2016; Jacob,

2015). Faculty and mentors ideally foster an intellectual community encouraging interdisciplinary balance and additional learning support that allow the student to form an academic identity and ability to navigate multiple disciplines (August et al., 2010; Graybill et al., 2006; Holley, 2015).

Learning Theory. Lastly, although learning theories may subtly influence these models, none of the seven doctoral education models explicitly describes a learning theory framework (Kniola et al., 2012). Although not directly applied to a doctoral education model, three learning theories are anecdotally evident in doctoral education: self-directed learning, metacognition, and experiential learning. Self-directed learning is present in doctoral education through independent study or research projects, where individual motivation drives learning (Brookfield, 2009). In this regard, adult learners take initiative by making conscious decisions on how to learn new concepts and information (Brookfield, 2009). Metacognition theory is based on self-knowledge or internal representations of information, regardless of whether those perceptions are correct or incorrect (Hacker, 1998; Veenman et al., 2006). Doctoral education exemplifies metacognition through the creative intelligence necessary for research design (Cravens et al., 2014). Experiential learning principles align with doctoral education, as students become an expert in their field of discipline through obligatory skill development activities like data analysis, academic writing, and critical reflection (Lam et al., 2018). Of these three learning theories, self-directed learning and metacognition generally disregard the individual experience in adult education while experiential learning advocates for the learning experience but falls short in defining reflection specific to adult learning. Thus, could the inclusion of an adult learning theory rooted in experiences and reflection be the missing piece for doctoral education models?

Learning Theory Foundation.

Given the aforementioned doctoral education concerns and in particular how previously identified models do not directly connect to an established learning framework, adult education learning theories were also considered in forming a new doctoral education model. Recognizing the importance of learning frameworks, pedagogical researchers ultimately identified transformative learning theory to be universally applicable for doctoral education. As such, transformative learning theory serves as the foundation for the newly created Transformative Doctoral Education Model.

Transformative learning theory (TLT), initially developed by Mezirow (1991), theorised adult education as a process of critical reflection and learner transformation. Adult learners possess a frame of reference encompassing the cognitive and affective components of meaning-making through individual experience (Mezirow, 1991, 2000). TLT in practice comprises four key elements: critical reflection, creative and/or imaginative problem-solving, effective discourse, and fostering authentic relationships (Cranton, 2006; Taylor and Cranton, 2012).

Critical reflection implies an adult learner challenges the validity of previous perspectives and biases gained in prior experience or learning, and requires not only awareness of one's own beliefs, values, and opinions, but also that of others (Mezirow, 1991, 2012). Creative and imaginative problem-solving is necessary to not only better understand the perspectives of others, but also to redefine and re-examine problems from new frames of reference (Mezirow 2012, p. 85). Fostering this process of critical reflection and creative problem-solving requires effective discourse; the open dialogue whereby the learner(s) asserts their own perspective, examines alternate interpretations, and justifies or changes their own thinking as needed. Lastly, Cranton (2006) suggested the impact of authenticity on student-teacher relationships can promote transformation alongside cognition.

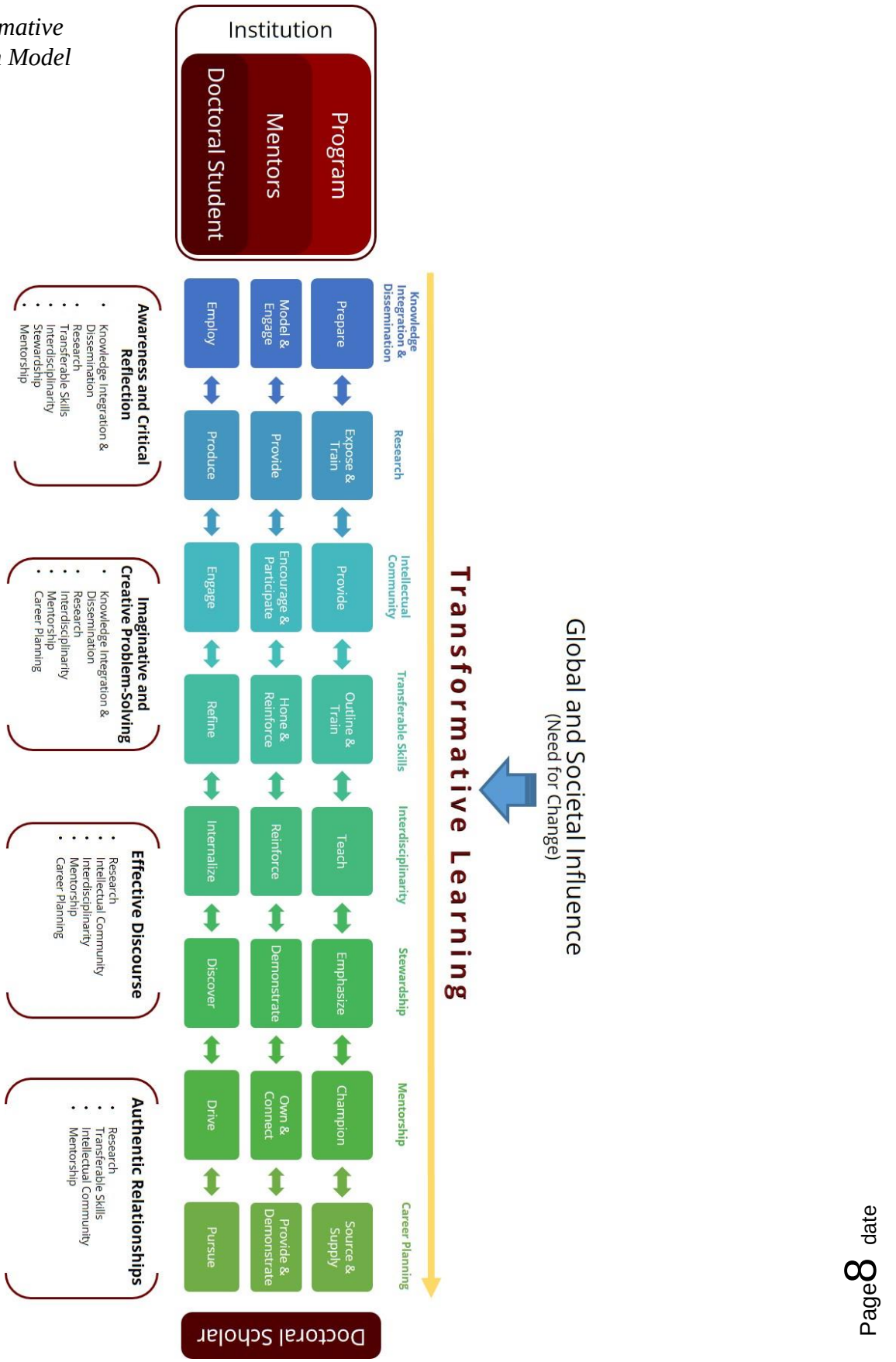
Although threshold concepts is growing in higher education, the pedagogical literature is sparse regarding TLT's direct application and practice in doctoral education. Bergeå and colleagues (2006) conducted a study of pedagogical concepts through the curriculum re-design process of a doctoral-level

EcoDesign course. Findings indicate the importance of transformative learning principles (e.g., critical reflection and effective discourse) within doctoral education as a means for solidifying meaning making and transforming the learner perspective through interdisciplinary study. Using a broader perspective of TLT in doctoral education, Stevens-Long and colleagues (2012) discovered transformative learning experiences such as multidisciplinary coursework, mentorship activities and student learning communities, were critical components in influencing overall doctoral student growth or "transformative outcomes". Despite advances in how transformative learning can be applied in United States' doctoral education, the field lacks a flexible model that has the potential to be implemented across disciplines.

***Transformative Doctoral Education Model* (TDEM)**

Based on a review of current global doctoral education models, pedagogical literature, and professional experiences with an interdisciplinary doctoral program, TLT principles appear foundational to the transformative doctoral education model (TDEM) (Figure 1). Conceptually, the intent of the new model is customizability for individuals, disciplines, and programs. Aspects of the model become salient as students progress through their academic program and evolving needs, demonstrating how TDEM transforms the learner from student to multidimensional adaptive scholar on the journey to doctoral completion. The authors define a multidimensional adaptive scholar as a mentally and situationally flexible, forward-thinking individual firmly rooted in empirically based-knowledge who consumes, organizes, and analyses complex information and renders it into understandable and actionable material.

Figure 1. Transformative Doctoral Education Model



To achieve this learner transformation, an evaluation of the global and societal influences and challenges, or the needs for systematic change ensues. Today's problems are complex, often demanding innovative competencies and teams for effective solutions. Externally driven, TDEM faculty identify research questions to address these global and societal challenges or an innovative graduate student identifies a problem they seek to address in their future research.

Higher education systems internally drive TDEM through the institution, program, mentor(s), and doctoral student. The *institution* takes a supportive and enabling role in TDEM by setting the overarching vision of the model including institutional flexibility and core values. The *program* is responsible for setting the agenda of the department and emphasizes the importance of each fundamental element within TDEM. Multiple *mentors* such as faculty members, external industry leaders or postdoctoral associates, offer guidance, feedback, and advice to help students in customizing their educational experience. The key here is multiple mentors rather than the single faculty advisor, emphasized in the traditional apprenticeship model. Finally, *students* actually drive the model. As students take an active role in their education and goal setting, they become more invested in their development and begin to shape their experiences towards desired educational and career goals. Each of these four internal drivers have unique responsibilities in fulfilling expectations of the eight elements emphasized within TDEM. The following eight elements, anchored in the literature and informed by professional experiences, elicit learner transformation.

Eight Elements of TDEM

1. *Knowledge Integration & Dissemination:* The internal development of knowledge, skills, and ability to communicate information that has been learned or created to varied audiences (Prewitt, 2006).
2. *Research:* The capacity, including the skills, to engage in rigorous, creative, and ground-breaking inquiry and scholarship (Walker et al., 2008).
3. *Intellectual Community:* "The hidden curriculum" representing verbal and nonverbal communication in which the program's purpose, commitment, and roles establish an environment where intellectual risk-taking, creativity, and entrepreneurship are welcomed and demonstrated (Walker et al., 2008, p. 10).
4. *Transferable Skills:* Skills, independent of disciplinary content mastery, required for success during and post-graduate school (Cassuto, 2015). Transferable skills transcend professional skills and include but are not limited other specialized skills particular to specific academic and career goals, such as coding, big data analysis, and software proficiency (Bridgstock, 2009; Denecke et al., 2017).
5. *Interdisciplinarity:* The core concepts, theories, and methods of a discipline(s) contribute to and influence interdisciplinary opportunities. Development of content mastery and identification of critical gaps occur here (Repko, 2011; Walker et al., 2008).
6. *Stewardship:* Consideration of applications, uses, and purposes of the discipline and favouring wise and responsible applications (Walker et al., 2008). Encompasses individual value development or reinforcement.
7. *Mentorship:* The exploration, assessment, and refinement of content, skills, and goals experienced in multiple careers and life experiences (Walker et al., 2008).
8. *Career Planning:* Creation, encouragement, and participation in activities to generate social capital with alumni, faculty, university staff, career center, and professional association

members to further desired career (Bridgstock, 2009).

Element Engagement

The following describes the role of the program, mentor(s), and student in fulfilling the eight elements. Institutional changes have ripple effects across TDEM, influencing the various internal drivers and reinforcing the notion transformation is bilateral and simultaneous.

Knowledge Integration & Dissemination. As a research degree, the Ph.D. assumes students not only consume information, but also produce and disseminate knowledge. Understanding how others learn provides a basis where scholars efficiently transmit learning outcomes. The program *prepares* students by introducing learning theory as a core curriculum component, which supports an understanding of the learning process and how to structure learning for others. Mentor(s) *model and engage* effective learning strategies and pedagogical best practices in interactions with the student, thereby reinforcing information studied in coursework and demonstrating a real-world example. Additionally, most faculty mentor(s) are responsible for teaching a class or supervising research teams, allowing flexibility to insert a mentee into a guest lecture, group discussion as facilitator, or presenter. Students are pushed to *employ* the science of teaching and learning, address wider audiences, and to apply their learning to social challenges, providing preparation in tasks representative of requirements in the ever-changing working world (Weisbuch and Cassuto, 2016).

Research. Studies show many doctoral students are not well grounded in how to conduct research, particularly research solving the complex problems of today (Boote and Beile, 2005; Weisbuch and Cassuto, 2016). Students realize the composite parts, but lack basic skills needed to conduct rigorous research, such as conducting an efficient and thorough literature review through proper database search techniques, as well as understanding the purpose of literature reviews in research, critiquing articles and taking a stand (Boote and Beile, 2005). TDEM suggests the doctoral program *exposes and trains* the student within a broad range of research, methodologies, and colleagues, providing students with opportunities to engage in rigorous and innovative scholarship (Cassuto, 2015). This broader exposure also supports interdisciplinary research. Faculty mentor(s) *provide* students with skills by providing opportunities, through their own labs, connecting the student to resources of colleagues or literature in areas of interest to help the student grow their scholarly network. External mentors from industry or government entities offer projects students utilize as an impetus for their research. Students *produce* applicable knowledge and skills to boost competence, and begin to align curricular and co-curricular experiences with research interests.

Intellectual Community. An intellectual community encourages student participation, socializing the student in professional discourse and the norms of scholarly exchange, as well as keeps students and faculty current with the latest research (August et al., 2010; Golde, 2007). TDEM proposes going beyond the traditional graduate seminar by adopting an educational environment where everyone is researching, asking, learning, and creating anew. The doctoral program *provides a* welcoming, safe, inclusive, and non-judgmental setting for transforming information. Inclusion in an intellectual community more closely aligns the student with the program creating a mutual feeling of investment, belonging, and cultivation of identity, preventing feelings of mismatch, drift, or imposter syndrome, which can improve attrition rates (O'Keeffe, 2013). Faculty and external mentors *encourage and participate* as peer learners in the intellectual community. Through words and actions, mentor(s) foster a caring and supportive atmosphere by praising student input, offering feedback, and recognizing their role not as expert, but as active learners in the community. Students meaningfully *engage* in wrestling with ideas and dialogue with their academic colleagues, external mentors, and fellow students.

Transferable Skills. Transferable skills emphasized in the model are communication (oral, written, electronic), critical thinking and questioning, collaboration including interdisciplinarity, cultural competency, adaptability and flexibility in changing environments, tolerance for ambiguity, appreciation for lifelong learning, how to be goal directed, and navigating ethical dilemmas. Specialized skills for specific academic and career goals can also be included here, such as big data analysis, intellectual property management, etc. (Denecke et al., 2017). The doctoral program *outlines and trains* the skills necessary for success in graduate school and the job market by explicitly including them in the curriculum. Connections between transferable skills and application outside of graduate school help to place the skills in context. The expanded mentor network of TDEM offers multiple resources to *hone and reinforce* the student's transferable skills. Coordination between the student and mentors regarding areas in need of improvement, unexplored areas, and specific skills necessary for certain career paths are open for discussion and brought to light through an individual development plan. The student *refines* their skills by pursuing resources and ways to practice their skills. Mentor(s) and the academic network of a doctoral student provide individualized and custom feedback on progression of the student's transferable skills.

Interdisciplinarity. The theories, concepts, and methods learned within a discipline are foundational for doctoral students (Repko, 2011). Exploring seminal works bring students in touch with a discipline's building blocks and will ultimately assist identification of research gaps. In TDEM, program faculty *teach* the need for collaboration across disciplines to address critical gaps unable to be solved within the discipline. In so doing, mentor(s) identify opportunities to not only lay the disciplinary foundation but also more importantly, *reinforce* interdisciplinary linkage through analysis and discussion of internal contradictions, incompleteness of prevailing theories, and competing paradigms that engage students to more broadly interact with the material (Elkana, 2006). While completing coursework, doctoral students begin to *internalize* and develop a curiosity to discover on their own. Students continue to explore the current literature to see the progression of the discipline, applying long-standing theories in innovative ways through interdisciplinary foundation. A variety of educational methods, mentorship network, and global awareness espoused within an interdisciplinary approach prepare scholars for the complexity of problems they will face beyond graduation.

Stewardship. Through reflection and inquiry, stewardship anchors disciplinary identity. The process of fully understanding the discipline's history and purpose encourages wise and responsible application of the discipline. The doctoral program *emphasizes* the importance of stewardship, or the act of caring for the discipline. Courses and seminars preserve the best of the past, but continually challenge students to move forward by encouraging questioning and creativity (Walker et al., 2008). Mentor(s) *demonstrate* behaviour of a steward by challenging students to think about and articulate how their work fits into the moral and social role that the discipline plays in academe and society. Within higher education, TDEM challenges the commonly accepted supposition academic citizenship is intended solely for faculty and not students (Macfarlane, 2007). Because TDEM expands academic citizenship (stewardship), students *discover* stewardship when engaging in program activities, meaningful inquiry, and mentor interacting. This perspective fosters an expectation to give back to the broader community; further emphasizing the role of caretaker of the discipline.

Mentorship. As an innovative element of TDEM, mentorship fulfils a broader role than traditional apprenticeship. Such an expanded mentorship network encompasses multiple mentors inside and outside the university setting not only combines but also strengthens disciplinary and interdisciplinary research (Cassuto, 2015). The doctoral program *champions* mentorship as a valuable and worthwhile venture through inclusion in mission and goals, faculty recognition, and reward. Additionally, the program provides necessary accountability, structure, training, and information to

enable mentor success through guidelines for effective mentorship meetings and various resources to enhance the relationship (Michael and Wilkins, 2017). Mentor(s) *own and connect* the relationship and growth of their mentees by creating an arsenal of resources to direct the student in an efficient path to the proper contact person to better answer their question and help them explore the opportunity, field, or research. Mentors challenge students to ask different questions that more fully align with interests and potential career paths, including outside academia (Cassuto, 2015). Most noteworthy, the student *drives* the mentorship relationship and develops a plan for their educational and career growth, which allows them to proceed more confidently toward graduation with potential career goals in mind (Bray and Boon, 2011; Milos, 2018).

Career Planning. A student's education influences, prepares, and calls for career planning that offers greater insight into the wide array of potential job opportunities available as a result of transformative doctoral education (Bridgstock, 2009). With increased clarity and less uncertainty of their future career path, attrition rates may be minimized and student graduation outcomes maximized (Bray and Boon, 2011; Milos, 2018; Russell Group, 2014). The program *sources and supplies* various levels of institutional and external support for doctoral students, including communication surveys, alumni listservs, and program newsletters. Graduate school partnerships form with career services and explicitly communicate to the faculty while simultaneously being introduced early and repeatedly to the students (Cassuto, 2015). Mentor(s) *provide and demonstrate* the importance and power of membership in professional networks and relationships. Mentors help students build their network by putting them in contact with alumni, colleagues, collaborators, or other connectors who may assist the students with research or professional connections (Russell Group, 2014). The student *pursues* career inklings generated by the program and their faculty mentor(s). A good network of contacts allows the student to form a knowledge base to explore different career paths, settings, and applications of the discipline that may differ from those introduced by the home institution.

Discussion

Societal needs, rapid technological advances, and the drive toward greater globalization shape the direction of higher education through career diversity, interdisciplinary, and research initiatives (Bosque-Perez et al., 2016; Kniola et al., 2012; Lattuca and Stark, 2011). Additionally, cultural competence and sensitivity are increasingly relevant because students and mentors hail from all over the globe and each must effectively work across platforms, different perspectives, and intellectual frameworks (Denecke et al., 2017). Doctoral students need to learn methods and etiquette necessary for successful cross-cultural collaboration. The new doctoral enterprise reframes current doctoral education by expanding mentor networks, integrating interdisciplinarity, and broadening career scope preparedness. Thus, TDEM enhances the characteristics of current doctoral education, as identified in Table 2.

Table 2. Comparison of key characteristics in doctoral education

Current Doctoral Education	Transformative Doctoral Education
Faculty-centric single mentor	Mentor network on and off campus
Discipline grounding	Interdisciplinarity
Narrow career scope preparedness	Agile career scope preparedness

Mentoring Characteristic

Associated with current doctoral education in the United States, traditional faculty-centric mentor relationships can create meaningful and positive mentorship environments; however, students risk missing alternative perspectives throughout the degree (Bain et al., 2009). Challenging these long standing issues, TDEM promotes multiple mentor access and engagement throughout the entirety of each student's doctoral training, offering more diverse learning opportunities and perspectives. A well-connected mentor enhances the possibility for student success in TDEM, as current faculty benefit from learning more about career options and connections outside of academia to better inform students. Promoting secondary and supportive mentor relationships with non-PI faculty, departmental advisors or graduate program directors, as well as other leaders on and off campus can be a benefit for the entire doctoral education system (Bao et al., 2018; Bray and Boon, 2011; Milos, 2018; Russell Group, 2014). The student then further *drives* mentorship by incorporating these potentially transformative engagements with the primary mentor within their doctoral education discipline and structure.

Interdisciplinarity Characteristic

Disciplinary grounding begins the journey in a doctoral program (Repko, 2011); however, solving today's global and societal issues highlight the need for interdisciplinary research, resources, and programs (Bosque-Perez et al., 2016; Cassuto, 2015; Chang et al., 2017; Lattuca and Stark, 2011). TDEM advocates an interdisciplinary learning environment where students are grounded in the discipline and further develop through interdisciplinary experiences across a broad range of research, methodologies, and colleagues. Intellectual community within an expanded mentor network encourages students to begin embracing the value of interdisciplinarity while also developing technical skills that influence their post-graduation impact (Cassuto, 2015; Bosque-Pérez et al., 2016; Uhlenbrook and Jong, 2012).

Career Scope Characteristic

Current doctoral graduates have the research skills necessary for success in academic careers; however, students lack sufficient information of other available career paths (Bray and Boon, 2011; Nerad, 2004; Rudd, et al., 2008). TDEM inspires increasingly valuable knowledge and transferable skill connections across labs, workplaces, or at conferences. Each of these contextualize the science of teaching and learning for doctoral students, independent of career path (Cumming, 2010; Gilbert et al., 2004). As a result, TDEM students become agile because they possess the skills and knowledge necessary for specific occupational requirements in the discipline or domain, independent of job sector (Bridgstock, 2009). Transferable skill development and reflective methods of thinking, such as individual development plans, assist in improving student development, learning outcomes, and career preparation. By providing doctoral students with these training experiences, TDEM encourages learner transformation into multidimensional adaptive scholars who thrive in an ever-changing workforce (Bridgstock, 2009; Cassuto, 2015; Denecke et al., 2017; National Science Foundation, 2016).

TDEM implementation relies on collaboration and support among the institution, program, and mentors. These three internal drivers jointly establish an educational ecosystem where doctoral students receive multidimensional training to promote agile career preparedness. However, if any one of these drivers are not fully engaged with the process, resulting barriers may leave the model at risk. For example, institutional economics might impact the entire model's sustainability; program allegiance to the eight elements could influence the quality of their implementation; mentor time commitment would critically determine the mentorship environment. Therefore, keeping these three internal drivers involved and dedicated to the effort is important during TDEM implementation.

Future Research

Given TDEM is conceptual in nature and neither truly tested nor supported by empirical data, several future research directions exist. First, educational research of TDEM's implementation into a doctoral program is necessary. The external and internal drivers, as well as the eight elements eliciting learner transformation, are each envisioned salient for optimum career opportunity. Therefore, identifying or developing assessment instruments is essential to measuring their impact and contribution to learner transformation. In addition to the TLT foundation, the TDEM learner transformation vision also connects to threshold concepts. TDEM emphasizes learner transformation from doctoral student into doctoral scholar, whereby students face new learning outcomes within each element. Threshold concepts, a recent educational research focus, studies learner transformation as a result of encounters with troublesome knowledge, ultimately enabling the learner to accomplish new ways of thinking (Meyer and Land, 2003; Mayer et al, 2010). Therefore, investigating TDEM learner experiences and transformation of known and unknown doctoral education threshold concepts is recommended.

Second, to understand the effectiveness of TDEM, studying whether TDEM scholars in the workforce have successful careers as well as enough agility and capacity to solve the complex problems is important. Longitudinal studies can determine TDEM's influence across various stages of a doctoral student, including at graduation and during intermittent timeframes of a career. And given the flexible intent of TDEM, future studies can investigate how the TDEM framework can be applied in different contexts, such as varying disciplines (e.g., STEM or non-STEM), platforms (e.g., face- to-face or online), populations (e.g., first-generation, underrepresented minorities, international students), cultures (e.g., institutions, countries), and challenges (e.g., global, societal, institutional).

Conclusion

Considering the emergent themes in the global doctoral education literature and model review, TDEM encompasses each criteria, but most noteworthy of all is the model's direct link to learner theory. TDEM proposes a re-envisioning of doctoral education by providing a fresh doctoral education paradigm that also considers an individual's ability, career preparation, and learner-centered perspectives in the educational process (Baker et al., 2015; Cassuto, 2015; Doyle, 2012). While the shift to learner-centered education with foci on non-traditional doctoral educational outcomes and goals may be challenging, institutions seeking to provide students with the necessary education to transform their thinking and impact change is a worthwhile effort. Positive retention effects occur when students understand how academic studies fit into career goals and are encouraged through outreach and reflection (Bray and Boon, 2011; Russell Group, 2018). TDEM is a fresh doctoral education paradigm considering an individual's ability, career preparation, and learner-centered perspectives in the educational process (Baker et al., 2015; Cassuto, 2015; Doyle, 2012).

The landscape of doctoral education is ever-changing and requires graduates to go beyond disciplinary boundaries and promote collaboration across fields (Cassuto, 2015; Bosque-Pérez et al., 2016; Kniola et al., 2012). Addressing current global demands, TDEM streamlines graduate education into an experience of intentional, pertinent, and meaningful opportunities to transform the learner from doctoral student into multidimensional adaptive scholar. Implementing the transformative doctoral education model involves significant change and overcoming the inertia to create that change requires identifying the sense of urgency to drive it (Kotter, 2012). The question remains: what sense of urgency will be enough to move such a model forward regardless of where you reside across the globe?

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