

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

Citation – Patterson, C.A., Chang, C.N., Lavadia, C.N., Pardo, M.L., Fowler, D.A., and Butler-Purry, K. (ahead of print). Transforming doctoral education: Preparing multidimensional and adaptive scholars. *Studies in Graduate and Postdoctoral Education*. Doi: 10.1108/SGPE-03-2019-0029

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Additional resource - <http://cte.tamu.edu/Graduate-Student-Support/Transformative-Doctoral-Education-Model>

Acknowledgements - TDEM spun out of a funded proposal (NSF-DGE-1545403) to design an interdisciplinary curriculum specific to materials science, informatics, and engineering education. The authors are grateful for the faculty and students at Texas A&M University's D3EM program. In addition, the authors wish to thank the reviewers for their constructive feedback and appreciate anyone who had helpful discussions with them.

40 Concerning trends in graduate education combined with global, complex problems continue to
41 drive toward a new doctoral education approach (Bosque-Perez et al., 2016; Nerad, 2004; Walker et al.,
42 2008; Weisbuch and Cassuto, 2016). Traditional faculty-centric methods lack effectiveness in preparing
43 students for the evolving demands facing graduates, whereas learner-centered processes consider a
44 variety of educational and career goals (Doyle, 2012; Huba and Freed, 1999; Lattuca and Stark, 2011).
45 Although students dedicate years to their doctoral education, graduates unfortunately are often ill-
46 equipped and without the necessary skills required by today's workforce (Bao et al., 2018; Bray and
47 Boon, 2011; Denecke et al., 2017; Weisbuch and Cassuto, 2016). As problems become increasingly
48 complex, overspecialization in graduate school deprives students of the breadth needed to work
49 innovatively and broadly to solve global and societal challenges (Elkana, 2006; Uhlenbrook and Jong,
50 2012). Moreover, rapid globalization necessitates recognition of a more diverse and inclusive world
51 (Denecke et al., 2017).

52 Although the number of available faculty jobs is dwindling, global doctoral education continues
53 pointing students toward academic careers (Larson et al., 2014). In the United States, most doctoral
54 graduates are expected to enter jobs outside academia (Cassuto, 2015; National Science Foundation,
55 National Center for Science and Engineering Statistics, 2018; Stephan, 2012). This is a similar trend
56 internationally, as Russell Group universities report (2014) just under half of United Kingdom doctoral
57 graduates enter a career in higher education, and roughly 20% teach. Additionally, international
58 doctoral education purposely integrates career development within doctoral education (Bray and Boon,
59 2011; Milos, 2018), while programs and universities in the United States often lack information and
60 guidance to educate students of career options (Nerad, 2004; Rudd, et al., 2008).

61 Given the many factors at play in the attainment of a doctoral degree and subsequent
62 employment (i.e., family responsibilities, financial concerns, globalization and diversity, social
63 challenges, and career goals), an innovative, adaptive, and customizable framework for doctoral
64 education is needed (Baker and Pifer, 2015; Bosque-Pérez et al, 2016; Cassuto, 2015; Powell and Green,
65 2007; Weidman et al, 2001). Answering the call to provide a learner-centered approach while
66 specifically attempting to address the current shortcomings in United States' doctoral education,
67 pedagogical researchers at Texas A&M University's Center for Teaching Excellence developed the
68 *Transformative Doctoral Education Model*. A thorough review of relevant literature, experiences with a
69 National Science Foundation interdisciplinary training grant, and an on-campus partnership with the
70 Office of Graduate and Professional Studies influenced the creation of this model. The aims of this
71 conceptual paper are to (a) review current global doctoral education models and related literature, (b)
72 advocate for a learning theory foundation, (c) describe the new transformative doctoral education
73 model, and (d) discuss this new model's vision to enhance doctoral education.

74 **Literature Review**

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

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

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

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

107 **Russell Group.** Comprised of over twenty leading United Kingdom higher education institutions,
 108 Russell Group universities (2014) are committed to research, teaching and learning, while also
 109 innovatively collaborating with the workforce. According to the Russell Group's website (2018), this
 110 university consortium trains over "80% of the UK's doctors and dentists, and half of mathematics and
 111 physical science graduates". The Russell Group seeks to maximize their collective research impact,
 112 especially for facility and graduate student funding. In doctoral education, Russell Group universities
 113 (2014) encourage research's inclusion in teaching and offer temporary research placement in the
 114 workforce.

115 **T-Shaped Competency.** Today's multidisciplinary work and doctoral education research requires
 116 skills considered absent in traditional single discipline-based pedagogy (August et al., 2010). T-Shaped
 117 Competency uses the letter 'T', where the horizontal bar indicates an individual's interdisciplinary
 118 breadth while their disciplinary range is depicted down the 'T's vertical bar (August et al., 2010; Reis,
 119 2001; Uhlenbrook and Jong, 2012). The University of Rhode Island's Coastal Institute created a tool to
 120 assess student's multidisciplinary training based on the T-Shaped Competency (August et al., 2010).
 121 Regular engagement with problem-solving and career development contributed an intellectual
 122 community among faculty and students across the disciplines (August et al., 2010). Similarly, the
 123 UNESCO-IHE Institute for Water Education in the Netherlands created a doctoral learning environment
 124 using a T-Shaped Competency model (Uhlenbrook and Jong, 2012). Although considered a
 125 multidisciplinary field, these water education students still specialize (vertical bar) in their doctoral focus
 126 and integrate complementary professional competencies across the horizontal bar (Uhlenbrook and
 127 Jong, 2012).

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

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

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

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

156 Six themes emerge from the seven models (Table 1). Further detail encompasses the theme’s
 157 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	

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

167 **Learner Development.** The second theme, also common among all seven models, is learner
 168 development. In other words, those doctoral education moments that produce long-lasting and
 169 meaningful student impact. Threshold concepts, a theory growing in the higher education literature,
 170 represent a transformational and irreversible shift in learner perspective and identity (Meyer and Land,
 171 2003; Mayer et al, 2010). Various threshold concepts have been identified in doctoral education,
 172 including “analysis, theory, knowledge creation, research paradigm, framework, argument/thesis,
 173 creativity, writing, and doctorateness” (Kiley, 2017, p. 296). In addition to those researcher development
 174 concepts, skills such as critical awareness and reflection, project management, and communication are
 175 also integral in overall learner development (August et al., 2010; Bray and Boon, 2011; Kniola et al.,
 176 2012; Milos, 2018). Student immersion experiences, another higher educational trend, create learner
 177 development by linking academia with industry (Bao et al., 2018; Perry, 2016; Russell Group, 2014).
 178 Additionally, blending technical and transferable skill development in doctoral education further
 179 promotes a student’s career awareness and preparation. This, along with an expanded mentorship,
 180 counterbalance the institutional career development resources that may be lacking for doctoral
 181 education.

182 **Image.** The third theme of interest includes the availability of a graphic or framework image
 183 identified for the doctoral models. Visualization communicates complex ideas to a variety of audiences
 184 (Otten et al., 2015). Five doctoral education models incorporated graphics (Vitae n.d., August et al.,
 185 2010; Bosque-Perez et al., 2016; Perry 2016; Virginia Tech University n.d.). The Vitae Researcher
 186 Development Framework (n.d.) offers a complex image of several intrinsic circles and layers, whereas
 187 others are simply depicted by horizontal and vertical bars (August et al., 2010; Bosque-Perez et al.,
 188 2016). The image associated with the Virginia Tech TGE example, also adopted by their graduate school,
 189 allows extension to their broader student population (Virginia Tech University n.d.).

190 **Uniformity.** A fourth theme, uniformity, describes the doctoral education model’s level of
 191 replicability across institutions. Model uniformity is distinguished between and across nations, as the
 192 majority of Chinese doctoral education programs create similar institutional collaborations (Bao et al.,
 193 2018), doctoral education aims are embraced by all twenty-four Russell Group (2014) members, and the
 194 Vitae Researcher Development Framework is adopted in countless institutions and multiple countries
 195 (Vitae n.d.; Bray and Boon, 2011). Perhaps influenced by the recent charge to re-define their discipline,
 196 the doctorate of education is a notable example of uniformity in the United States (Perry, 2016). Each
 197 example possesses clear connections and dependable contributions with their national workforce.
 198 Conversely, model customizability offers higher education programs an option to apply aspects most
 199 appropriately fitting their educational landscape and national context.

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

206 2015). Faculty and mentors ideally foster an intellectual community encouraging interdisciplinary
207 balance and additional learning support that allow the student to form an academic identity and ability
208 to navigate multiple disciplines (August et al., 2010; Graybill et al., 2006; Holley, 2015).

209 **Learning Theory.** Lastly, although learning theories may subtly influence these models, none of
210 the seven doctoral education models explicitly describes a learning theory framework (Kniola et al.,
211 2012). Although not directly applied to a doctoral education model, three learning theories are
212 anecdotally evident in doctoral education: self-directed learning, metacognition, and experiential
213 learning. Self-directed learning is present in doctoral education through independent study or research
214 projects, where individual motivation drives learning (Brookfield, 2009). In this regard, adult learners
215 take initiative by making conscious decisions on how to learn new concepts and information (Brookfield,
216 2009). Metacognition theory is based on self-knowledge or internal representations of information,
217 regardless of whether those perceptions are correct or incorrect (Hacker, 1998; Veenman et al., 2006).
218 Doctoral education exemplifies metacognition through the creative intelligence necessary for research
219 design (Cravens et al., 2014). Experiential learning principles align with doctoral education, as students
220 become an expert in their field of discipline through obligatory skill development activities like data
221 analysis, academic writing, and critical reflection (Lam et al., 2018). Of these three learning theories,
222 self-directed learning and metacognition generally disregard the individual experience in adult
223 education while experiential learning advocates for the learning experience but falls short in defining
224 reflection specific to adult learning. Thus, could the inclusion of an adult learning theory rooted in
225 experiences and reflection be the missing piece for doctoral education models?

226 **Learning Theory Foundation.**

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

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

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

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

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

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

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

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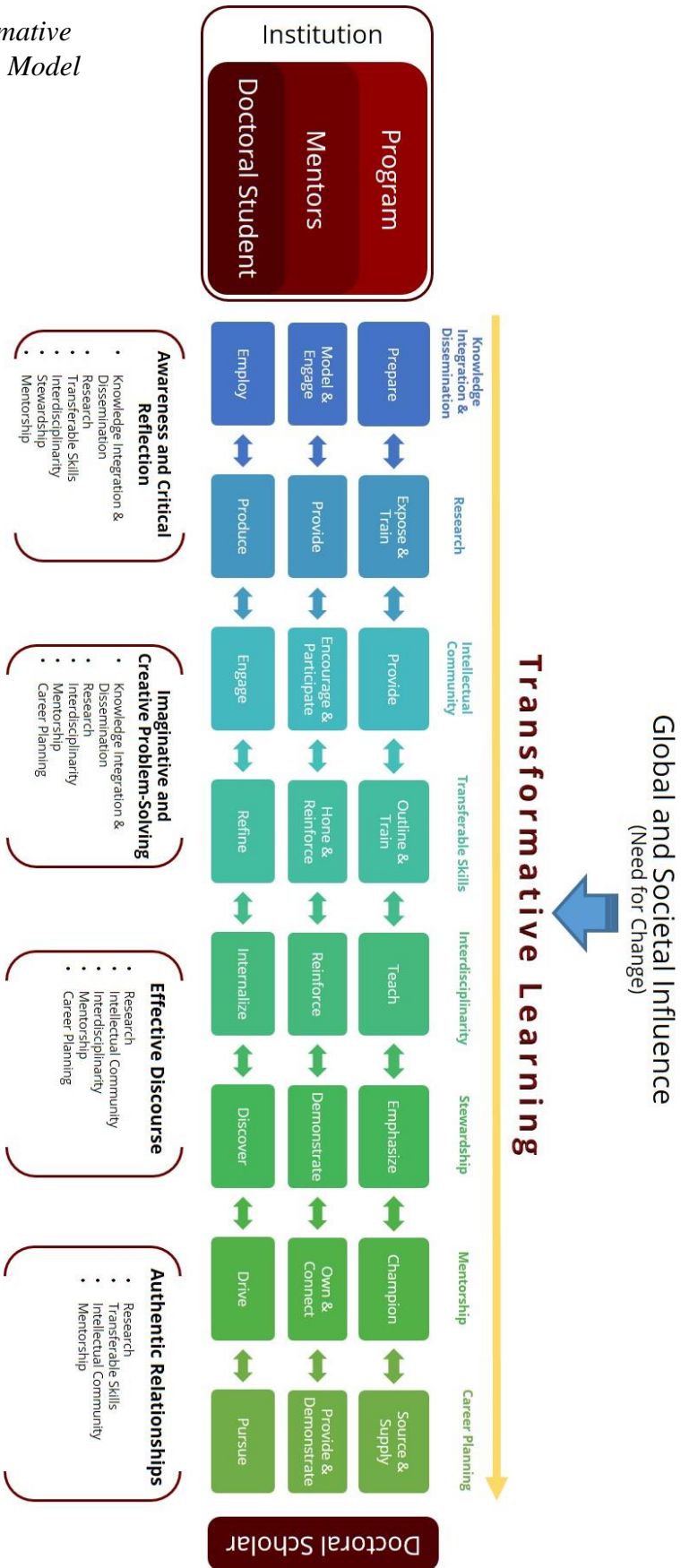
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Figure 1. Transformative Doctoral Education Model



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

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

300 **Eight Elements of TDEM**

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

325 members to further desired career (Bridgstock, 2009).

326 **Element Engagement**

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

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

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

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

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

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

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

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

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

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

439 **Discussion**

440 Societal needs, rapid technological advances, and the drive toward greater globalization shape
 441 the direction of higher education through career diversity, interdisciplinary, and research initiatives
 442 (Bosque-Perez et al., 2016; Kniola et al., 2012; Lattuca and Stark, 2011). Additionally, cultural
 443 competence and sensitivity are increasingly relevant because students and mentors hail from all over
 444 the globe and each must effectively work across platforms, different perspectives, and intellectual
 445 frameworks (Denecke et al., 2017). Doctoral students need to learn methods and etiquette necessary
 446 for successful cross-cultural collaboration. The new doctoral enterprise reframes current doctoral
 447 education by expanding mentor networks, integrating interdisciplinarity, and broadening career scope
 448 preparedness. Thus, TDEM enhances the characteristics of current doctoral education, as identified in
 449 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

450

451 **Mentoring Characteristic**

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

464 **Interdisciplinarity Characteristic**

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

473 **Career Scope Characteristic**

474 Current doctoral graduates have the research skills necessary for success in academic careers;
475 however, students lack sufficient information of other available career paths (Bray and Boon, 2011;
476 Nerad, 2004; Rudd, et al., 2008). TDEM inspires increasingly valuable knowledge and transferable skill
477 connections across labs, workplaces, or at conferences. Each of these contextualize the science of
478 teaching and learning for doctoral students, independent of career path (Cumming, 2010; Gilbert et al.,
479 2004). As a result, TDEM students become agile because they possess the skills and knowledge
480 necessary for specific occupational requirements in the discipline or domain, independent of job sector
481 (Bridgstock, 2009). Transferable skill development and reflective methods of thinking, such as individual
482 development plans, assist in improving student development, learning outcomes, and career
483 preparation. By providing doctoral students with these training experiences, TDEM encourages learner
484 transformation into multidimensional adaptive scholars who thrive in an ever-changing workforce
485 (Bridgstock, 2009; Cassuto, 2015; Denecke et al., 2017; National Science Foundation, 2016).

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

494

495

Future Research

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

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

517

Conclusion

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

530 The landscape of doctoral education is ever-changing and requires graduates to go beyond
531 disciplinary boundaries and promote collaboration across fields (Cassuto, 2015; Bosque-Pérez et al.,
532 2016; Kniola et al., 2012). Addressing current global demands, TDEM streamlines graduate education
533 into an experience of intentional, pertinent, and meaningful opportunities to transform the learner from
534 doctoral student into multidimensional adaptive scholar. Implementing the transformative doctoral
535 education model involves significant change and overcoming the inertia to create that change requires
536 identifying the sense of urgency to drive it (Kotter, 2012). The question remains: what sense of urgency
537 will be enough to move such a model forward regardless of where you reside across the globe?

538

539

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699 Manuscript Acceptance




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To  Patterson, Clinton A;  chining@tam.u.edu;  cnlavadia@tam.u.edu;  Pardo, Marta Lynn;  Fowler, Debra A;  Dr. Karen Butler-Purry

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We removed extra line breaks from this message.

09-Jul-2019

Dear Dr. Patterson,

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Yours sincerely,

Dr. Karri Holley

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