Individual resilience as a competency for aviation professionals: A review of the literature

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Abstract

Graduates from aviation and aerospace technical and engineering disciplines emerge with certifications and academic coursework to fulfill the respective degree requirements, but may still lack fluency in key non-technical competencies to fully leverage their professional credentials and academic preparation. Due to the applied nature of the aviation and aerospace disciplines, problem-based learning approaches implicitly seek to incorporate and develop such skills as part of the educational experience. Individual resilience is one example of a non-technical competency sought by employers across high consequence, technology-based industries. However, a stronger shift from traditional lecture/lab course formats to more in-depth problem-based approaches can cause some learners to retreat from challenges due to early failures or from lack of sufficiently developed recovery techniques. This paper presents a theoretical model of individual resilience for applied engineering and technology-based learners. Such a model could assist instructors tailor pedagogical experiences to more fully integrate resilience during academic preparation. Toward this end, a cross-domain review from seminal and modern research on resilience theory from aviation/aerospace, education, medical and psychology literature was conducted. Five common resilience themes emerged: (1) Adversity persistence/perseverance; (2) Contextual awareness (picture making; visualizing and assessing problems and synthesizing decision strategies); (3) Self-directed/learning autonomy; (4) Change management and innovation, and (5) Social connectivity (peer relationships). The paper concludes with suggestions for next steps toward a practical teaching and learning resilience model for educators.

Introduction

Graduates must be prepared to enter the workforce with technical capabilities, but also with higher level competencies. Writing on *lean engineering* education and the role of competency mastery, Flumerfelt et.al, refer to engineering problems learners face in the industry as “multi-disciplinary” requiring competencies like systems-thinking, innovation and adaptive competencies [1]. They emphasize the need for “the engineering education academy to evolve to include competency mastery” in engineering education programming in areas of continuous persistence, ethical decision making and problem-solving [2]. A need exists for graduates in applied sciences like engineering and technology education to acquire non-technical, transdisciplinary competencies like resilience. Problem solving, encountering and learning from error and engaging with team members with mature levels of emotional intelligence all require persistence [1], [2].

Hernandez et al. in 2018 include resilience among top mental attitude and contextual responses necessary for retaining engineering students. Resilience competency attributes are practiced and transferred into the engineering environment where one faces challenge and failure modes as a matter of routine [3, pp. 2-3]. Aviation and aerospace education face similar competency challenges for learners and the workforce. There is strong emphasis for challenge-based learning scenarios to facilitate learners in establishing a continuously "inquisitive, resilient, critical thinking approach" to open-ended, problem-based learning that replicates industry [4]. Yet metrics for educators for strategic insertion and assessing successful integration remain a challenge [3, pp. 3-4].

Consistent with earlier research on aviation workforce competencies [5], in a 2019 industry survey of U.S. and Latin American aerospace manufacturers and aviation maintenance and repair organizations, 70% of the respondents identified people/social, teamwork and problem-solving competencies just as important as technical skill sets, and lack of higher-level professional competencies were cited as a leading basis for new hire technicians' failure to succeed through probationary hiring phases in aerospace manufacturing [6]. Leaders across technology-driven industry express similar needs. As one Senior Economic Economist articulated, "learning agility…able to do fast, quick-learning research on the job instead of a three to five year traditional idea of research…there is a growing skills gap in the local labor force who need to blend these and collaboration skills into daily routines and it is supremely important to cross train people in how to problem solve, understand and use data" [7]. Accordingly Head of Innovation Ecosystems Eric Acton at Rolls-Royce ATG R2 Data Lab stated, "workers, graduates coming in need to become *second-domain* experts in other skills complimentary to their technical skills to take on expected problem-solving" [8]. Similarly, U.S. Air Force Colonel Jeffrey A. Collins, Chief Technology Innovation Officer of NORAD and USNORTHCOM at Peterson Air Force Base noted innovation and resilience required of workers today: "people need to adapt to changing technology and data sets to do things differently" [9]. Finally, Sherry Aaholm, Vice President and Chief Information Officer, Cummins Inc. said of today's worker supporting advanced and evolving smart sensor-embedded equipment, "the individual must be resilient…willing to re-learn and upgrade their certifications. They need to persist when things fail and persist against the nay-sayers. Those skills are what we're looking for" [10].

Workers in high precision, data-driven pharmaceutical and healthcare industries face similar challenges. Successful workers must work in teams, "interdisciplinary, internal squads that fix problems instead of sending problems out to a consulting firm" [11]. They must be "translators, educators and adept at being business partners" [12]. These echo the need for an aviation and aerospace engineering workforce prepared to be more innovative and agile and versed in participative teaming skills, all of which have been explicitly emphasized as key business differentiators [13], [14], [15].

Within psychology literature, many traits equating to the resilient individual were asserted to have been forged from childhood and early life experiences [16], [17], [18]. However it has also been observed that resilient behavior, characterized as the ability to bounce back, endure or persevere, is a temporal, contextual process that can be shaped and tuned from "dynamic person–environment interactions" where one exercises behavioral responses (proactive and reactive) addressing both [19], [20], [21]. Hollnagel's work on resilience in engineering design evolved into organizational resilience using four 'potentials': respond, monitor, learn and anticipate [21], [22]. These categories were used to assess resilience readiness in hospital emergency departments where daily operations are notably unpredictable as a matter of routine [23]. Resilience was found to be "something multifaceted rather than something that can be described by a single quality or dimension" [24]. Of equal importance was tailoring performance goals to the particular domain.

To better understand how these traits might be more effectively integrated within engineering and technology curriculum, a review of literature was conducted regarding the notion of resilience within applied engineering and technology-based education. Data from aviation, engineering and technical collegiate education, medical and psychology was reviewed in an effort to identify more refined and consistent competency-based terms and behavioral attributes of resilience which could be recognized, practiced and applied among engineering and technology learners. Those identified were: (1) Adversity persistence/ perseverance; (2) Contextual awareness (picture making; visualizing and assessing problems and synthesizing decision strategies); (3) Self-directed/learning autonomy; (4) Change Management and Innovation during failure or difficulty, and (5) Social connectivity (peer relationships). These are shown in Appendix A – Resilience Traits Table.

Method

A goal of literature reviews is to provide a framework to relate new findings to previous findings while showing associated research advances and new lines of inquiry and methodological insights that can lead to advancing theory into application [25]. A systematic approach, following Fink's model for literature review was used to consider a theoretical teaching and learning concept of resilience for educators. [26]. This model consists of seven steps: 1. Select research question, 2. Select database, 3. Choose search terms, 4. Apply practical screening criteria, 5. Apply methodological screening, 6. Conducting the review, 7. Synthesize results.

Truncation and Phrase Searching methods were used to cast a broad net around the notion of individual resilience and its traits applied to curriculum, teaching and learning strategies. Initial returns yielded 185 sources on resilience. This included literature on physical/ physiological responses and psychological/mental attitude and behaviors. The predominant domains returned on resilience came from Educational Theory, Medical (hospital critical care, emergency room, surgical), Aviation/Aerospace and other technology industry (industrial engineering, human factors, NASA) and Psychology (early childhood, social and industrial). Ijnterna's differentiation between physiological resilience and psychological resilience traits was used to filter the search to relevant psychological attitudes and behavioral responses [27], as these were more relevant to the focus of the study as it applies to teaching and learning in engineering and technical education.

Keyword searches were then made using "mental resilience", "worker resilience", "learner resilience" and "psychological resilience" with additional keyword modifiers including "engineering", "aviation", and "aerospace" to further refine the list. Early seminal works by researchers and theorists in transformational education (Dewey, Bloom, Knowles, Brookfield) were also reviewed, as many of their pedagogical and anagogical learning models remain foundational in education. Five databases were used:

1. Academic Search Complete

2. ScienceDirect
3. Engineering Village
4. Science Citation Index
5. PsycInfo Database

Sources were then evaluated for key words describing 1. Thematic area clusters, 2. Thematic area Sub-topics and 3. Behavioral traits stated in the literature relating to thematic sub-topics. A modification of Jackson & Trochim's five-step concept mapping process [28] was used to perform unit clustering of consistently used positive resilience themes, associated sub-topics and behavioral traits (Appendix A – Resilience Traits Table).

Results

As a result of the review and framed within the context of the learning and working environment, resilience was defined as:

The ability to anticipate challenges to accomplishing established goals; persevere through those challenges; adapt personal behaviors, acquire new knowledge/skills to innovate after initial failures, or adjust the established goals; and effectively build relevant social (peer) connections.

Resilience Traits Identified

Resilient learning approaches and theories are not new [29], [30], [31], [32], [33], [34]. While foundational sources from educational theorists did not explicitly use the term "resilience", key constructs historically used in context of experiential, problem-based learning experiences and subsequent competencies were remarkably congruent.

Both positive and negative based definitions of resilience were observed in the literature. In the early 1990s, the focus of resilience began to shift from identifying protective factors (like enduring hardship) toward understanding more tangible positive processes and reactions through which individuals overcome adversity [20], [18]. With the goal of developing observable, behavioral-based actions that could be incorporated into pedagogical or anagogical applications, five prominent resilience trait categories with subsequent behavioral descriptions were identified:

1. Adversity persistence (adaptability and perseverance)
2. Contextual awareness (picture making; visualizing and assessing problems and synthesizing decision strategies)
3. Self-directed action/learning autonomy
4. Change Management and Innovation during initial failure or difficulty
5. Social connectivity (peer relationships).
   (Appendix A – Resilience Traits Table)

Adversity Persistence

Resilience incorporates multiple combinations of response tactics depending on dynamic contexts both proactive and reactive [19]. The nature of team resiliency in workplace adversity situations was described as,

> “the capacity of a team to withstand and overcome stressors in a manner that enables sustained performance where the overall contributions and experience of the group enduring a situation together generates more resiliency than an individual alone might have… managing variation and rising stressors through huddles, regrouping discussion and “mending” [14].

At a personal level, the ability to cultivate perspective and “personal calm” and the concept of “sense-making” while undergoing adverse situations was emphasized [35]. Other long held anagogical principles viewed adversity positively when leveraged correctly as a deep learning transfer opportunity [29], [31]. Cognitive learning development models emphasized “transcendability” as a positive byproduct of persistence in achieving transformative learning outcomes [36]. Adversity persistence has long been recognized as essential for spurring positive attitudes and action [37] and igniting deep personal growth and self-actualization [38], [39], [40].

Contextual Awareness (Picture Making)

The ability to maintain a mental model of a current situation and then contextualize new situations was a heavily emphasized behavior observed across the resilience literature. Writing about cognitive processes and situational awareness related to aviation human factors, Endsley’s definition of situational awareness in aviation operating environments provided a foundation to context-driven awareness: “The perception of the information in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future” [41], [42]. This definition is used in aviation human factors literature [43], [44] and cognitive engineering literature on human mental workload for automated air vehicle flight deck environments [45]. Safe operation in commercial aviation depends on front-line operators’ continuous awareness of their operational environment which is inherently risky [46]. The importance of picture making or mental models for situational awareness was emphasized in FAA Industry Training Standards (FITS) scenario-based and problem-based training and in routine Practical Test Standards (PTS) for pilots [47], [48]. Amann reported self-awareness, sensory and affective learning experiences as essential for deep learning and generating new knowledge [49]. Contextual awareness was also found in seminal theorists in pedagogical and andragogic methods of learning, as in Bloom’s original and revised learning taxonomies [30], [50].

In his work on human factors, Sheridan discusses resilience engineering and emphasizes visualizing a variety of possible scenarios in aviation human factors as an essential modern proactive approach preparing for future and unforeseen incidents and recovery scenarios in which no explicit table or algorithm exists” [51]. Medical surgical training using Virtual Reality applications and smart devices to enhance awareness further substantiated the value of the ability of the individual to rapidly envision “what if?” scenarios [52]. Underpinning these advances is the nuance of the Big Data environment, where blended automation changes human contextual decision making and coordination demands [53]. This has impact on approaches to Rasmussen’s foundational Skill-Rule-Knowledge mode commonly incorporated into teaching and learning methodologies to describe human performance during routine and unfamiliar task conditions and where the individual’s analysis of the environment and key goal formulations are believed to occur [54].

Self-directed Action / Learning Autonomy

A recurring positive behavioral theme that quickly followed resilience terminology was the notion of one who continually took it upon themselves to be inquisitive and deliberately open to learning new things. Bloom emphasized the challenging experiential learning process itself as an important learning outcome [30] that works to empower the learner to become self-directed and autonomous in applying problem-solving competencies. The positive impact of a mentor's guidance on a learner's self-directed learning autonomy was directly emphasized as a component of learner resiliency [55]. Technical learners and workforce members must develop the mindset of lifelong learners who continuously engage problems-and-learning as a continuous act [56], [57].

The aerospace industry additionally articulated the value of empowered employees who were self-directed particularly in risk-sensitive operations for risk mitigation, contribution to the learning organization [58], [13], [4] and critical as a high performing, visionary leadership trait [59]. The International Civil Aviation Organization (ICAO) emphasized the critical nature of empowered, autonomous individuals and work teams as success factors in global aviation safety and process standardization [60], [61] applicable to all of the aviation industry [6], [61]. Self-responsibility and proactive problem-solving expectations are likewise modeled by the FAA in its relationship with industry in safety and quality management of daily processes [4]. Problem-based learning in engineering was consistently emphasized in preparing engineering graduates, and development of collaborative teamwork, self-directed, independent learning and problem solving based upon critical self-reflection were considered "crucial competencies" in addition to technical degree knowledge [1, p. 41].

Change management / Innovation

The importance of managing change, adapting attitudes and behaviors in education and the influence on larger interactions with society was noted by the transformative learning theorist Mezirow:

> "Contradictions generated by rapid, dramatic change and diversity of beliefs, values, and social practices are a hallmark of modern society. Adults in society face an urgent need to keep from being overwhelmed by change…Rather than merely adapting to changing circumstances by more diligently applying old ways of knowing, they discover a need to acquire new perspectives in order to gain a more complete understanding of changing events and a higher degree of control over their lives" [33].

Change management was likewise commonly found to describe a person's ability to manage both small alterations in direction to plans, to completely disruptive and unforeseen events. In either sense the ability to adapt, find innovative ways to remain in relationships and regain a path to a goal were associated with Change management and Innovation themes. In terms of dynamic organizational or community-wide situations, three levels of resilience were described by Ryan et al.in a community/cultural study on positive responses to negative extremism and how it equated to community violence and terrorism. These levels were described as 1) National, 2) Community and 3) Individual adaptive change. Ryan reports embracing the necessity of change as healthy "positive adaptation" to dynamic environments enabled community members to resist negative stresses or succumb to radicalized thinking in unhealthy ways [62]. Steinberg discussed a necessary web of personal characteristic responses to adversity, using the term “resiliency to failure” as a culmination of adaptive internal emotional coping characteristics enabling a person to change during various life challenges. He later coined the term *change resiliency* as a “new science” in response to change [36]. Dimitrov discussed the necessity of “freedom to engage in continuous change” and critical role of innovative thinking for the betterment and emancipation of oppressed people [63].

Reporting on building risk resilience directly in the aerospace manufacturing sector, change was identified as an expectation, with one being “…ready to go to Plan B if Plan A is not available, and then move on to consider Plans C and D, and perhaps Plan E if circumstances dictate” [64]. In terms of Big Data and automation technologies in aircraft the need for the humans to adapt more fluidly are significant in the sense of changing and working through times of sudden disorder and uncertainty [65], [66]. Traditionally structured views of “the round peg goes into the round hole… that there is only one answer to a question… these structures are more malleable in modern operations. than we may want admit…ultimately the big data messiness concept requires the human being to change in order to tap into and harness part of its usefulness” [66]. Willingness to face and learn from errors and listen to feedback, having an understanding of one’s strengths and limitations and the ability to remain calm under pressure or when things go wrong were highly ranked and emphasized as competencies desired in final year engineering students [1, pp. 36,41].

Safety culture research on high reliability operations (oil rig, aviation, medical) found the most important characteristic was the ability to adapt to new situations or hazards [67], [68], [69]. The ability of individuals to embrace “bolder and more radical changes” as the norm in the aerospace workforce was also found to be among the larger modern challenges for the industry where the learning curve remains constant and intense [70], [71], [72],[73]. This includes changes in use of technology for training approaches in industry (using augmented / virtual reality devices) and has begun driving change in aviation technical education tools of practice as well [74], [75].

Social Peer Relational Connectivity

Social or peer-group connectivity and support with focus on participative teaming skills were also consistently identified as critical competencies specifically within the aviation environment [6], [13], [15], [60], [61]. This includes all organizational levels including upper management [55]. A study of community resilience stressed the role of social bonding and a noted both a proactive reduction in perpetuation of violence as well as “ability to maintain a stable level of functioning after traumatic events” [76]. Peer relational constructs were attributed to ability of individuals and groups to resist negative influence and temptation to fall into unhealthy, dangerous, radical or other extremist and untoward thinking [76].

In industrial settings, peer group resilience studies found teams actively briefing and debriefing together had operational performance rates up to 25% higher, tending to defer to within-group expertise rather than individual rank/status for problem-solving [14]. Knowledge-based participatory innovation for complex problem-solving and more rapid solution implementation was also found when teams connected verbally and shared experiences and concerns [77], [78]. Educational theorists also acknowledged the impact of peer-to-peer relationships, social dynamics and the trust, community and support for personal risk-taking as well as the positive influence this had on learning outcomes [33], [55], [79]. The same dynamic was found in leadership roles and effectiveness of teams in operations [80].

Research on attachment and resiliency among university students pointed to the important role of positive mentoring attachments which directly impacted overall resiliency of individuals [81], [82]. Friborg's Resiliency Scale for Adults (RSA) [83], [84] and other collaborative research on resilience validity [85] directly measured social competence within his 6-point measurement scales. Organizational and team "connectedness" were found essential for identifying, acting and containing errors, [86] and obtaining vital minority voice inputs for solutions who might otherwise not be heard [21], [87], [88], [89].

Discussion

Resilience in terms of a professional competency seems to be a simple concept at the surface level. But there are numerous contexts that make both teaching and practicing this critical competency a challenge. Viewed holistically, two primary inferences regarding the approach to teaching resilience stand out. First, resilience is influenced from many directions from youth. The literature is clear that certain resilience traits are shaped beginning in childhood. Early pedagogical patterns and as well as tangential familial and social experiences imprint upon and set a learner's entry level default behavioral responses to some degree. For better and worse, each person brings a myriad of life experiences shaping their perceptions and traits. Educators must therefore be cognizant that learners will have varied backgrounds that will influence their approach to learning new or developing resilience competencies.

Second, resilience is dynamic and fluid. A person's current reality - the context of one's current career path, educational process and learner age group, health, career or family dynamics - all shape resilience responses. The challenge for educators is to identify and facilitate opportunities to more deliberately mentor resilience as part of the active learning experience. This is especially important in engineering and technology education where problem-solving, dynamic systems, challenge and failure modes are an expected part of the everyday experience.

It appears that either certain resilience attributes are context-dependent and other are context independent, or all attributes could be mapped on a maturity continuum with one end of the continuum being entirely context-independent and the other end being entirely context-dependent. The degree to which certain attributes, or all of the attributes, are context-dependent could also be tested by administering the resilience survey among subjects in different environments.

Conclusion

The purpose of this literature review was to identify a thematic list of resilience attributes and observable behaviors salient to teaching and learning design strategies for educators in engineering and technical education. While the focus of this report was in context of aviation and aerospace, such a model has potential to benefit other educational domains where command of both technical and high-level competencies like resilience are desired.

Five thematic categories of resilience were identified with behavioral descriptions. These five thematic categories present a preliminary structure to construct a proposed model for individual resilience. According to the review, resilience attributes fall on a continuum from context-independent to context-dependent. The degree to which attributes are context-dependent could be identified by administering a resilience survey to subjects from different learning environments. A theoretical teaching and learning model of resilience incorporating more precise descriptors and learner behavioral benchmarks will help administrators and educators better plan and deliver content that helps learners within engineering and technology programs develop the sort of resilience that will better prepare them for the challenges of their profession.

In the future, this model should be converted into a "scale" that could be tested using exploratory and confirmatory factor analysis. Also, early reflections on the thematic categories suggests that they could be arguably stated dependent or independent of the context because they appear to develop in different ways in different environmental contexts. For example, the adversity that a student might experience in completing a learning assignment may be quite different from one that a pilot might experience while handling an in-flight emergency. One could also argue that the fundamental resiliency skills in both contexts are "the same." A theoretical teaching and learning model of resilience incorporating more precise descriptors and learner behavioral benchmarks will help administrators and educators better planning and deliver content that helps retain younger learners within engineering and technology programs, while equipping them as continuous, agile learners out in the workforce.

Appendix A
Resilience Traits Table

Table 1

Resilience Traits

Trait	Behavioral Descriptors	Literature: Aviation	Education	Medical/ Healthcare	Psychology
Adversity Persistence		Alliger (2015)			Bruneau (2016) Fletcher & Sarkar (2013) Arlin (1975) Inhelder & Piaget (1958) Kubler-Ross (1969) Rees et al., (2015)
	Purposefully endure uncertainty (undergoing)		Bloom (1956) Dewey (1916)		
	Leverage uncertainty into positive action			Calebrese (2008)	Steinberg (2007) Kegelaers & Wylleman, (2018)
Contextual awareness			Hollnagel et al. (2006)	Nehme et. al., (2015)	
	Acknowledge/engage the situation	Rochlin (1993) Durso & Alexander (2010) Parasuraman et al. (2008) Endsley (1999) Endsley (1995)	Amann (2003) Bloom (1956) Dewey (1916/ Boydston (2008) English (2016) Sum (2015) Smith (2011) Thambyah (2011) Newman & Blackburn (2002)		Steinberg (2015) Kegelaers & Wylleman, (2018)
	Self-reflection/ meaning-making	Mosier,(2010) Endsley (1988)	Bloom (1956) Dewey (1916/ Boydston,(2008) Boucouvalas (2016) Brookfield (1995) Loder (1981)		Bruneau (2016)
	Formulate new decision strategies / Structured decision making	Glista, (2003) Jones (2013) Robertson, Petros & Schumacher (2005) Rochlin (1993)	Rasmussen (1983)	Arico et al. (2016)	Fuchs et al (2007)

Table 1, Continued

Resilience Trait Typology

Trait	Behavioral Descriptors	Literature: Aviation	Literature: Education	Literature: Medical/ Healthcare	Literature: Psychology
Self-directed (Core)		ICAO (2016) Lercel, et al. (2015) Saxena (2016) U.S. Dept. of Labor, (2018)	Anderson & Krathwohl (2001) Bloom (1956) Bowers (1984) Dewey (1916) Mezirow (1991) Southeastern LA. Univ. (2018)		
	Autonomy	ICAO (2019, 2016)	Cranton (2016) Knowles (1975) Purdue Univ. (2018)		
Change management /Innovation (Core)		Lasky (2017)	Taylor (1998) Texas A&M (2017)		Steinberg (2015)
	Adaptive	Boyle, (2017) FAA (2019) FAA (2017) FAA (2015) Garret, (2017) Gohardani (2018) Kellner (2017) Lasky (2017) Patankar & Sabin (2010)	Mayer-Schonberger & Cukier (2013) Soans & Stevenson (2006) Mezirow (2003) Wang, et al. (2016) Hartman & Ropp (2013)	Schmarrow & Kruse (2002) Stanley et. al (2009)	Kegelaers & Wylleman, (2018)
	Positivity (positive perspective)		Gallagher (1997) Cranton (2016)	Alexander & Klein (2001)	Ellis & Abdi (2017) Luthar (2006) Luthar & Cicchetti (2000) Friborg (2003, 2005) Kendall-Taylor (2012)
	Establish new paths/goal realignment	Acton, (2019) FAA (2019) FAA (2017) FAA (2015) Dekker & Woods (2010	Gallagher (1997) Mezirow (1991) Texas A&M (2017)		Bernard (1995) Dimitrov (2018) Ryan et al. (2018) Ellis & Abdi (2017)

Table 1, Continued

Resilience Trait Typology

Trait	Behavioral Descriptors	Literature: Aviation	Literature: Education	Literature: Medical/ Healthcare	Literature: Psychology
Social/Peer Relational Connectivity (Contextual)			Gallagher (1997)		English (2016) Friborg (2003;2005)
	Engage peer support	Alliger (2015) Lercel, et al. (2015)			Goldstein (2013) Hjemdal et.al.(2011) Tepeli-Temiz. & Tari-Comert (2018) Gallagher (1997) Ferrari et al. (2018) Ellis & Abdi (2017)
	Participative teaming	Alliger (2015) ICAO (2013) ICAO (2016) ICAO (2019) Lasky (2017) Lercel, et al. (2015)	Nathanael, et. al (2014) Mathieu et al (2008)	Chassin & Loeb (2013)	Ferrari et al (2018)
	Idea sharing for Innovation	Broderick (2015) Jones (2013) Dekker & Woods (2010) Hollnagel et al. (2006)	Gallagher (1997) Nathanael et al., (2014)		Ferrari et al (2018)

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