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A Framework of International Competencies for Systems Engineers

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Abstract. In the course of their career, many systems engineers are likely to interact with engineers of other nationalities as they collaborate on large, complex projects and system of system problems. These partnerships are necessary to support international goals, such as those for sustainable development. System engineers may even work onsite in other countries where they must adapt to different styles of doing business. This requires a set of global skill sets for cooperating and decision making, as well as basic social skills for interacting with the local community. These global skills can be included in a graduate level system engineering curriculum by integrating a set of "international competencies" that includes cognitive style differences, culture awareness, communication, ethics, and teamwork. The competencies were identified through a literature review of suggested global engineering skill sets; these five themes consistently appeared throughout the literature. The Graduate Reference Curriculum for Systems Engineering (GRCSE) was then reviewed to link these competencies to established systems engineering learning outcomes and System Engineering Body of Knowledge (SEBOK) topics. Finally, teaching elements are suggested that can be included even in established curriculums to introduce systems engineers to the skills they need to be successful in a global world.

Introduction

The 21st century systems engineer requires technical, professional, and global skills. International engineering is not new as a contingent of system engineers have been working on global projects for years. Academics and industry partners have long recognized the importance of preparing engineers for the global market (Hipel, Okada, and Fukuyama 2003; Jesiek et al. 2014; Warnick 2011; Streiner and Besterfield-Sacre 2018). However, the global landscape is changing. Davies, et al (2011) listed increased global connectivity as one of six drivers that will impact organizations' operations and the environment within which system engineers work. Four of the top ten skills required as a consequence of increased global connectivity are social intelligence, novel and adaptive thinking, cross-culture competency and virtual collaborations (Davies, Fidler, and Gorbis 2011). The likelihood that today's systems engineer interacts with international colleagues either in the workplace or through networked interactions continues to grow, therefore developing global competencies within systems engineers supports global partnerships and promotes adaptability to the changing technology landscape. Modelling of cross-cultural teams showed improved decision-making performance when international team members developed a shared understanding (Handley and Heacox 2010). The importance of local culture awareness, to facilitate multi-national communication and shared understanding, has also been noted (Hipel, Okada, and Fukuyama 2003; Sanchis et al. 2014). Additionally, systems engineers often assume a technical leadership role on project teams (Sheard 1996). In the

1990s, corporate leaders were identified as needing cross-cultural competencies to address the internationalization of the workplace occurring at the time (Adler and Bartholomew 1992). This implies that systems engineers will have to be prepared with the skills to lead when working in a global context (Barrager 2016).

This study aims to identify and integrate into a graduate level curriculum the required international competencies for systems engineers to be successful in a global workplace. The authors were guided by two questions; first, is there a set of international competencies a systems engineer should be equipped with to operate globally? And second, can these competencies be integrated seamlessly within current educational curriculums? The method follows that proposed by Bourn & Neal (2008) who incorporated global skills within the United Kingdom curriculum for engineering education, i.e., identify the international competencies important for systems engineering, link the competencies to established systems engineering learning outcomes, identify body of knowledge topics to support the learning outcomes, and finally suggestion ways to introduce the international competencies within these systems engineering topics.

Identifying the International Competencies

A comprehensive literature review was conducted to identify the attributes that have been previously suggested for successful global engineers. (Note that most of these studies do not identify systems engineers in particular, but rather engineers in general). The results are shown in Table 1. The first column lists the global attributes in alphabetical order with a check mark placed across the row in the column of the supporting literature. Of particular note is the previous work of Hundley (2014) who identified twenty attributes required for global engineering success. After receiving feedback from a set of stakeholders, eight of the 20 attributes were identified as attributes to be emphasized for global engineers (American Society for Engineering Education 2015). While five of the eight attributes were technically or professionally focused, three of the attributes emphasized global skills: cultural sensitivity, tolerance to other people and perspectives, the ability to behave ethically across cultures.

Recently, the U.S. Department of Education (DOE) published a framework for developing global and cultural competences to enable equity, excellence and economic competitiveness (U.S. Department of Education 2017). The framework includes four themes for postsecondary education (not just engineering):

- *Collaboration and communication (CC)*: The ability to effectively communicate with people in cross-cultural settings.
- *Languages (L):* The ability to communicate in at least one other language other than the speaker's native language.
- *Diverse perspectives (DP):* The ability to analyze and reflect on concepts from diverse perspectives.
- *Civic and global engagement (E):* The ability to engage meaningfully in a wide range of civic and global issues and be successful in one's own discipline in a global context.

The four themes listed by the U.S. DOE were cross referenced with the attributes identified by the engineering literature review; refer to the last column of Table 1. Note that all the skills related to the systems engineering technical discipline were classified as Technical (T); these included entrepreneurship, problem solving, research, and technical skills. These rows have been italicized in Table 1. For the purposes of this research, it is assumed that the systems engineer is competent on the required technical skills. Of interest is what additional international competencies are required to operate and be successful in a global context.

Table 1: Review of Global Attributes for System Engineers

Attribute	Description	(Chan and Fishbein 2009)	(Ayokanmbi 2011)	(Warnick 2011)	(Hundley 2014)	(American Society for Engineering Education 2015)	(Gebreyohannes et al. 2017)	(Delicado, Salado, and Mompó 2018)	(U.S. Department of Education 2017)
Change	Ability to adapt and be open-minded				√			√	DP
Cognitive style awareness	Tolerance how other people think and respond			√	√	√		√	DP
Communication	Ability to communicate effectively in different ways, and methods across cultures	√	√	√	√	√		√	CC
Culture awareness	Appreciation and sensitively for other cultures		√	√	√	√	√	√	CC
Entrepreneurship	*Entrepreneurship*	√			√	√		√	*T*
Ethics	Ability to behave ethically across cultures	√	√		√	√	√	√	??
Language	Ability to communicate across language barriers	√		√		√		√	L
Local industry knowledge	Ability to derive an understanding of political, social and economic perspectives of the local environment			√		√			E
Problem solving	*Ability to solve problems and improve capability*	√			√	√			*T*
Research	*Ability to do research and think analytic*	√			√	√			*T*
Social responsibility	Ability to understand social responsibility requirements within different environments	√			√	√			E
Teamwork	Ability to work in global teams across culture	√	√	√	√	√		√	CC
Technical skills	*Discipline specific skills assumed*	√	√	√	√	√			*T*

After examination of the literature review presented in Table 1, and the cross referencing with the U.S. DOE framework, four attributes emerged as desired international competencies for systems engineers: cognitive style awareness, communication, culture awareness, and teamwork. These rows were referenced by multiple sources and have been highlighted in Table 1. An additional attribute, ethics, has also been included in the set of recommended international competencies. While this was not included in the U.S. DOE framework, the engineering literature repeatedly identifies ethics as an important attribute, both nationally and internationally. For example, there are many ethical questions raised by the fourth industrial revolution concerning how technology advances may adversely impact society, and systems engineers must evaluate these considerations during design decisions (Doucet et al. 2018). These five attributes, as described below, will be considered the desired international competencies for systems engineers.

Cognitive style awareness refers to the ability to adapt ones thinking to consider diverse perspectives. Systems engineers need to learn to tolerate other people's viewpoints, especially in an international collaboration (American Society for Engineering Education 2015; Hundley 2014). This awareness of how different types of people think and respond is complicated when there are cross-culture perspectives, which may include different beliefs, values and worldviews (Steers and Nardon 2016). The ability to be mindful of different cognitive styles allows the systems engineer to adapt their decision-making approach to support the system engineering process in a global context.

Communication refers to the ability to communicate in a second language as well as the ability to communicate across cultural barriers. The ability to communicate in another language at a professional proficiency level enables better understanding and reduces miscommunications, as well as facilitates more personal relationships to those native speakers (Warnick 2011). In some institutions, international academic program already include a second language requirement during the development of global engineering competencies (Lohmann, Rollins, and Hoey 2006). However, even without mastering a second language, systems engineers can still learn how to communicates effectively in a variety of different ways and methods suitable for a global audience. They can learn strategies to better communicate across cultures and how to adapt their communication style and content to be appropriate for an international collaboration.

Culture awareness refers to the appreciation and sensitivity of other cultures. The growing multicultural world has challenged the global workforce to consider culture awareness as a priority. Culture awareness is an ongoing process in which the global systems engineer has to continuously strive to understand the cultural context of the environment in which they work (Ayokanmbi 2011). To be effective, they must understand and appreciate basic cultural differences and be aware of many factors that differentiate business practices.

Ethics, in an international context, is the ability to behave morally across cultures; a global engineer must behave consistently in accordance with clear personal ethics and values (Ayokanmbi 2011). International systems engineering projects requires engineers to work in varying national and cultural settings and ethical issues can be magnified when cultural issues come into play (Barry and Herkert 2015). For example, it is common in some cultures or countries for business to be conducted by offering bribes or kickbacks, whereas in the U.S. such conduct is considered to be unethical and illegal. System engineers can be provided the training and resources to effectively deal with ethical issues arising from cultural or national differences.

Teamwork implies the ability to work effectively with people that may define the problem differently (Downey et al. 2006). Systems engineers will need to function effectively on interdependent global teams. This requires the ability to understand the team goals, contribute effectively to team assignments, support team decisions and respect the other team members. This includes skills to support working in or directing a culturally diverse team.

The five selected internationally competencies provide the basis to practice successful systems engineer in a global context. However, there is always the requirement for the systems engineer to become familiar with local customs. This location specific information should be researched by the systems engineer once the assignment has been made and prior to arrival in country in preparation of living in a different culture.

Systems Engineering Learning Outcomes

Many existing system engineering curriculums may already highlight one or more of the five international competencies identified above, i.e., cognitive style awareness, communication, culture awareness, ethics and teamwork. However, we propose a more in-depth coverage tied to both learning outcomes and curriculum content to better prepare system engineers to work on global assignments. Table 2 describes a typical treatment of the five international competencies in system engineering curriculums, usually through case studies or other exercises. The left-hand column describes the desired breadth of the topic required to be considered a global curriculum.

Table 2. As-Is and To-Be International Competencies

International Competencies	Typical Curriculum Treatment (As – Is)	Global Engineering Curriculum (TO- BE)
Cognitive Style Awareness	Different styles encountered based on specialty or expertise	Tolerance to other people's perspectives and global worldviews
Communication	Focus on the ability to communicate technical issues	Realizes the implications of culture on communication and comprehension
Culture Awareness	Awareness of different cultural backgrounds	Cultural sensitivity and willingness to embrace diverse viewpoints
Ethics	Professional honesty and integrity	Sense of social responsibility and ethical behavior across cultures
Teamwork	Team skills focused on negotiation and decision making	Multidisciplinary and interdisciplinary global cooperation skills

The first step in implementing the international competencies in a graduate level systems engineering curriculum is to link the competencies to existing learning outcomes. The Graduate Reference Curriculum for Systems Engineering (GRCSE) is a set of recommendations for the curriculum development of a professional master's degree program in systems engineering. As part of its guidelines, the GRCSE identifies sets of learning outcomes identifying the specific capabilities gained by the student who successfully completes a graduate program based on its recommendations (Pyster et al. 2015).

The learning outcomes are grouped into four high-level categories that reflect the topics covered in the System Engineering Body of Knowledge (SEBoK 2019). The Systems Engineering Concepts category focuses on the depth and breadth of knowledge required to practice system engineering; this includes the systems engineering foundation knowledge as well as knowledge required for a specific concentration area. The Systems Engineering Role category focuses on the interdisciplinary skills specific to an application domain and/or specialty topic area. The Systems Engineering Practice category focuses on the ability of graduates to design and implement a successful system, including generating requirements and evaluating alternatives. The learning outcomes from these three topic areas, Concepts, Role and Practice, focus on the technical competencies required for system engineering practice.

However, the GRCSE also acknowledges that systems engineering graduates need to be successful in a variety of positions that require leadership, teamwork and communication skills. The last learning outcomes category, the Systems Engineering Professionalism category, focuses on the characteristics of the systems engineer to be successful over the course of their career. This category includes three specific learning outcomes: professional development, teamwork and ethics. Professional development is defined as the ability to learn new models, techniques and technologies as they emerge; teamwork is defined as the ability to perform as a member of a multidisciplinary team, by communicating effectively and displaying leadership skills, and ethics is defined as the demonstration of knowledge of professional ethics and their application in systems engineering practice (Pyster et al. 2015). The definitions of these three learning outcomes can be expanded to include facets of the five international competencies, derived from Hundley (2014), Ayokanmbi (2011), Warnick (2011), as shown in Table 3. By reading across the row for each learning outcome, additional requirements can be added to augment the existing learning outcomes for the five international competencies.

Table 3. Augmented System Engineering Professionalism Learning Outcomes.

SE Professionalism: Characteristics to be successful as a (Global) Systems Engineer	Cognitive Style Difference	Communication	Culture Awareness	Ethics	Teamwork
Professional Development: Learn new models, techniques and technologies as they emerge;	Practice engineering decision making with cognizance of global style differences;		Embrace a global context and culturally sensitive perspective.		
Teamwork: Perform as a member of a multidisciplinary team, by communicating effectively and displaying leadership skills;		Communicate effectively in a variety of different methods suitable for a global audience;			Proficiency working in and leading a culturally diverse team.
Ethics: Demonstrate knowledge of professional ethics and their application in SE practice;				Including the ability to effectively deal with ethical issues arising from international differences	

The learning outcomes identified for each of the four high-level system engineering knowledge categories, Systems Engineering Concepts, Roles, Practice and Professionalism, are then referenced to specific curriculum elements that provide the necessary knowledge to satisfy the learning outcome requirements. The GRCSE suggested curriculum consists of six knowledge areas, including Foundations of Systems Engineering, Systems Engineering and Management, Applications of Systems Engineering, Enabling Systems Engineering and Related Disciplines (Pyster et al. 2015). The GRCSE cross references the content of each of these knowledge areas to support the individual learning outcomes. The two knowledge areas that were referenced to the Systems Engineering Professionalism learning outcomes are Systems Engineering and Management and Enabling Systems Engineering. Systems Engineering and Management addresses how systems engineering is conducted and includes both systems development and systems management processes, while Enabling System Engineering includes aspects of ethics, team dynamics and culture. The support from these two content area subtopics to the Professionalism learning outcomes is shown in Table 4. This table identifies opportunities in the current systems engineering curriculum to enhance the knowledge topics presented to the students with improved global engineering content to meet the augmented learning outcomes with knowledge requirements for the five international competencies.

Table 4. Support for SE Professional Outcomes (Adapted from GRCSE, pg. 96)

Systems Engineering Curriculum Knowledge Area	SE Professionalism Learning Outcomes		
	Professional Development	Teamwork	Ethics
Part 3: Systems Engineering and Management			
System Definition			Moderate
System Realization		Moderate	
System Deployment and Use		Moderate	Moderate
Systems Engineering Management		Strong	Moderate
Product and Service Life Management		Moderate	Moderate
SE Standards			Strong
Part 5: Topics on Enabling Systems			
Enabling Businesses and Enterprises	Strong	Strong	Moderate
Enabling Teams	Strong	Strong	Strong
Enabling Individuals	Strong	Strong	Strong

For example, the curriculum knowledge area of Topics on Enabling Systems strongly supports the Professional Development learning outcome. Table 3 has indicated that Professional Development learning outcome can be augmented to support both cognitive style differences and culture awareness international competencies. The subtopic areas of this curriculum module, Enabling Business and Enterprises, Enabling Teams and Enabling Individuals, can be expanded to include aspects of these international competencies.

Teaching the International Competencies

The last step in the development of the framework is to provide curriculum developers and instructors some recommendations on how to incorporate the international competencies into their programs. The literature review was revisited, this time from the perspective of identifying recommendations appropriate for a systems engineering curriculum. The goal was to identify teachable elements and learning guidelines for each of the five competencies that instructors can seamlessly include in their systems engineering content.

Most of the literature for educating engineers on global skills focuses on the undergraduate curriculum (Lohmann, Rollins, and Hoey 2006; Downey et al. 2006; Parks 2018). These programs rely on the large number of credit hours and longer timeline for undergraduate students to integrate a global curriculum within their degree. However, many students at the master's level are taking their programs part-time while working full time and often on-line. This limits both the time and content focused on global education. While many articles suggest international internships as the best way to build a global mindset, it is simply not feasible for most graduate students. The learning suggestions in this section seek to provide the predisposition for the international competencies within the restrictions of current curriculars, with the understanding that it is not a substitute for the preferred in-person activities of international enrollment at a foreign university, completing an international project abroad, international work placement or an international field trip (Downey et al. 2006). The goal is to provide an integrative enhancement, providing new elements that emphasize characteristics of the global engineer (Chan and Fishbein 2009).

Cognitive style awareness refers to the ability to adapt ones thinking to consider diverse perspectives. Repeated throughout the literature is the use of self-reflection; students' self-reflection leading to the self-awareness of others, as well as reflection with others, were at the core of learning and developing a global mindset (Cseh 2013). Students can be instructed to spend five minutes during class on an informal writing reflection. After discussing or reading about a key term or idea, have students write one paragraph relating the concept to their personal experience. Students can share their responses with a partner, in small groups or aloud. In this way students become aware that different solutions are available for the same problem. This will start the development of the global competency to work effective with people who approach the problem and or solution from a different perspective (Downey et al. 2006).

Communication refers to the ability to communicate in a second language as well as the ability to communicate across cultural barriers. Most global education programs advocate the need to learn a second language (Parks 2018). While this is generally not feasible with the constraints of current graduate systems engineering programs, students can be taught communication strategies that will improve their ability to interact comfortably with persons from a different culture (Lohmann, Rollins, and Hoey 2006). Of importance is the development of non-verbal communication techniques, such as reading facial expressions and other forms of body language, as well as recognizing other nuances in social interactions that may help explain what others are thinking (Nardon, Steers, and Sanchez-Runde 2011). One technique for improving the recognition of non-verbal cues is through class presentations where both the student presenter and the audience are asked to identify the non-verbal cues that either added or distracted from the delivery of the presentation. These questions can be included as part of the presentation peer-review process that is frequently used in graduate level courses. The ability to understand these implications and communicate effectively will enable engineers to be more successful in a global environment (Warnick 2011).

Culture awareness refers to the appreciation and sensitivity of other cultures. Exposing students to other cultures is important to avoid cultural stereotyping and enhances understanding of alternative worldviews and perspectives (Steers and Nardon 2016). This is especially important for programs that do not have a large international enrollment (Zhou and Pilcher 2018). A method to deliver a more integrated class experience is to present an engineering project from another country and provide independent reading on specific countries and cultures as part of the assignment (Nardon, Steers, and Sanchez-Runde 2011). The ensuing discussion can then be enhanced by a guest lecture or other encounter with a national engineer that provides a deeper understanding of the cultural worldview (Downey et al. 2006). This activity can also be integrated with the self-reflection activity introduced earlier, to better understand the origination of the cross-cultural issues (Handford et al. 2019).

Ethics, in an international context, is the ability to behave morally across cultures; a global engineer must behave consistently in accordance with clear personal ethics and values (Ayokanmbi 2011). A comprehensive system engineering program should provide students with a broader view of the profession to emphasize the responsibilities that engineers have to the rest of society (McPhail 2001). Major goals for ethics education for engineers should include the recognition that engineering and construction projects may have considerable political, economic and social implications, especially those that cross national boundaries. Boundary crossing problems refers to ethical problems that are produced by entering countries or regions with different cultural social or economic conditions (Harris, Pritchard, and Rabins 2008). The extreme solutions are absolutist solution – the laws, customs, and values of the home country should always be followed; however, this is not always feasible as it may be impossible to do business without following the cultural norms of the host country. The other extreme, is the relativist solution, i.e., home country citizens should always follow the host country customs and values even if they are contrary to home country standards. This also has problems as it may lead to illegal actions. Case studies can be used that force students to think through the implications of choices made throughout the engineering process that are impacted by local norms and how they affect the decision-making process.

Teamwork implies the ability to work effectively with people that may define the problem differently (Downey et al. 2006). International teamwork competencies is one of the most difficult to develop without participation in a multinational team, as it requires directly engaging with people from culturally diverse backgrounds (Ayokanmbi 2011). Preferably, an opportunity within the program would present itself for students to work together with multinational students, either from the same or another program, or from a collaborating instructor at another university. In lieu of that experience, a video analysis of a multinational team interacting together can be used to present teachable points on the challenges of such interactions, similar to the popular "Groupthink" video (CRM 2010). This educational video recreates the group decision making dynamics that lead to the space shuttle Challenger disaster and provokes student discussions on how groups make decisions.

These suggestions for including the foundations for international competencies can be constructed around the systems engineering content for particular modules. For example, from Table 3, Systems Engineering Management has strong ties to Teamwork and Ethics. In the context of a module for project management, the discussion can be expanded to include the implications of distributing the project tasks over a multinational team as well as the ethical issues for completing the tasks in different countries.

The Framework for International System Engineering Competencies

The result of this research is a framework for developing international system engineering competencies, as shown in Table 5. This table captures the five identified competencies, their definitions and the specific learning outcomes that can be incorporated into existing system engineering curriculums. This framework can also be used to identify the gap between the current curriculum elements to the desired elements, i.e. the as-is and to-be states as identified in Table 2. For example, most systems engineering curriculums incorporate ethics elements, either as a separate engineering ethics module, or integrated into specific assignments or case studies. These topics can be examined to see how they can be improved to present ethics from not only an international perspective, but to also incorporate the additional topics that support this discussion. For example, boundary crossing problems refer to ethical problems that are produced by entering countries or regions with different cultural, social or economic conditions (Harris, Pritchard, and Rabins 2008). Engineers who try to adhere to the standards of their home country encounter difficulties as it may be impossible to do business without following the cultural norms of the host country, however some of these procedures, such as bribes, may be illegal in the home country.

Table 5. Framework for Developing International System Engineering Competencies

International Competency	Description and Context	System Engineering Learning Outcome	Suggested Activity
Cognitive style awareness	Cognitive style awareness refers to the ability to adapt ones thinking to consider diverse perspectives. The cognitive style awareness competency refers to the ability to work effectively with people who define problems and solutions differently.	Systems engineers need to practice engineering decision-making with cognizance of global style differences; this develops the ability to integrate different perspectives into individual thinking style and problem solving (Downey et al. 2006).	Self-Reflection and Discussion for Identifying Alternative Perspectives

Communication	Communication refers to the ability to communicate in a second language as well as the ability to communicate across cultural barriers. The communication competency indicates that individuals are thinking about the meaning of their thoughts and actions in other contexts and languages (Parks 2018).	Systems engineers need to communicate effectively in a variety of different methods suitable for a global audience; this develops the ability to understand one's own thinking as well as to understand the limitations of both one's own and the foreign language (Parks 2018).	Recognition and Evaluation of Non-Verbal Cues
Culture awareness	Culture awareness refers to the appreciation and sensitivity of other cultures, a continuous process to strive to understand the cultural context of the work environment (Ayokanmbi 2011). The cultural awareness competency focuses on the individual ability to develop an understanding of the origination of their own view and recognize the worldviews of others.	Systems engineers need to embrace a global context and culturally sensitive perspective; this develops the ability for reflection on where personal worldviews originate from based on different and diverse cultures (Handford et al. 2019).	Independent Readings and Guest Lectures for Multinational Perspectives
Ethics	Ethics is the ability to behave morally across cultures; a global engineer must behave consistently in accordance with clear personal ethics and values (Ayokanmbi 2011). The ethics competency focuses on the development of critical awareness of own values and the understanding of their application in other cultures (McPhail 2001).	System engineers need to effectively deal with ethical issues arising from international differences; this develops moral sensibility through self-reflection and consideration with others on complex problems resulting from cultural conflicts (McPhail 2001).	International Case Studies with Boundary Crossing Problems
Teamwork	Teamwork implies the ability to work effectively with people that may define problems differently (Downey et al. 2006). The teamwork competency development should leverage social, cultural, communication and discipline differences to integrate different ideas and increase the quality of work (Binkley et al. 2012)	System engineers need to develop proficiency in working as part of and leading a culturally diverse team; this develops strategies for interacting and managing global teams.	Video Analyses of Multinational Team Dynamics and Decision-making

The international system engineering competencies were compared to trends in training and development approaches practiced by international companies. Google, for instance, is a multi-national company with a large engineering staff. One example of how Google facilitates communication and cross-cultural awareness is by sponsoring foreign language classes to all employees (Rodrigo 2016). Additionally, 30% of employee time is allocated to learning and development, highlighting the importance of time for individual reflection and self-development of cognitive abilities. Ethics is addressed through specific customized training sessions focused on issues typically encountered in particular situations or projects (Tran 2017).

Conclusions

The framework for international system engineering competencies was developed by identifying global engineering attributes through an extensive literature review and identifying the five dominant competencies. These international competencies were then linked to established systems engineering learning outcomes identified by the GRCSE; Systems Engineering Professionalism was identified as the category that included the learning outcomes that could be expanded to include the international competencies. Additionally, systems engineering topics that were strongly associated with the Professionalism learning outcomes were identified as candidates to be expanded to include aspects of global engineering education. The last stage of the research revisited the literature review to suggest ways to include the international competencies for these topics in an existing curriculum.

The framework can provide standardization across systems engineering programs to ensure that the international competencies are included in system engineering curriculums for all students (Del Vitto 2008). Improving global competencies in system engineering is facilitated by integrating the competencies across the curriculum rather than in a separate module (Warnick 2011). These integrations can vary from reinforcing elements of the global engineering in all aspects of a course to adding a single question on assignments prompting students to include international aspects (Chan and Fishbein 2009). For example, an engineering design course might modify an existing assignment to design a system to meet international standards (Warnick 2011). Including these global engineering concepts in the curriculum, as well suggesting teachable and learning guidelines, provides instructors the tools to educate our systems engineering graduates with the skills they require to be successful in the global economy.

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