VALIDITY OF A SELF-ASSESSMENT SURVEY AND ITS IMPLICATIONS FOR CLINICAL EDUCATION AND PRACTICE FRAMEWORK

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Dedication

This work is first and wholeheartedly dedicated to my husband, Dan, my daughter, Audrey, and my son, Ethan. Without their support and high expectations, I would not have been able to complete this doctorate. Dan, thank you for being there when times were hard and for encouraging me to complete this achievement. Without *your* faith in me, I would not have taken this leap of faith. Audrey, thank you for always asking about my ‘big paper.’ I wanted to make sure I finished this project to show you that you could do hard things, as long as you put your mind to it. Ethan, you were just three months old when I started my doctoral program. As I was writing this manuscript, you came in to check on me and ask me how I was doing. I’m so excited to see you and Audrey grow up to be caring and supportive adults, much like you are as children.

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Abstract

Background: Researchers, educators, and accreditors in the medical and health professions have increasingly emphasized competency-based education and assessment. Professional requirements for evidence-based practice and continuing professional development require clinicians to self-assess their performance and make decisions about practice limitations and continuing education throughout their careers. The clinical training portion of a health professions program relies upon both the learner and supervisor to make judgements about clinical performance in order to determine competency. In orthotics and prosthetics, professional competency is structured around the American Board for Certification's Practice Analysis (2015) framework, which has implications on educational standards and certification exam construction. The Analysis outlines the following domains: patient assessment; formulation of the treatment plan; plan implementation; follow-up to the treatment plan; practice management; and, promotion of competency and enhancement of professional practice. While researchers have studied the accuracy of self-assessment in clinical education, none has presented a validated tool for self-assessment in orthotics and prosthetics clinical education. This study used Kane's Validity Framework (2006) to explore a self-competency self-assessment tool used in orthotics and prosthetics education. **Purpose:** The objectives of this study were to evaluate the reliability of items in the self-assessment survey, examine the latent common factors measured by the survey, use inferences from clinical practice to refine and reduce the items in the survey, and examine the relationship between clinical autonomy and self-assessment. **Methods:** Retrospective data from students in one orthotics and prosthetics education program from July 2017 to December of 2019 were used for analysis. At multiple times during the educational program students completed a self-assessment survey which included 29 items addressing the National Commission on Orthotic and Prosthetic Education's residency objectives. The researcher analyzed reliability of the survey using Cronbach's alpha. The evaluation of latent common factors was initiated with a six-factor confirmatory factor analysis using principal axis factoring and direct oblimin rotation. Following confirmatory factor analysis, the researcher used exploratory factor analysis to determine additional items for reduction and the most appropriate model fit. Finally, clinical autonomy was compared to a sum self-competency self-assessment score through Bivariate Pearson correlation. **Results:** Reliability analysis demonstrated a robust instrument with a Cronbach's alpha of 0.927 and indicated a potential to drop four items. Confirmatory factor analysis indicated a poor fit of the six-factor model, and exploratory factor analysis and further item evaluation resulted in a total reduction of 15 items from the survey. The final and best-fitting model suggested four latent common factors: patient centeredness, regulatory awareness, device evaluation, and professional responsibility. The sum scores of the self-assessment survey did not correlate significantly with clinical autonomy. Review and revision of the self-assessment items resulted in a revised fourteen-item instrument for use in additional research. **Conclusion:** The results of the study imply a need to re-examine the current clinical practice framework in orthotics and prosthetics. Additionally, future research should evaluate the shortened self-assessment survey, determine extrapolation of the results, and consider implications for educational practices.

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Chapter I

Introduction

Health professions education frequently involves a combination of classroom and clinical education. The profession of orthotics and prosthetics is a health profession in which orthotists and prosthetists evaluate, design, and fit patients with custom-made orthoses (braces) and prostheses (artificial limbs) in an effort to restore function and mobility, improve environments for healing, and prevent progression of deformity. Currently, students training in orthotics and prosthetics are required to complete requirements for a graduate degree and a clinical residency in order to be eligible for board certification (American Board for Certification in Orthotics, 2015). In the completion of the clinical residency, supervisors deem residents competent in thirteen competency areas (Education, 2018). There have been no studies or publications providing descriptive information on what clinical experience leading to competency looks like, nor has there been validation of any method of competency assessment.

Competency-based medical education implies the explicit description and assessment of professional competencies within an educational context. In health professions, where clinicians are making decisions which may affect a patient's health status and quality of life, the ability to accurately self-assess competency is an integral part of making patient-centered decisions. Additionally, learners must be able to reflect upon personal motivation and performance in order to make decisions leading to professional improvement. Environments in which people are encouraged to be autonomous and progress toward competence result in intrinsic motivation and self-determination (Ryan & Deci, 2000). As orthotists and prosthetists are required to participate in continuing professional education for the entirety of their professional career (American Board for Certification in Orthotics, 2017) examining ways to measure self-assessment in learners may become critical components of professional success.

An inability to accurately self-assess can lead to distorted ideas of competence and ability. Kruger and Dunning (1999) found that high performers tend to underrate themselves while low performers tend to inflate their abilities. The interaction between performance and self-assessment has also been documented in dental education (K. A. B.-M. Mays, G.L., 2016). In critical care nursing simulation exercises, nursing students' self-assessments correlated negatively with supervisor and external ratings of performance (Baxter & Norman, 2011). However, researchers in medical education have demonstrated that trainee self-assessment can positively correlate with supervisor assessment (Young et al., 2017), and that the ability to critically self-assess is a skill required to continue professional medical education throughout a career (Epstein, Siegel, & Silberman, 2008). One study in orthotics and prosthetics education has demonstrated that graduate self-assessment of competency does correlate positively with employer assessment of competency (Boe & Gardner, 2019). Exploring the construct and external validity of a self-assessment tool in orthotics and prosthetics may allow educators and learners to use such an instrument for competency assessment.

Perhaps, more importantly, an orthotic and prosthetic resident's ability to accurately self-assess has a relationship with a supervisor's willingness to progress that resident to independence (Cruz, Utay, & Mullen, 2020) an experience without which clinical residents may not be prepared to enter practice. Surgical educators have found that current general surgery residency training does not result in surgeons who perform their skills independently at the end of their training, a fact which calls into question the readiness of trainees (George et al., 2017). There are currently no studies demonstrating the progression of an orthotic and prosthetic resident to independent practice during the clinical residency. Yet, in order for orthotic and prosthetic residents to complete their training, supervisors must deem them competent in thirteen device-specific areas (Education, 2018). Is competency achieved without independent clinical practice? How much independent practice results in a supervisor deeming a resident competent?

Determining the answers to these questions may help quantify competency in orthotic and prosthetic clinical education. During clinical residency, trainees are required to document basic information on their patient encounters in an online data base (NCOPE Tracker). Prior to 2018, residents documented case encounters through an online data base used by other educational programs and health professions (Typhon Group, Metairie, LA). Throughout the use of both systems, residents were instructed to log any patient encounter lasting more than 15 minutes and to document how autonomously they provided care. No researcher or professional organization has published normative standards of patient volume or resident autonomy during clinical residency. Without these guidelines, supervising practitioners and clinical residents have no framework, beyond personal experience, for the type of experience required to gain competency as an orthotic and prosthetic clinician.

Entrance into the profession of orthotic and prosthetics now requires a master's degree, followed by the completion of a clinical residency, during which residents are either not paid or are paid a meager salary. The cost of tuition and fees for graduate education in orthotics and prosthetics ranges from around $40,000 to $65,000.

Compounded with the cost of living and other educational expenses, students may take out upwards of $100,000 in student loans (Medicine, 2019). Since most residents complete their master's degree prior to starting their clinical residency, repayment on student loans begins during a time period in which they are making just under $40,000 a year (Unknown, 2017). The profession owes it to new students and recent graduates to examine the pathways to competency and the clinical experiences required for a complete education so that graduates can make an informed investment in their career.

The purposes of the study are to: 1) Evaluate the reliability of a self-competence self-assessment tool and the items contained within it, 2) Examine the latent common factors being assessed by the tool, and 3) Refine the survey based on results and clinical practice, and 4) Determine if the self-assessment tool scores correlate to clinical autonomy. Through the framework of Kane's Validity Framework (Kane, 2006), the researcher will explore the internal and external validity of a self-competency self-assessment tool used in orthotics and prosthetics clinical education and its relationship to resident development. The evaluation of these parameters will result in the description of a revised self-assessment inventory for orthotic and prosthetic clinical education that is contextualized through clinical experience.

Chapter II

Literature Review

The National Commission on Orthotic and Prosthetic Education describes the clinical residency as "an educational program centered on clinical training that results in the resident's attainment of competencies in the management of comprehensive orthotic and prosthetic patient care" (Education, 2018, p.2). The standards for accreditation as a residency program document thirteen competencies which the resident must achieve in order to complete the residency. In the process of obtaining competencies, residents must log patient encounters in an online database and be "deemed competent" by their residency supervisor. The majority of the orthotics and prosthetics practitioner education programs in the United States do not include the clinical residency—at all but one institution, students graduate prior to seeking employment as a clinical resident in order to complete their training. This model of education is based strongly off of the undergraduate and graduate medical education model, in which physicians complete their degrees (undergraduate medical education) prior to completing clinical training (graduate medical education).

Competency-Based Medical Education

Competency-based medical education is nestled within the context of its history, definition, curricula, and accreditation (Cooney et al., 2017). Within medical education, the Flexner Report of the early twentieth century changed the course of medical education (Bailey, 2017), standardizing systems and serving as a catalyst to contemporary education standards. It is from the lens of this report that researchers still view the birth of competency-based medical education. The need for outcomes and accountability for professional standards in the late twentieth century further progressed a movement toward competency-based education (Frank et al., 2010). Although most institutions don't adhere to strict definitions of a competency-based education, the goal of producing competent clinicians through competency-based education is almost ubiquitous today.

When considering the history and future needs of medical education, competency can be described as a concrete, learnable task which is part of a broader set of tasks making up professional activities (Ten Cate, 2017). These tasks may be context-specific or generalizable to the profession, yet they are clearly defined and measured. Carraccio et al. (2002) synthesized multiple descriptions in order to provide the following definition of competency: "a complex set of behaviors built on the components of knowledge, skills, attitudes, and 'competence' as personal ability" (p.362). Carraccio et al.'s definition of competency allows for a direct connection between educational methods, assessments and outcomes; the effective measurement of competency becomes as important as the attainment of the competency itself. The National Commission on Orthotic and Prosthetic Education (2018) defines competency as "a specific range of skill, knowledge, and ability to do something, especially measured against a standard" (p. 16). With the adoption of post-graduate training and competency-based accreditation, orthotics and prosthetics education mimics both the framework and the curricular model in medical education.

Competency-based medical education highlights a distinct shift away from a structure and process-based educational model that is teacher-driven, focuses on time, and emphasizes summative assessment (Carraccio et al., 2002). Holmboe et al. (2017)

describe competency-based medical education as addressing needs-based outcomes, being learner-centered, having authenticity, providing frequent feedback, employing systematic assessment, and using time only as a resource. Similarly, Mazerolle and Bowman (2017) note that a successful graduate of competency-based medical education has conscientiousness and reliability, self-awareness, and competence with patient and collegial interactions. Therefore, the competency-based curricula must account for the development of these qualities within students through the use of clearly defined assessment measures to ensure graduates embody acceptable knowledge, skills, and attitude. Current curricular standards in orthotics and prosthetics indicate that successful graduates must be able to articulate "the importance of lifelong learning with the goal of maintaining knowledge and skills at the most current level" (Programs, 2017).

When accreditors implemented graduate entry-level education in orthotics and prosthetics, competency-based education both survived and supported the transition. The clinical residency, which had previously been based around time and competency attainment, remained competency-focused (American Board for Certification in Orthotics, 2017), and new master's degrees followed suit by emphasizing competency-attainment and outcome measurement (Havorka, Shurr, & Bozik, 2002). During the clinical residency, students or graduates are required to complete anywhere from six to thirteen competencies which reflect current standards of practice (Education, 2018). Orthotic and prosthetic graduate students must meet competency in patient care, professionalism and technical or hand skills (Spaulding, Yamane, McDonald, & Spaulding, 2019). After completion of both graduate programs and clinical residencies, practitioners have their competency assessed by way of a series of board examinations assessing knowledge and skill through multiple methods of computer-based and in-person evaluation (American Board for Certification in Orthotics, 2017).

Implementing competency-based education requires attention to the process of competency identification, competency components, competency evaluation, and assessment of the competency process (Carraccio et al., 2002). This process is fundamentally tied to the use of objective measures and validated tools from which competency can be described and assessed. Ultimately, curricula centered around this approach can lead to transformation, not just at the graduate level, but throughout a professional career (Holmboe, Sherbino, Long, Swing, & Frank, 2010; Schumacher, Englander, & Carraccio, 2013; Ten Cate & Carraccio, 2019). This educational framework relies heavily on the judgement of outcomes and assessments, not unlike the work of an autonomous professional. As described in the orthotic and prosthetic residency standards, competent clinicians must have appropriate knowledge, judgement, and skills to implement patient care (Education, 2018). In this way, the achievement of competency in both medical and orthotics and prosthetics education is predicated on an ability to compare standards, measure outcomes, and tailor self-development toward a skill set, patient outcomes, and professional goals. Competency, therefore, becomes heavily dependent on one's ability to self-assess, self-direct, and continue to progress.

Self-Assessment

Health professions, including orthotics and prosthetics, require continual education in order to maintain professional certification (American Board for Certification in Orthotics, 2017). Continuing education is one of the hallmarks of a field distinguishing itself from a trade and becoming a profession (Greenwood, 1957). The decision of which continuing education pathways to pursue is driven mainly by internal factors: a clinician assesses where they need additional knowledge or skill and participates in education in order to fill the gap and gain additional competency. Concurrently, clinicians may be required to meet certain hour requirements in specific competency or professional development areas. These decisions require an ability to critically self-assess one's own knowledge and skills.

Even in new learners, the ability to self-assess comes primarily from the self and is only secondarily influenced by external factors (Epstein et al., 2008). Both positive and negative feedback have been shown to affect self-assessment. Erhlinger and Dunning (2003) demonstrated that students who were provided with more favorable feedback during a testing situation reported higher self-assessment of knowledge and performance. While the ability to more accurately self-assess doesn't always result in improved performance, self-assessment can help learners identify strengths and weaknesses when deciding how to improve (Eva & Regehr, 2005). Eva and Regehr suggest that using self-assessment predictively, concurrently, and summatively encourages health professions students to engage in metacognition and to improve their skillsets. Mazerolle & Bowman (2017) identify self-awareness of strengths and weaknesses as one tenable component of competency.

The ability to self-assess and create resulting pathways for learning is often referred to as self-determination or self-regulated learning (Ryan, Kuhl, & Deci, 1997). Both self-assessment and self-determination are key to lifelong learning and development in medicine (Schumacher et al., 2013). Researchers have examined the impact of self-regulated learning on student performance in medical and health professions education.

Brydges et al. (2015) evaluated the effect of self-regulation interventions during a simulated patient activity on immediate and longer term knowledge and skill retention. While opportunities to engage in self-regulated learning had no impact on immediate testing, those who received the self-regulated learning intervention demonstrated improved skill retention in delayed testing scenarios.

Self-assessment is often considered most meaningful when it correlates positively with external assessment. Boe and Gardner (2019) found that graduates of an orthotics and prosthetics program rated their competencies similarly to the rating of their supervisors in most domains. Ganni et al. (2017) determined that clinicians training in laparoscopic surgery were able to accurately self-assess when compared to expert appraisal of performance. Yet, there is also a well-documented tendency for high-performing students to rate themselves lower and low-performing students to rate themselves higher than their actual performance (J. Kruger & Dunning, 1999; K. A. Mays & Branch-Mays, 2016). Additionally, self-assessment frequently demonstrates a negative correlation to supervisor-rated performance (Baxter & Norman, 2011) with students more often rating themselves higher than a supervisor would assess.

Due to inconsistencies in the relationship between self-assessment and actual performance, other performance metrics may be necessary to validate the findings from self-assessment and provide a more definitive picture of competency. The development of an educator and a learner's ability to define competency will lead to the ability to more accurately assess it. Yet, even if competency is defined, there is value in understanding how a learner rates their own competency. The inflation or deflation of self-ratings may lead to meaningful discussions on self-confidence or self-awareness. Ultimately, the accuracy of self-assessment may be of lesser value to health professions researchers than the ability to determine the impact of self-assessment on student outcomes and professional decisions (Eva & Regehr, 2005).

Autonomy

In the absence of autonomy, self-assessment has little opportunity to inform professional growth (Williams & Deci, 1998). In a recent scoping review of medical education literature (Allen, Gawad, Park, & Raiche, 2019) researchers noted the paucity of literature relating autonomy in medical education to educational outcomes. Students and residents in health professions education encounter barriers such as hour restrictions and concerns for patient safety, which persist in preventing trainees from reaching full independence during learning periods (Biondi et al., 2015; Gunter & Greenberg, 2017). Even when the supervisors and residents equally expect independence within these restrictions, residents still struggle to perform at the highest level of autonomy (Meyerson, Sternbach, Zwischenberger, & Bender, 2017). Researchers in surgical education have found that some residency supervisors indicate their trainees never obtain full autonomy by the end of the residency (Patel, 2015) or obtain such a low level of autonomy that they are ill-prepared for independent clinical practice (George et al., 2017). In this restricted environment, Allen et al. (2019) argue that there is a continued need for researchers to explore the relationship between autonomy and clinical expertise.

There is a continued need to examine methods through which clinical educators can increase resident autonomy while maintaining patient safety and quality outcomes (Hashimoto, Bynum, Lillemoe, & Sachdeva, 2016; Kennedy, Regehr, Baker, & Lingard, 2005). The literature reflects a pervasive view that training should include a progressive growth from guided to independent clinical practice, emphasizing the value of reduced supervision over time (Kennedy et al., 2005). Goldberg et al. (2015) observed that learners who completed a simulated crisis exercise without supervision took more time to self-correct and study post-exercise that those who were supervised, resulting in the unsupervised learners having a stronger performance during a second evaluation procedure. Piquette et al. (2013) found that removing direct supervision of critical care residents resulted in no difference in performance over time. The presence of a supervisor may have no impact on trainee performance when compared to trainees who perform independently (Snyder, Vandromme, Tyra, & Hawn, 2010). When residents were randomized to various levels of distant, immediately available, and direct supervision during overnight rounds, there were no observed differences in learning opportunities or feedback provided. In one study involving orthotic and prosthetic education, researchers discovered that early autonomy has more relationship with outcomes than volume of patient encounters or the presence of explicit learning objectives (Miller, 2018). It is possible that decreased supervision allows for more self-reflective processes to occur. Increasing the need for self-assessment and self-regulation may result in stronger long-term performance and demonstrates behavior needed for lifelong regulation of learning.

Conceptual Framework

Self-assessment tool. The ability to self-assess becomes crucial in the development of competency when considering various adult learning theories. Kolb's Experiential Learning Theory and Self-Determination Theory both take in to account one's ability to self-assess, incorporate external feedback, and take action to self-regulate.

Williams and Deci (1998) aptly applied self-determination to medical education in a framework in which autonomy-supportive environments create learning that is mediated by self-assessment and directly affects student educational outcomes. It is the ability to self-assess in an accurate and timely manner that results in an opportunity to remediate, to review, and to reframe learning for continued clinical growth.

Kolb's Experiential Learning Model describes a continuous process in which learning is both affected by and an effect of experience (Kolb, 1984). The process can be summarized by a concrete experience prompting a learner to reflect and observe. These reflections and observations create a new framework or understanding that the learner tests through additional experience. The result of this testing may be a new set of constructed knowledge or further solidification of previous knowledge. Kolb's model, which been applied extensively to medical education (Lavoie et al., 2018), clearly identifies the transformative process of clinical experience on learning outcomes. This transformative process is not isolated to required educational experiences, however, and can be a framework through which professional education continues throughout a healthcare career (Medina, Castleberry, & Persky, 2017; Schumacher et al., 2013).

The experiences of learning and the self-regulated decisions as a result of learning are uniquely connected. Few would argue that the learning environment has little impact on educational experience. Findings regarding the impact of the clinical learning environment in other health professions have particular importance to the orthotics and prosthetics program in this study. Most health professions training programs follow a similar clinical education model which incorporates the clinical training in to the professional degree. In nursing clinical education, the individual experience of being supervised, the relationship with the supervisor, and the learning climate are predictive of student outcomes (Dante, Fabris, & Palese, 2015). As in nursing, strong teaching skills among physician faculty can result in improved student outcomes (Griffith, 2000; Stern, 2000). Not surprisingly, students rate the interpersonal skills of the clinical educator as important factors in their clinical success (Collier, 2018).

It is the experience of learning, as much as the content, that a learner recalls when reflecting upon a clinical placement. Therefore, it is reasonable to suggest that a trainee's perception of a clinical rotation impacts learning, and a trainee's learning likely impacts their self-regulation process. If a trainee, resident, or student is progressing through multiple clinical placements, or even just through various time periods of development, self-assessment can play an important role in determining the next phase of learning.

Acknowledging the impact of the learning environment, those who ascribe to Self-Determination Theory believe people have extrinsic environmental constraints, in addition to innate characteristics, which influence behavior and impact the decision-making process (Ryan & Deci, 2000). These innate characteristics construct self-regulation, or one's ability to reflect upon an environment and adjust accordingly in order to satisfy competence, relatedness, and autonomy. An awareness of the thought process surrounding these innate characteristics and environmental constraints may even serve to improve physician performance (Borrell-Carrio, 2004). Furthermore, an ability to self-assess internal and external factors surrounding performance will result in continued growth and development (Ten Cate & Carraccio, 2019). The situation of educational experiences within the clinical environment demands healthcare trainees explore the opportunities and constraints of their environment, relate the environment to their performance, and merge these reflections to create directions for future learning.

Kolb's Experiential Learning Theory and Self-Determination Theory are two similar frameworks through which one can view clinical education in the health professions. Both highlight the importance of previous experience and the human need to reconcile prior knowledge with varying situational contexts. Both acknowledge the influence of internal and external motivating factors in the educational experience. Kolb's theory more directly describes a cyclical process for clinical learning, while Self-Determination Theory offers a broader view of the multi-faceted human approach to growth and social incorporation. The use of a self-assessment tool in health professions clinical training may allow learners to reflect on performance and self-modulate their clinical education experience in order to reach competency.

Yet, the results of the self-assessment may be less meaningful than the subsequent action taken by the trainee (Eva & Regehr, 2005). When evaluating the use of a self-assessment, researchers must also consider what implications stem from the results of the assessment. Validity of a reflective tool in an educational process may not be as meaningful as its perceived utility in directing the educational pathway—what assumptions can be made as a result of the scores from the tool, and how can a learner redirect or adjust focus in order to obtain competence in deficient areas?

Validity framework. The process for validation of an instrument can be complex. Kane (2006) suggests an approach to validation that considers various aspects of instrument development, implementation, and utilization. Such consideration creates an argument around which validation is framed, rather than solely computed. The aspects of validation within Kane's Framework include scoring, generalization, extrapolation, and implication (Figure 1). While the framework is generally presented as a stepwise process, many elements of each domain are affected by and are an effect of parts of other domains.

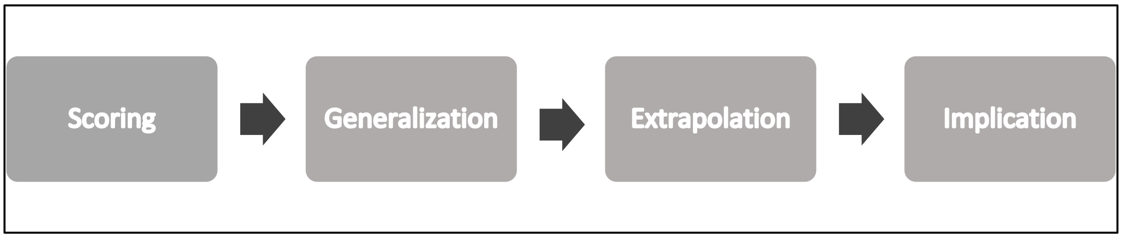

Figure 1. Domains within Kane's Validity Framework

Examination of scoring includes scrutinizing assessment implementation in order to ensure testing procedures and protocols are followed consistently. In the context of self-assessment, one might consider the clarity of the instrument, the communication of the intended purpose, and the motivation of the learners to complete the form accurately. Scoring may also be affected by anchors, items, and testing conditions. In the context of this study, scoring will be evaluated through the methods of data collection and examination of response trends. In this case, the self-competency self-assessment survey was intended to provide residents with an opportunity to reflect upon performance over a period of three months prior to the beginning of their next clinical rotation. In this way, scoring was likely impacted by clinical experience and educational intentions for subsequent clinical rotations.

The second domain of Kane's Validity Framework is generalization. Generalization includes an evaluation of the dataset and its relationship to broader groups, as well as the instrument and its relationship to broader contexts. Generalization also includes an analysis of instrument reliability and interpretations of test scores. Given that the self-competency self-assessment instrument in this study was intended to progressively measure resident competency, reliability can be evaluated both from the perspective of the longitudinal data set and from that of cross-sectional data set, given an appropriate sample size.

Extrapolation is the third domain of Kane's framework. This domain is highly associated with classic validation practices, and relies upon an examination of instrument responsiveness, as well as convergence with other measures of a given construct. Assessing the ability of this self-assessment tool to measure change in competency over time contributes to the extrapolation domain and supports the intent of instrument use. Importantly, factor analysis is essential to extrapolating latent traits from assessment instruments and is a large component of this domain. Additionally, correlating self-competency to clinical autonomy determines the relationship between two constructs relating to clinical competence, possibly establishing convergent validity.

While more pertinent to a high-stakes assessment than a formative assessment, such as a self-assessment tool, implication is the final domain of Kane's framework. Implications revolve around the results of testing outcomes, such as passing or failing a course or board certification exam. Unintended consequences of testing, such as anxiety or impact on assessors, can also be evaluated within the implication domain. In the context of this study, implications were more formative. With the intent of this study being to refine a clinical education tool, the implications of the assessment itself were considered within the decision-making process for tool refinement.

Researchers in medical education have applied Kane's framework to the process of evaluating clinical competency and medical skills (Cook, Brydges, Ginsburg, &

Hatala, 2015). Cook et al. point out that the process of validation must begin with a statement of purpose clearly indicating the use of the assessment tool. Hawkins et al. (2010) also point out that the process of collecting evidence and framing a validity argument is paramount to establishing validity itself. In the context of self-assessment and self-regulated learning, this study begins the process of creating a framework through which an educational tool may be revised and found meaningful in the realm of orthotics and prosthetics clinical education.

Clinical practice. Current educational standards and research in medical and health professions education demonstrate the need for clinical trainees to achieve competence by the end of their training. Furthermore, self-assessment and self-regulation in lifelong professional improvement are important aspects of maintaining competence throughout a professional career. Clinical education, therefore, situated at the end of an educational journey, is a timeframe in which students, residents, and trainees need to develop the ability to critically self-reflect and make decisions based upon self-reflection. Research has demonstrated the impact of the learning environment on the learning process, and the experience of learning cannot be ignored. Ideally, self-assessment is an accurate measure of performance apart from educational experience; however, research has demonstrated the limitations of using self-assessment as an objective metric. Learning theory can offset this limitation—educational experience provides context to self-assessment, and self-regulated learning offers a measurable product of self-assessment.

The literature demonstrates the importance of both the accuracy of and the use of self-assessment in health professionals. Yet, there is little published research on student outcomes and no research on student or resident self-assessment in orthotics and prosthetics education. As the profession of orthotics and prosthetics seeks to improve educational standards, evaluation of the assessment of competency is critically important. Any instrument which may offer a lens through which educators and students can monitor progress toward clinical competency offers an opportunity to evaluate the efficacy of educational practices and the development of healthcare professionals.

In this study, the clinical experience being evaluated involves a series of clinical placements, or rotations. The structure of these rotations offers a concrete set of experiences that fits within the framework of Kolb's theory and rely upon Self-Determination Theory in order for progression to occur. The parameters of the rotations allow for assessing periods of time which may highlight the development of a resident's competence and clinical independence. Each resident's rating of the clinical rotation and each clinical preceptor's rating of the resident provides potential context for adjustments in self-assessment or clinical autonomy. Should a resident's rating of self-competence improve from one rotation to the next, a change in clinical independence, either positive or negative, may reflect the process of self-regulated learning. In this way, the literature and theory support the need to validate measures of student outcomes, particularly self-assessment and self-regulated learning, in order to provide credence to the premise of competency-based education. The validation of those outcomes through Kane's Validity Framework generates an approach to situating self-assessment meaningfully within clinical education, as well as relates the instrument to broader clinical practice.

Chapter III

Methods

This study was a retrospective secondary data analysis of evaluation instruments used during the 18-month clinical residency at one orthotics and prosthetics program. The clinical residency model features six three-month rotations during which residents participate in patient care, technical fabrication, documentation, and practice management. The institutional review board approved and exempted this study (Appendix B).

Participants

Data included in this study cover three cohorts of residents (n=72) who participated the residency program from July of 2017 to December of 2019. Residents are placed by faculty in clinical affiliates across the country and internationally. No two residents complete the same series of rotations or work with the same set of clinical preceptors, although many preceptors will work with multiple residents over the course of a residency. All preceptors of the residents are required to complete a series of training modules prior to supervising the resident, in addition to having at least three years of experience since board certification. All residents are required to complete the educational standards for competency during the duration of the residency period.

Instruments

The residents' self-competency self-assessments and cases logged were used in this study. The self-competency self-assessment tool was developed in 2017 based upon the latest published Practice Analysis framework (American Board for Certification in Orthotics, 2015), which guides assessment practices on board certification exams. In addition, residents are asked to rate their level of competency on the outlined National Commission on Orthotic and Prosthetic Education residency objectives (Education, 2018) and their experiences with interprofessional education. The broad objectives and interprofessional education items were note analyzed in this study, as the focus of this work was to analyze and reduce the detailed items outlining specific competency areas. The development of the self-assessment survey occurred within the framework of Item Response Theory—the six domains categorizing items in the survey are what experts believe to account for overall clinical competency (Sharkness, 2014). Not counting demographic questions in the introduction to the survey, the instrument consists of 41 items with five possible responses (1=very unable to 5=very able). The self-assessment of competency related to the Practice Analysis consists of 29 items which are grouped within the six domains of practice: patient evaluation (4 items), plan formulation (4 items), plan implementation (7 items), treatment follow-up (5 items), practice management (5 items), and professional development (4 items).

Residents completed the competency self-assessment at the end of each rotation, resulting in an anticipated total of six surveys completed per resident per cohort. This instrument is designed to be a norm-based evaluation which is able to detect changes over time (Pett, Lackey, & Sullivan, 2003). The anchors on the instrument range from ‘very unable’ to ‘vary able’ (1 to 5 scale) and represent ordinal variables with ‘very able’ being considered the highest measure of self-assessment of self-competency. Analysis of the change of responses over time, along with the range and frequency of the responses, will inform the refinement of the evaluation tool for continued use.

During the clinical residency, each resident logged clinical encounters in an online tracking system (Typhon and NCOPE Tracker). With each case logged, residents indicate the level of clinical autonomy they had during the encounter: observation, assistance, or performance. As residents become competent, the clinical preceptors are prompted to provide the resident with more clinical independence. This entrustment process is widely accepted in the health professions and has been documented in orthotics and prosthetics (Cruz et al., 2020). Therefore, the percentage of cases a resident logs as independently performed may serve as a measure of competence and have a relationship with the self-competency self-assessment score.

Statistical Analysis

Data analysis was employed to evaluate the latent factor structure of the self-competency self-assessment and the relationship between clinical independence and self-competency self-assessment. Descriptive statistics of subject demographics and individual item responses on the self-competency self-assessment survey were generated. These descriptive statistics were evaluated by rotation, as growth over time may also indicate differences in scoring from the beginning to the end of the residency.

Reliability. The first portion of data analysis was to determine the reliability of the evaluation tool. A measure of scale reliability, Cronbach's alpha, was computed for the instrument in its entirety and each item on the survey. Examination of the reliability scale if each item were dropped allowed the researcher to consider dropping terms prior to factor analysis (Moyer, Morrison, Encandela, Kennedy, & Ellman, 2019). Given the current length of the tool and the frequency with which residents complete the assessment, dropping items which did not contribute to overall reliability of the instrument may improve validity and decrease the time and effort needed to complete the evaluation.

Factor analysis. According to nursing education research (Byrne, 2005), the most appropriate method to analyze validity of an instrument is to complete confirmatory factor analysis and evaluate goodness of fit of the model. In this case, confirmatory factor analysis was used to examine model fit with six latent factors, paralleling the six domains identified in the survey instrument. Since the items were likely highly correlated, oblique rotation of the matrices was used to determine the simple structure of the model and factor loadings greater than 0.40 were retained for simplification. Prior to analysis, the items were examined for correlation, and any items with intercorrelations greater than 0.80 or less than 0.30 were considered for removal from the analysis (Pett et al., 2003). Items with intercorrelations greater than 0.80 are likely to be redundant with another item, and items with intercorrelations less than 0.30 are likely to be unrelated to other items on the survey. Redundancy or unrelatedness suggests a possibility that an item may be dropped to decrease survey length or mitigate extraneous data points, respectively.

Multilevel confirmatory factor analysis has been used in social science research (Dyer, Hanges, & Hall, 2005) in evaluating clusters of data in the evaluation of survey instruments. The use of multi-level factor analysis, therefore, could account for the repeated measures design of the survey implementation. Although the total number of samples was large, the data were inter-dependent due to the same residents completing the survey after each rotation. While multi-level factor analysis can be used to determine more appropriate model fit of such a data set (Muthen, 1994), the small sample size of students completing the evaluations prohibited this method. While 72 participants completed the surveys, only 27 participants completed all six surveys in their entirety. Although there are 319 completed surveys in the data set, there are only 72 participants.

In order to account for the inter-dependence of the data set in this repeated measures design, only data from the surveys completed after the first residency rotation were evaluated in this analysis. Since the instrument was developed to assess the increase of competency over time, it was reasonable to expect the most variability in the data set completed after the first clinical rotation. In the time period of this study, the data set of surveys collected after the first residency rotation also provided the largest set of independent samples. Additionally, analysis of the latent factor structure after only one rotation limited the potential impact of other unmeasured variables.

Therefore, principal axis common factor analysis forcing a model with six latent factors to the data was the method used to examine factor structure. When the common factor analysis failed to yield a well-fitting model, exploratory factor analysis was used to determine the number of latent factors assessed by the survey. The researcher retained factors with Eigen values greater than one, retained factor loadings with absolute values greater than 0.40 (Pett et al., 2003) and analyzed scree plots to determine the number of latent factors (Gaskin & Happell, 2014; Sun, Adegbosin, Reher, Rehbein, & Evans, 2019). As in the confirmatory analysis, oblique rotation was used to determine the simplest factor loadings. Exploration of the reproduced correlation and residuals greater than 0.05 aided in determining if additional factors need to be accounted for in the model.

Responsiveness. Finally, responsiveness of the survey was examined through a within-subject comparison of the self-competency self-assessment survey after each rotation, with the hypothesis that items would be discriminant enough to reflect improvement in competency over time. In this case, a sum of all items was created for each resident at each rotation. The 29 items being evaluated on the self-assessment survey were summed to create a singular representation of competence, as has been done previously in other health profession self-efficacy assessment (Zurca, Olsen, & Lucas, 2019). The higher the summative score, the more self-competence indicated by the resident. Following assessment of normality and the presence of outliers, a repeated measures ANOVA was used to evaluate statistical differences between sum scores across the six rotations within the residency program.

Convergent validity. In order to determine if the self-competency self-assessment survey results related to clinical autonomy, the researcher examined the percentages of cases logged as performed during the first rotation of the residency. This percentage, serving as a measure of clinical autonomy, was then compared to the sum self-competency self-assessment score through Pearson correlation analysis.

Survey refinement. Following statistical analyses, the author evaluated the findings to offer suggestions for refinement of the instrument. The relevance of the Practice Analysis (American Board for Certification, 2017) and the assessment of comprehensive clinical competency were used as guiding frameworks through which items were dropped, kept, or rearranged. Assessment of the factor matrix informed a description of the latent variables being assessed by the instrument, as they do not appear to align with the hypothesized structure and sub-scales.

There were limitations to this analysis, the most pervasive of which was the lack of adequate sample size for factor analysis. Nunnelly (1978) suggests at least 10 subjects for each item in the assessment in order to reduce sampling error during factor analysis. This suggestion indicates a need for 290 subjects, which is far greater than the 72 being used for this factor analysis. An assessment of Bartlett's test of sphericity and the Kaiser-Meyer-Olkin test served to provide additional measures of sampling adequacy, in addition to evaluating the MSA values for each item. There were also limitations to the use of scree plots in decisions about factor retention, as the sample size was small and scree plots have greater reliability with larger samples (Gorsuch, 1983).

Despite the limitations, this study was the first of its kind in orthotics and prosthetics education. It is a necessary step in being able to generate information about the clinical residency experience and possible ways in which to assess clinical competence. Healthcare providers must be able to critically assess their own performance in order to make thoughtful decisions and progress professionally. The use of a valid self-assessment instrument in clinical education sets learners on a path to continuous self-reflection in clinical practice—a practice which is ultimately beneficial to patient care.

Chapter IV

Results

The self-competency self-assessment survey was completed by 72 residents during July of 2017 to December of 2019. Residents in the graduating classes of 2018 and 2019 had the opportunity to complete the evaluation six times, whereas members of the class of 2020 completed the evaluation after the end of their first year of curriculum and after their first rotation. 135 surveys were submitted from members of the class of 2018, 137 from the class of 2019, and 47 from the class of 2020 (Table 1). 79.9% (n=59) of residents completed all evaluations at each timepoint requested; 18.1% (n=13) of residents did not complete the evaluation at each potential time point, resulting in a lack of complete data for these participants. In total, 319 evaluations were submitted across the three cohorts and time periods with 307 being fully completed.

Table 1

Graduating Year of Participants

Graduation Year		Frequency	Percent	Cumulative Percent
Valid	2018	135	42.3	42.3
	2019	137	42.9	85.3
	2020	47	14.7	100.0
	Total	319	100.0	

The data set had the most self-competency self-assessments completed during the first rotation (71), given the timing of the data collection across three cohorts (Table 2). The least number of evaluations (24) were completed immediately following the first (didactic) year of curriculum, as the timing of this evaluation was only offered to members of the class of 2020.

Table 2

Survey Completion by Rotation

Rotation		Frequency	Percent	Cumulative Percent
Valid	1	71	22.3	22.3
	2	48	15.0	37.3
	3	46	14.4	51.7
	4	45	14.1	65.8
	5	42	13.2	79.0
	6	43	13.5	92.5
	Immediately Post Didactic Year	24	7.5	100.0
	Total	319	100.0	

Descriptive statistics for item performance are presented in Table 3. Most item prompts resulted in the use of anchors 2 (unable) through 5 (very able) on the ordinal scale. One item only received answers ranging from 3 to 5, and one item from 4 to 5. The lowest rated item on the evaluation was ‘demonstrate knowledge of federal and state legislation and regulations’(3.42±0.909). The highest rated item on the evaluation was ‘exemplify professional responsibility and ethical conduct’ (4.73±0.444).

Table 3

Descriptive Statistics of Survey Items

	N	Minimum	Maximum	Mean	Std. Deviation
Patient Evaluation and Assessment - Perform comprehensive assessment	318	2	5	4.21	.586
Patient Evaluation and Assessment - Make a determination of referrals as necessary	318	1	5	3.97	.755

Patient Evaluation and Assessment - Document assessment, treatment plan, and fabrication requirements to meet third-party payer standards	318	2	5	4.14	.717
Patient Evaluation and Assessment - Develop a relationship with the patient in order to obtain necessary information	318	3	5	4.64	.494
Formulation of Treatment Plan - Integrate foundational knowledge and evidence from the literature	318	2	5	4.09	.601
Formulation of Treatment Plan - Identify functional limitations, patient goals, and biomechanical objectives	318	2	5	4.31	.580
Formulation of Treatment Plan - Design an orthotic-prosthetic treatment plan in collaboration with the patient to meet objectives	318	2	5	4.14	.608
Formulation of Treatment Plan - Demonstrate the ability to form a comprehensive treatment plan	318	2	5	4.07	.644
Implementation of Treatment of Plan - Perform assessment and fabrication procedures as necessary	317	2	5	4.09	.669
Implementation of Treatment of Plan - Discern the use of the device as corrective or accommodative	318	2	5	4.43	.594
Implementation of Treatment of Plan - Assess the quality, structure, and appropriateness of the device	318	2	5	4.33	.626
Implementation of Treatment of Plan - Evaluate the fit and function of the device	318	2	5	4.37	.579
Implementation of Treatment of Plan - Perform and provide transfer, gait training, and mobility instructions	318	1	5	3.85	.853
Implementation of Treatment of Plan - Provide effective and complete education and instructions to patients	317	2	5	4.33	.651
Implementation of Treatment of Plan - Document the level of patient comprehension of instructions	318	1	5	4.32	.699

Follow Up - Provide evaluation and maintenance of devices	318	2	5	4.29	.635
Follow Up - Develop a follow up plan	318	2	5	4.33	.650
Follow Up - Educate the patient on the follow up plan	318	2	5	4.47	.608
Follow Up - Document interaction with patient and caregivers	317	2	5	4.57	.551
Follow Up - Utilize outcome measures	318	1	5	3.82	.822
Practice Management - Demonstrate knowledge of billing and coding	317	1	5	3.81	.740
Practice Management - Demonstrate knowledge of federal and state legislation and regulations	318	1	5	3.42	.909
Practice Management - Document clinical chart notes, legal compliance, and insurance issues	318	1	5	4.04	.801
Practice Management - Understand management of ethical and legal responsibilities related to patient management	316	1	5	4.16	.736
Practice Management - Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements	318	1	5	3.87	.798
Professional and Personal Development - Articulate the importance of personal development in relation to lifelong learning, community service, and service to the profession	317	3	5	4.58	.526
Professional and Personal Development - Pay attention to personal well-being	317	2	5	4.46	.648
Professional and Personal Development - Exemplify professional responsibility and ethical conduct	316	4	5	4.73	.444
Professional and Personal Development - Provide advocacy for and engagement in research	316	2	5	4.37	.617
Valid N (listwise)	307				

Reliability

Since the largest sample from the data set was from rotation 1, those evaluations were selected for reliability and factor analysis. Reliability statistics are presented in Table 4. The overall instrument demonstrated strong reliability, with a Cronbach's alpha of 0.927.

Table 4

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.927	.928	29

Scales if item deleted (Table 5) indicated only two items which would improve the overall reliability if dropped from the evaluation ('pay attention to personal well-being' and 'provide advocacy for and engagement in research') and two items which would not impact the reliability if dropped ('utilize outcome measures' and 'exemplify professional responsibility and ethical conduct'. These four items were dropped from the scale prior to principal component reduction. Assessment of the resulting inter-item correlation matrix revealed that all items in the survey correlated between 0.30 and 0.80 with other items on the survey. The range of intercorrelation was from less than 0.001 to 0.765, with all items correlating with at least three other variables above the 0.30 threshold. Therefore, no items were dropped from the analysis given the intercorrelation values.

Table 5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Patient Evaluation and Assessment - Perform comprehensive assessment	109.84	129.242	.505	.925
Patient Evaluation and Assessment - Make a determination of referrals as necessary	110.01	125.746	.560	.924
Patient Evaluation and Assessment - Document assessment, treatment plan, and fabrication requirements to meet third-party payer standards	109.97	124.775	.668	.923
Patient Evaluation and Assessment - Develop a relationship with the patient in order to obtain necessary information	109.26	130.824	.414	.926
Formulation of Treatment Plan - Integrate foundational knowledge and evidence from the literature	109.87	129.131	.497	.925
Formulation of Treatment Plan - Identify functional limitations, patient goals, and biomechanical objectives	109.60	128.541	.554	.925
Formulation of Treatment Plan - Design an orthotic-prosthetic treatment plan in collaboration with the patient to meet objectives	109.87	126.505	.618	.924

Formulation of Treatment Plan - Demonstrate the ability to form a comprehensive treatment plan	109.96	123.744	.740	.922
Implementation of Treatment of Plan - Perform assessment and fabrication procedures as necessary	109.81	126.038	.560	.924
Implementation of Treatment of Plan - Discern the use of the device as corrective or accommodative	109.54	128.371	.530	.925
Implementation of Treatment of Plan - Assess the quality, structure, and appropriateness of the device	109.59	125.768	.606	.924
Implementation of Treatment of Plan - Evaluate the fit and function of the device	109.54	125.834	.691	.923
Implementation of Treatment of Plan - Perform and provide transfer, gait training, and mobility instructions	110.26	122.078	.662	.923
Implementation of Treatment of Plan - Provide effective and complete education and instructions to patients	109.68	127.356	.551	.925
Implementation of Treatment of Plan - Document the level of patient comprehension of instructions	109.69	127.291	.510	.925
Follow Up - Provide evaluation and maintenance of devices	109.59	128.514	.574	.925
Follow Up - Develop a follow up plan	109.65	125.127	.660	.923
Follow Up - Educate the patient on the follow up plan	109.44	126.399	.650	.923
Follow Up - Document interaction with patient and caregivers	109.28	127.189	.626	.924

Follow Up - Utilize outcome measures	110.31	127.590	.407	.927
Practice Management - Demonstrate knowledge of billing and coding	110.37	127.102	.520	.925
Practice Management - Demonstrate knowledge of federal and state legislation and regulations	110.75	125.235	.487	.926
Practice Management - Document clinical chart notes, legal compliance, and insurance issues	110.19	124.366	.553	.925
Practice Management - Understand management of ethical and legal responsibilities related to patient management	109.97	122.745	.681	.923
Practice Management - Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements	110.46	125.565	.569	.924
Professional and Personal Development - Articulate the importance of personal development in relation to lifelong learning, community service, and service to the profession	109.32	130.162	.430	.926
Professional and Personal Development - Pay attention to personal well-being	109.34	133.332	.168	.929
Professional and Personal Development - Exemplify professional responsibility and ethical conduct	109.04	132.461	.313	.927
Professional and Personal Development - Provide advocacy for and engagement in research	109.56	132.489	.196	.929

Confirmatory Factor Analysis

Although maximum likelihood, an analysis frequently used to conduct common factor analysis, was the preferred method, it was not appropriate for this study. The items did not meet the assumption of normality, therefore the researcher moved forward with principal axis factoring. The first principal axis factoring model was set to use direct oblimin rotation with delta set to zero and to retain factor loadings with absolute values greater than 0.40. The Kaiser-Meyer-Olkin (KMO) measure and the Bartlett's test of sphericity were used to assess sampling adequacy (Table 6). The KMO statistic was 0.81, indicating a 'meritorious' overall measure of sampling adequacy (Kaiser, 1974). Individual measures of sampling adequacy for each item revealed each item achieved a score of greater than 0.70. Bartlett's test of sphericity was significant (X^2=1014.369, $p<0.001$).

Table 6

KMO and Bartlett's Test Initial Six Factor PAF Model

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.810
Bartlett's Test of Sphericity	Approx. Chi-Square	1014.369
	df	300
	Sig.	.000

The reproduced correlation matrix indicated 75 non-redundant residuals (25%) with absolute values greater than 0.05. There were seven eigen-values greater than one, suggesting that a six factor model did not fit the data well (Table 7). The six factors explained 59% of the total variance.

Table 7

Total Variance Explained Initial Six Factor PAF Model

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	9.755	39.021	39.021	9.382	37.527	37.527	6.371
2	2.035	8.139	47.159	1.667	6.670	44.197	3.581
3	1.712	6.849	54.008	1.292	5.167	49.364	5.373
4	1.268	5.074	59.081	.878	3.512	52.876	.924
5	1.173	4.690	63.771	.833	3.330	56.207	4.712
6	1.064	4.255	68.026	.736	2.945	59.151	5.253
7	1.043	4.170	72.196				
8	.985	3.940	76.137				
9	.784	3.135	79.271				
10	.708	2.831	82.103				
11	.656	2.624	84.727				
12	.531	2.123	86.850				
13	.486	1.943	88.793				
14	.447	1.788	90.580				
15	.377	1.507	92.088				
16	.330	1.321	93.409				
17	.285	1.139	94.548				
18	.275	1.101	95.649				
19	.241	.963	96.612				
20	.186	.745	97.357				
21	.184	.736	98.093				
22	.158	.632	98.724				
23	.141	.562	99.287				
24	.098	.394	99.680				
25	.080	.320	100.000				

Visual inspection of the scree plot (Figure 2) and variance table demonstrates one latent common factor explaining 38% of the variance. The six factors correlated with each other in a range from -0.452 to 0.435 (Table 8). Factors one, three, and six correlated moderately with each other, suggesting a common latent factor between them.

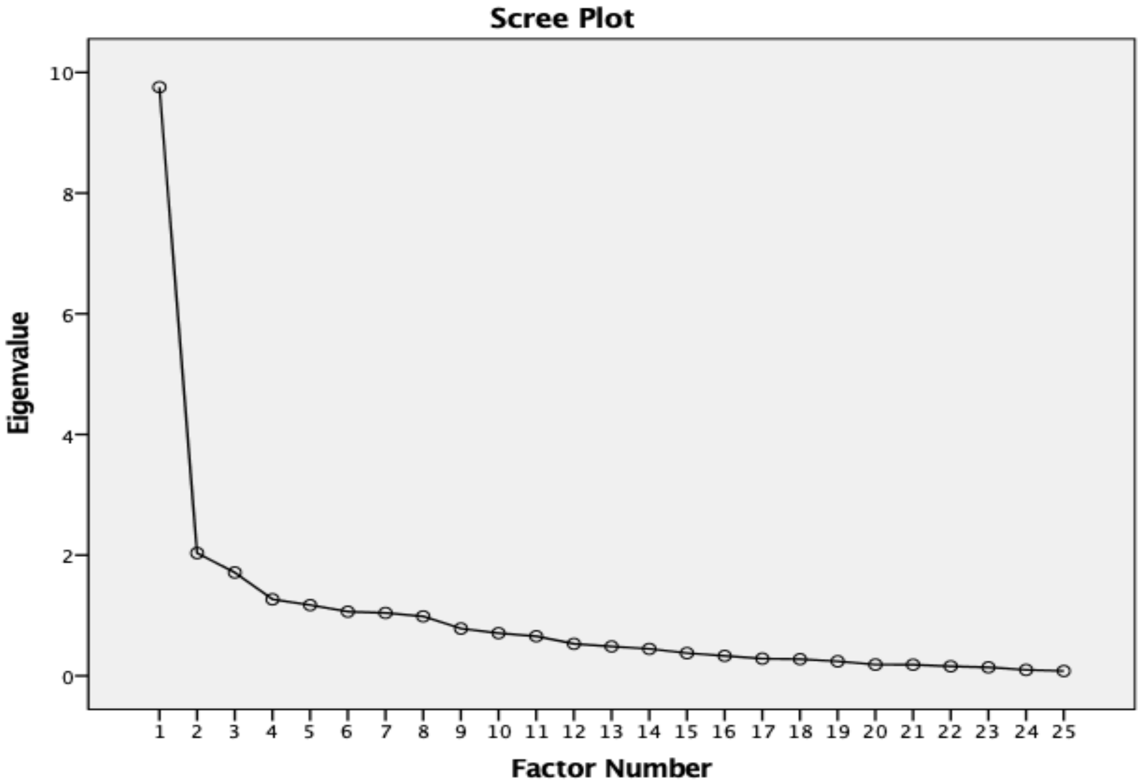

Figure 2. Scree Plot of Initial Six Factor PAF Model

Table 8

Factor Correlation Matrix Initial Six Factor PAF Model

Factor	1	2	3	4	5	6
1	1.000	.247	.435	-.007	-.312	-.425
2	.247	1.000	.172	.079	-.314	-.297
3	.435	.172	1.000	-.036	-.376	-.452
4	-.007	.079	-.036	1.000	.029	.002
5	-.312	-.314	-.376	.029	1.000	.383
6	-.425	-.297	-.452	.002	.383	1.000

Examination of the rotated factor pattern matrix (Table 9) and the rotated structure matrix (Table 10) demonstrated one item (‘importance of personal development…') which did not load on to a factor in both instances and two similar items which did not load on to any of the six factors. The item which did not load in either matrix described three components within the item, suggesting respondents may have answered the item according to any one of those components, rather than a consistent component. Two additional similar items describing patient assessment and evaluation, which was not reflected elsewhere in the instrument, did not load on to any of the factors. It was hypothesized that the two similar items were loading on to a seventh factor not present in the current model. Therefore, only the dissimilar item not loading on to any of the latent factors was dropped from the next phase of analysis.

Table 9

Pattern Matrix Initial Six Factor PAF Model

	Factor					
	1	2	3	4	5	6
Patient Evaluation and Assessment - Perform comprehensive assessment						
Patient Evaluation and Assessment - Make a determination of referrals as necessary					-.653	
Patient Evaluation and Assessment - Document assessment, treatment plan, and fabrication requirements to meet third-party payer standards						
Patient Evaluation and Assessment - Develop a relationship with the patient in order to obtain necessary information			.510			
Formulation of Treatment Plan - Integrate foundational knowledge and evidence from the literature						
Formulation of Treatment Plan - Design an orthotic-prosthetic treatment plan in collaboration with the patient to meet objectives						-.726
Formulation of Treatment Plan - Demonstrate the ability to form a comprehensive treatment plan						-.805

Implementation of Treatment of Plan - Perform assessment and fabrication procedures as necessary	.573					
Implementation of Treatment of Plan - Discern the use of the device as corrective or accommodative	.419					
Implementation of Treatment of Plan - Assess the quality, structure, and appropriateness of the device	.883					
Implementation of Treatment of Plan - Evaluate the fit and function of the device	.611					
Implementation of Treatment of Plan - Perform and provide transfer, gait training, and mobility instructions				.457		
Implementation of Treatment of Plan - Provide effective and complete education and instructions to patients			.586			
Implementation of Treatment of Plan - Document the level of patient comprehension of instructions			.699			
Follow Up - Provide evaluation and maintenance of devices	.718					
Follow Up - Develop a follow up plan	.634					
Follow Up - Educate the patient on the follow up plan	.494					
Follow Up - Document interaction with patient and caregivers				-.522		
Practice Management - Demonstrate knowledge of billing and coding		.737				
Practice Management - Demonstrate knowledge of federal and state legislation and regulations		.559				
Practice Management - Document clinical chart notes, legal compliance, and insurance issues					-.622	
Practice Management - Understand management of ethical and legal responsibilities related to patient management					-.538	
Practice Management - Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements		.762				
Formulation of Treatment Plan - Identify functional limitations, patient goals, and biomechanical objectives			.628			

Professional and Personal Development - Articulate the importance of personal development in relation to lifelong learning, community service, and service to the profession						

Table 10

Structure Matrix of Initial Six Factor PAF Model

	Factor					
	1	2	3	4	5	6
Patient Evaluation and Assessment - Perform comprehensive assessment			.521		-.462	
Patient Evaluation and Assessment - Make a determination of referrals as necessary					-.702	
Patient Evaluation and Assessment - Document assessment, treatment plan, and fabrication requirements to meet third-party payer standards	.476	.505	.406		-.602	-.448
Patient Evaluation and Assessment - Develop a relationship with the patient in order to obtain necessary information			.580			
Formulation of Treatment Plan - Integrate foundational knowledge and evidence from the literature			.471		-.410	-.427
Formulation of Treatment Plan - Design an orthotic-prosthetic treatment plan in collaboration with the patient to meet objectives		.408	.428			-.807
Formulation of Treatment Plan - Demonstrate the ability to form a comprehensive treatment plan	.502		.495		-.513	-.918
Implementation of Treatment of Plan - Perform assessment and fabrication procedures as necessary	.696		.423			-.527
Implementation of Treatment of Plan - Discern the use of the device as corrective or accommodative	.550		.421			
Implementation of Treatment of Plan - Assess the quality, structure, and appropriateness of the device	.882					-.436
Implementation of Treatment of Plan - Evaluate the fit and function of the device	.774		.619			
Implementation of Treatment of Plan - Perform and provide transfer, gait training, and mobility instructions	.575		.474	.450	-.465	

Implementation of Treatment of Plan - Provide effective and complete education and instructions to patients	.415		.707			-.428
Implementation of Treatment of Plan - Document the level of patient comprehension of instructions			.691			
Follow Up - Provide evaluation and maintenance of devices	.742					
Follow Up - Develop a follow up plan	.754		.406			-.515
Follow Up - Educate the patient on the follow up plan	.665		.445		-.467	-.540
Follow Up - Document interaction with patient and caregivers	.541		.535	-.522	-.431	
Practice Management - Demonstrate knowledge of billing and coding	.410	.797				-.425
Practice Management - Demonstrate knowledge of federal and state legislation and regulations		.691			-.532	
Practice Management - Document clinical chart notes, legal compliance, and insurance issues		.400			-.713	-.435
Practice Management - Understand management of ethical and legal responsibilities related to patient management	.406	.404			-.699	-.530
Practice Management - Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements		.816				
Formulation of Treatment Plan - Identify functional limitations, patient goals, and biomechanical objectives			.685			
Professional and Personal Development - Articulate the importance of personal development in relation to lifelong learning, community service, and service to the profession						

Exploratory Factor Analysis

Exploratory principal axis factoring using the remaining items was performed. The KMO statistic was 0.843 and the Bartlett's test of sphericity was significant ((X^2=971.891, p<0.001) (Table 11).

Table 11

KMO and Bartlett's Test Initial Exploratory PAF Model

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.843
Bartlett's Test of Sphericity	Approx. Chi-Square	971.891
	df	276
	Sig.	.000

Measures of sampling adequacy for each item were greater than 0.70. The reproduced correlation matrix indicated 31 (11%) nonredundant residuals with absolute values greater than 0.05. Seven factors with eigen values greater than one explained just over 64% of the variance in the data (Table 12). The seven factors correlated with each other in a range of -0.426 to 0.390, with factors one, three, and six continuing to correlate moderately with each other.

Table 12

Total Variance Explained Initial Exploratory PAF Model

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	9.621	40.088	40.088	9.282	38.676	38.676	6.157
2	2.029	8.453	48.541	1.674	6.973	45.649	3.872
3	1.653	6.888	55.429	1.307	5.446	51.095	4.440
4	1.259	5.248	60.677	.903	3.762	54.856	3.951
5	1.162	4.840	65.517	.851	3.546	58.402	1.078
6	1.049	4.372	69.888	.760	3.166	61.568	4.899
7	1.013	4.222	74.111	.657	2.738	64.306	3.661
8	.832	3.468	77.579				
9	.711	2.965	80.543				
10	.668	2.782	83.326				

11	.550	2.292	85.618		
12	.486	2.024	87.642		
13	.449	1.869	89.511		
14	.418	1.740	91.250		
15	.362	1.507	92.758		
16	.288	1.201	93.959		
17	.275	1.147	95.106		
18	.255	1.062	96.168		
19	.224	.932	97.100		
20	.185	.771	97.871		
21	.160	.666	98.536		
22	.147	.611	99.147		
23	.108	.452	99.599		
24	.096	.401	100.000		

Inspection of the scree plot (Figure 3) indicates a small but observable drop between factors 7 and 8, although the scree plot more clearly indicates similar eigen values for all factors after factor three.

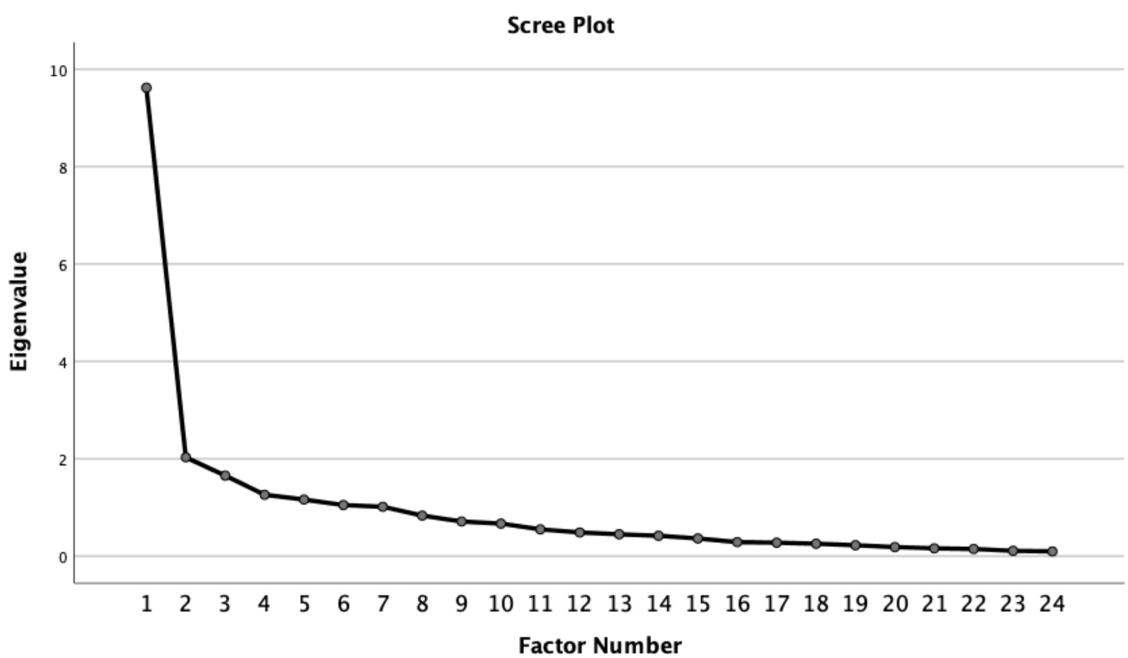

Figure 3. Scree Plot of Initial Exploratory PAF Model

Examination of the rotated factor pattern matrix (Table 13) and the rotated structure matrix (Table 14) suggested dropping three additional items from analysis. The items 'perform comprehensive assessment', 'document assessment, treatment plan, and fabrication requirements to meet third-party payer standards', and 'discern the use of the device as corrective or accommodative' did not load onto any of the seven factors identified in the model.

Table 13

Pattern Matrix Initial Exploratory PAF Model

	Factor						
	1	2	3	4	5	6	7
Patient Evaluation and Assessment - Perform comprehensive assessment							
Patient Evaluation and Assessment - Make a determination of referrals as necessary				-.602			
Patient Evaluation and Assessment - Document assessment, treatment plan, and fabrication requirements to meet third-party payer standards							
Patient Evaluation and Assessment - Develop a relationship with the patient in order to obtain necessary information			.526				
Formulation of Treatment Plan - Integrate foundational knowledge and evidence from the literature							.772
Formulation of Treatment Plan - Identify functional limitations, patient goals, and biomechanical objectives							.479
Formulation of Treatment Plan - Design an orthotic-prosthetic treatment plan in collaboration with the patient to meet objectives						-.640	

Formulation of Treatment Plan - Demonstrate the ability to form a comprehensive treatment plan						-.835	
Implementation of Treatment of Plan - Perform assessment and fabrication procedures as necessary	.679						
Implementation of Treatment of Plan - Discern the use of the device as corrective or accommodative							
Implementation of Treatment of Plan - Assess the quality, structure, and appropriateness of the device	.846						
Implementation of Treatment of Plan - Evaluate the fit and function of the device	.605						
Implementation of Treatment of Plan - Perform and provide transfer, gait training, and mobility instructions	.433				-.415		
Implementation of Treatment of Plan - Provide effective and complete education and instructions to patients			.519				
Implementation of Treatment of Plan - Document the level of patient comprehension of instructions			.806				
Follow Up - Provide evaluation and maintenance of devices	.719						
Follow Up - Develop a follow up plan	.536						
Follow Up - Educate the patient on the follow up plan	.404						
Follow Up - Document interaction with patient and caregivers					.542		
Practice Management - Demonstrate knowledge of billing and coding		.752					
Practice Management - Demonstrate knowledge of federal and state legislation and regulations		.587					
Practice Management - Document clinical chart notes, legal compliance, and insurance issues				-.621			

Practice Management - Understand management of ethical and legal responsibilities related to patient management				-.439			
Practice Management - Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements		.779					

Table 14

Structure Matrix Initial Exploratory PAF Model

	Factor						
	1	2	3	4	5	6	7
Patient Evaluation and Assessment - Perform comprehensive assessment			.427	-.430			.483
Patient Evaluation and Assessment - Make a determination of referrals as necessary				-.680			
Patient Evaluation and Assessment - Document assessment, treatment plan, and fabrication requirements to meet third-party payer standards	.446	.532		-.586		-.441	
Patient Evaluation and Assessment - Develop a relationship with the patient in order to obtain necessary information			.599				
Formulation of Treatment Plan - Integrate foundational knowledge and evidence from the literature							.797
Formulation of Treatment Plan - Identify functional limitations, patient goals, and biomechanical objectives			.557				.629
Formulation of Treatment Plan - Design an orthotic-prosthetic treatment plan in collaboration with the patient to meet objectives		.431				-.758	.456
Formulation of Treatment Plan - Demonstrate the ability to form a comprehensive treatment plan	.464		.467	-.457		-.942	
Implementation of Treatment of Plan - Perform assessment and fabrication procedures as necessary	.750					-.511	.432

Implementation of Treatment of Plan - Discern the use of the device as corrective or accommodative	.543		.431				
Implementation of Treatment of Plan - Assess the quality, structure, and appropriateness of the device	.872					-.459	
Implementation of Treatment of Plan - Evaluate the fit and function of the device	.768	.403	.574				.413
Implementation of Treatment of Plan - Perform and provide transfer, gait training, and mobility instructions	.596	.401	.495	-.439			
Implementation of Treatment of Plan - Provide effective and complete education and instructions to patients	.406		.677				.445
Implementation of Treatment of Plan - Document the level of patient comprehension of instructions			.788				
Follow Up - Provide evaluation and maintenance of devices	.749						
Follow Up - Develop a follow up plan	.723		.433			-.561	
Follow Up - Educate the patient on the follow up plan	.632		.418	-.463		-.569	
Follow Up - Document interaction with patient and caregivers	.497		.425	-.403	.584		
Practice Management - Demonstrate knowledge of billing and coding		.799				-.414	
Practice Management - Demonstrate knowledge of federal and state legislation and regulations		.704		-.490			
Practice Management - Document clinical chart notes, legal compliance, and insurance issues		.438		-.721		-.437	
Practice Management - Understand management of ethical and legal responsibilities related to patient management	.416	.431		-.630		-.488	.488
Practice Management - Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements		.823					

While these items describe important aspects of orthotic and prosthetic care, there are most certainly complexities in their interpretation. Performing a comprehensive assessment is not a well-defined aspect of current care and may be interpreted to mean a variety of skills and actions, suggesting the need to drop the item from additional analysis. Documenting the assessment, plan, and third-party payer requirements is a very comprehensive item, aspects of which are reflected more succinctly in another item within the survey ('document clinical chart notes, legal compliance, and insurance issues'). Since participants may be answering the item according to any of three subsets of documentation outlined, this item was dropped from additional analysis. Finally, 'discerning the use of the device as corrective or accommodative' is an item assessing a small portion of decision-making which is reflected more comprehensively in 'demonstrate the ability to perform a comprehensive treatment plan', and item which loads strongly on to factor six.

These three items were dropped from analysis (a total of eight now dropped), and exploratory principal axis factoring was run again. The resulting model had a KMO score of 0.834 and Bartlett's test of sphericity was significant (X^2=845.463, $p<0.001$). Measures of sampling adequacy for each item continued to be greater than 0.70, as expected since items were dropped from analysis. The reproduced correlation matrix indicated 52 (24%) nonredundant residuals with absolute values greater than 0.05. Five factors with eigen values greater than one explained just over 59% of the variance in the model. The five factors correlated with each other in a range of -.417 to .467, with factors one and three correlating moderately strongly with each other (r2=0.467). Although the model extracted five factors, evaluation of the scree plot did not demonstrate discrimination of the eigen values after five factors, with all factors after three continuing to produce similar values.

Evaluation of the pattern matrix for this model with eight items dropped from the initial survey revealed five extracted factors which did not load onto two items: ‘integrate foundational knowledge and evidence from the literature’ and ‘design an orthotic-prosthetic treatment plan in collaboration with the patient to meet objectives’. The former item does not relate to any other items in the survey in terms of content, and the latter item is reflected in the prompt ‘identify functional limitations, patient goals, and biomechanical objectives’, which with factor three loads relatively strongly. Therefore, these two items were also dropped from additional analysis and additional exploratory factor analysis was conducted in order to identify a more appropriate model with fewer nonredundant residuals greater than 0.05.

Exploratory factor analysis of the resulting 19-item model resulted in a slightly better fit. The KMO score was 0.843 and Bartlett’s test of sphericity continued to remain significant and had a lower chi-square value (X^2=729.318, $p<0.001$). Five factors with eigen values greater than one were extracted, and visual evaluation of the scree plot indicated an initial drop after the third factor, followed by a smaller but clear drop after the fifth factor. There were 30 (17%) non-redundant residuals with absolute values greater than 0.05, indicating that the model is still not best fit to the data. The pattern matrix indicated only two items loading onto the fifth factor. These two items, ‘perform and provide transfer, gait training, and mobility instructions’ and ‘document interaction with patient and caregivers’ seemed only indirectly related. The first item assessed three possible skill sets (transfer, gait training, and mobility instructions), and both items were assessed more broadly by other items in the survey related to patient education and documentation which loaded on to another factor. Given that they were the only two items loading on to this fifth factor, they seemed only indirectly related, and these items were represented elsewhere in the survey, the researcher decided to drop these items from additional analysis.

An exploratory factor analysis with twelve items dropped was performed in order to assess latent factors and model fit. The resulting model indicated improved fit with a KMO score of 0.856 and a significant Bartlett's test of sphericity with a lower Chi Square value (X^2=599.435, p<0.001). A total of four latent factors explaining just over 58% of the variance in the data with eigen values greater than one were extracted from the remaining items. Visual examination of the scree plot indicated a clear drop from the fourth factor to the fifth and suggested a more appropriate fit. The nonredundant residuals with absolute values greater than 0.05 also dropped to 26 (19%), but was still too large to indicate an appropriate model fit.

Examination of the pattern matrix (Table 15) revealed factor one loading on to six items, factor two loading on to three items, factor three loading on to four items, and factor four loading on to four items.

Table 15

Pattern Matrix Exploratory PAF with 12 Items Dropped

	Factor			
	1	2	3	4
Patient Evaluation and Assessment - Make a determination of referrals as necessary				-.498
Patient Evaluation and Assessment - Develop a relationship with the patient in order to obtain necessary information			.596	

Formulation of Treatment Plan - Identify functional limitations, patient goals, and biomechanical objectives			.498	
Formulation of Treatment Plan - Demonstrate the ability to form a comprehensive treatment plan				-.439
Implementation of Treatment of Plan - Perform assessment and fabrication procedures as necessary	.648			
Implementation of Treatment of Plan - Assess the quality, structure, and appropriateness of the device	.932			
Implementation of Treatment of Plan - Evaluate the fit and function of the device	.596			
Implementation of Treatment of Plan - Provide effective and complete education and instructions to patients			.629	
Implementation of Treatment of Plan - Document the level of patient comprehension of instructions			.776	
Follow Up - Provide evaluation and maintenance of devices	.723			
Follow Up - Develop a follow up plan	.630			
Follow Up - Educate the patient on the follow up plan	.498			
Practice Management - Demonstrate knowledge of billing and coding		.641		
Practice Management - Demonstrate knowledge of federal and state legislation and regulations		.578		
Practice Management - Document clinical chart notes, legal compliance, and insurance issues				-.843
Practice Management - Understand management of ethical and legal responsibilities related to patient management				-.622
Practice Management - Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements		.793		

The items loading on to factor four seemed to relate to each other in their description of comprehensive patient management for an orthotist prosthetist. The items loading on to factor three all related to an aspect of the interpersonal relationship with the patient. The items loading on to factor two very clearly described an ability to understand state, federal, and insurance regulations. The six items loading on to factor one related to device appropriateness and follow-up.

In order to explore the possibility of a better fitting model to this data set, the items related to each factor were analyzed for continuity and relatedness. Factor one loaded on to six items, with three items regarding evaluation of device appropriateness, two items directly assessing follow-up plans, and one item addressing both 'assessment and fabrication' of a device. In the interest of reducing items in the survey and exploring a better fitting model, consideration was made for dropping the three items loading on to factor one which did not relate directly to evaluating the appropriateness of a device for a given patient. The two items associated with patient follow-up were arguable represented in other items in the survey covering the development of a comprehensive treatment plan and providing patient education. The item asking respondents to rate their ability to 'perform assessment and fabrication procedures as necessary' is situated within the context of plan implementation. In the context of contemporary orthotic and prosthetic clinical service, however, clinicians are rarely responsible for fabrication of a device. Additionally, the 'as necessary' portion of this item adds a layer of ambiguity to its interpretation. Therefore, the researcher decided to drop these items from additional analysis.

Exploratory factor analysis of the remaining 14 items was performed. The KMO statistic was 0.838 and the Bartlett's test of sphericity was significant ((X^2=433.971, $p<0.001$). The reproduced correlation matrix indicated 10 (10%) nonredundant residuals with absolute values greater than 0.05. Four factors with eigen values greater than one explained just over 59% of the variance in the data (Table 16). The four factors correlated with each other in a range of -.411 to .420.

Table 16

Total Variance Explained Exploratory PAF with 15 Items Dropped

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	5.602	40.013	40.013	5.221	37.291	37.291	3.156
2	1.811	12.938	52.951	1.408	10.056	47.347	2.734
3	1.307	9.338	62.289	.975	6.965	54.312	3.311
4	1.111	7.938	70.227	.745	5.324	59.636	3.493
5	.727	5.191	75.418				
6	.591	4.219	79.637				
7	.568	4.054	83.691				
8	.527	3.762	87.453				
9	.422	3.017	90.470				
10	.367	2.618	93.088				
11	.281	2.007	95.095				
12	.260	1.855	96.950				
13	.234	1.673	98.623				
14	.193	1.377	100.000				

Inspection of the scree plot (Figure 4) indicated a clear identify of four discrete latent factors, with the remaining factors approximating one line. Each factor loaded on to at least three items.

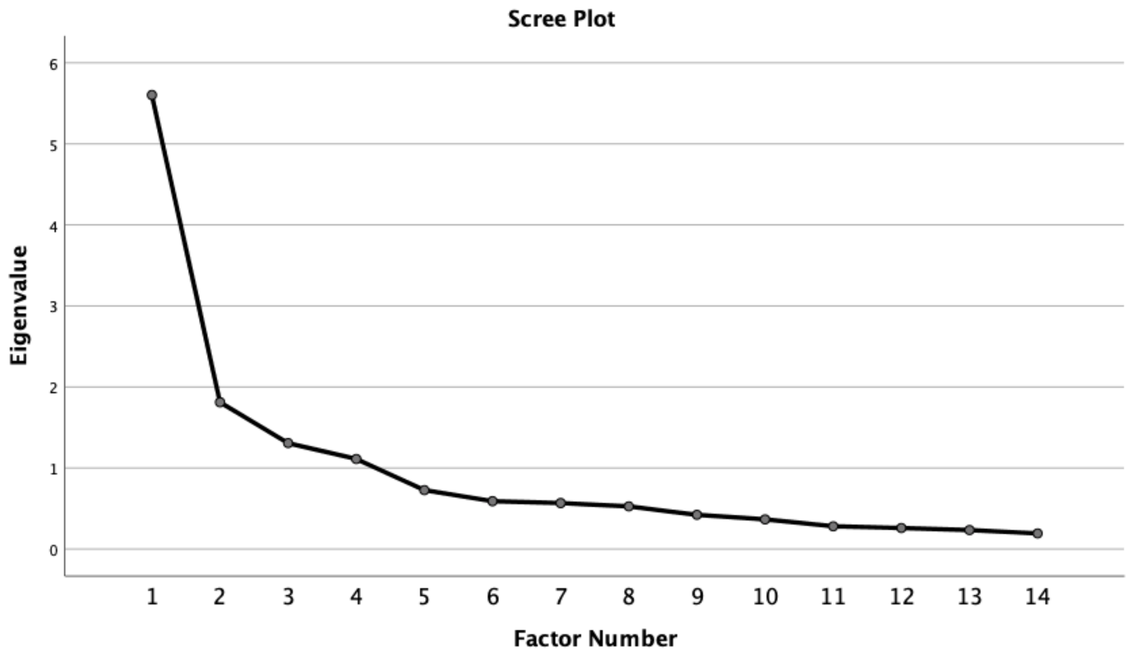

Figure 4. Scree Plot of Exploratory PAF with 15 Items Dropped

The four latent factors spanned most aspects of orthotic and prosthetic clinical care. One factor appeared to assess a clinician's ability to evaluate device fit and appropriateness. Another factor related to understanding of insurance and regulatory requirements. A third factor captured the clinician's relationship with the patient in the development of a care plan. A fourth factor centered around the role of the orthotist prosthetists in the healthcare spectrum. Figure 5 demonstrates the resulting path diagram from the best fitting model.

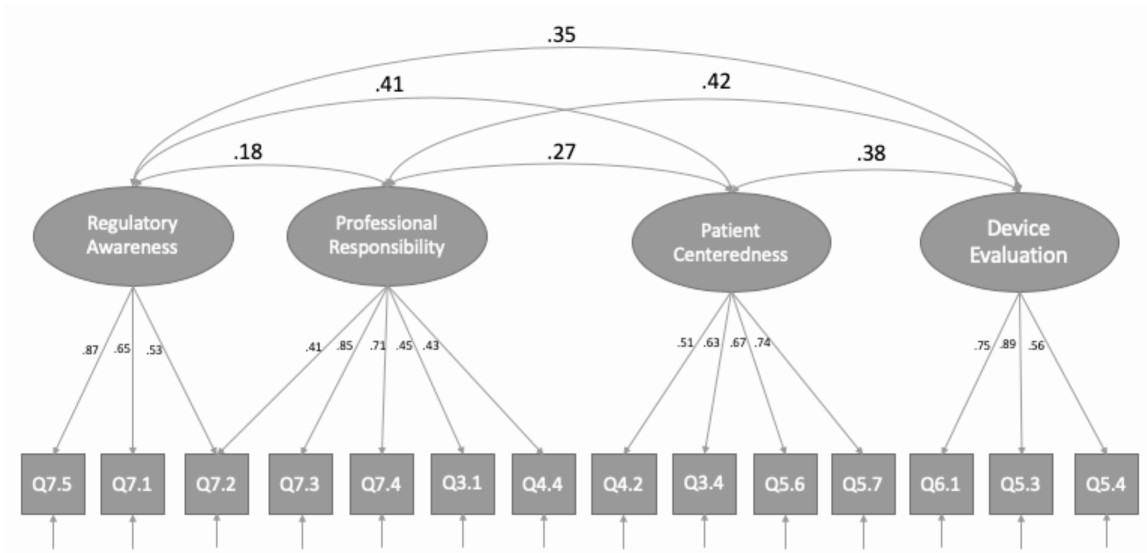

Figure 5. Path Diagram of Final Exploratory PAF Model

Responsiveness

For each rotation a sum of the total item scores was calculated for each participant. Since the class of 2020 was the first cohort to take the assessment measure immediately after the didactic year, those data were not included in the evaluation of changes from rotation to rotation. Tests for normality of the data indicated two outliers in rotation 1 and one outlier in rotation 3 (Figure 6).

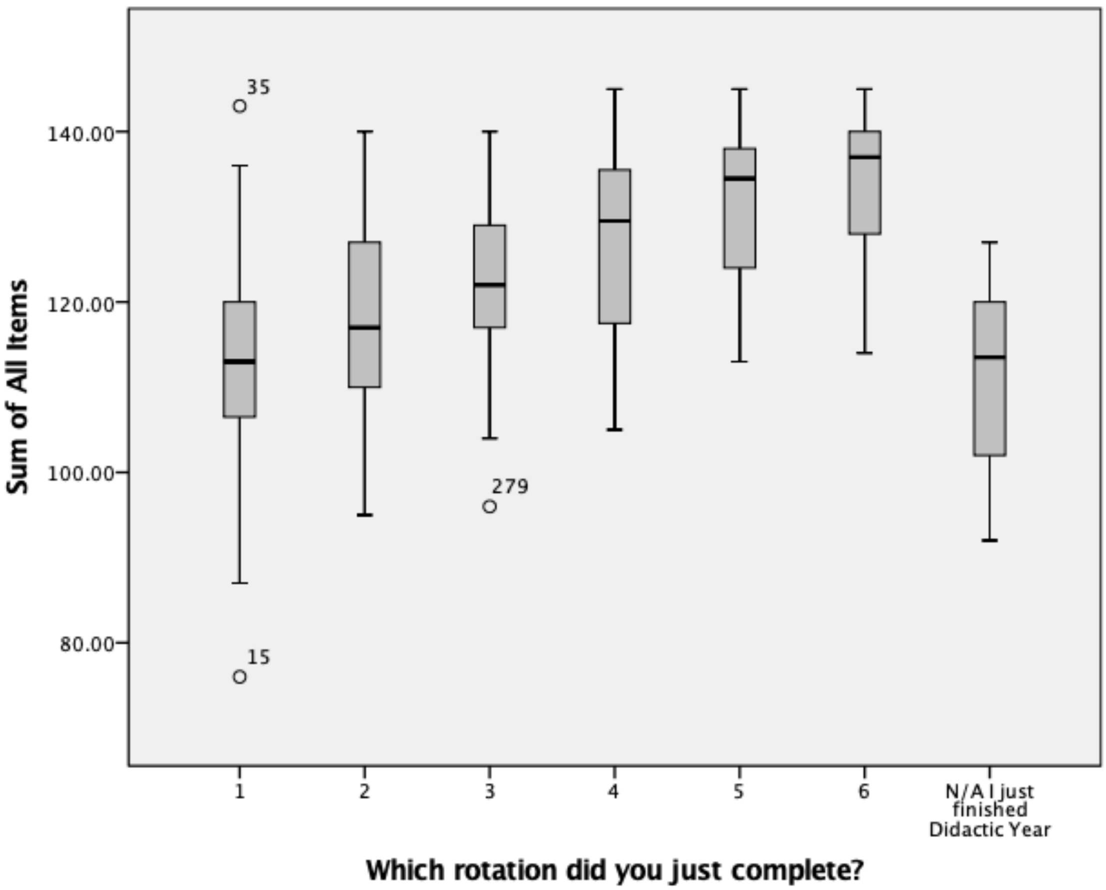

Figure 6. Boxplots of the Self-Competency Self-Assessment (SCSA) Sum Score

These participants were removed from the data set prior to additional analysis. Shapiro-Wilk tests for normality (Table 17) indicated normal distribution of the data in rotations 1 to 4 and non-normal distributions in rotations 5 and 6.

Table 17

Tests of Normality for SCSA Sum Score

	Which rotation did you just complete?	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Sum of All Items	1	.070	68	.200*	.982	68	.421
	2	.086	46	.200*	.980	46	.619
	3	.063	45	.200*	.976	45	.483
	4	.121	44	.113	.957	44	.102
	5	.183	40	.002	.911	40	.004

	6	.170	40	.005	.900	40	.002
	N/A I just finished Didactic Year	.158	24	.126	.943	24	.188

The assumption of sphericity was not met, with Mauchly's test of sphericity indicating statistical significance, $X^2(2)= 40.531$, $p < 0.001$. Epsilon was 0.639 (Greenhouse-Geisser) and was used to correct the ANOVA. A within-subject repeated measures ANOVA (Table 18) indicated a significant difference in self-competency self-assessment sum scores as the residency progressed, $F(3.195, 40.236) = p < 0.001$, partial $n^2=0.598$. The sum scores increased from 110.5±11.07 at the end of the first clinical rotation to 133.±1.988 at the end of the last clinical rotation.

Table 18

Tests of Within-Subjects Effects

Measure: Self-Competency Self-Assessment (SCSA) Sum Score

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
SCSA Sum	Sphericity Assumed	10017.333	5	2003.467	40.236	.000
	Greenhouse-Geisser	10017.333	3.195	3135.045	40.236	.000
	Huynh-Feldt	10017.333	3.674	2726.262	40.236	.000
	Lower-bound	10017.333	1.000	10017.333	40.236	.000
Error(SCSA Sum)	Sphericity Assumed	6722.000	135	49.793		
	Greenhouse-Geisser	6722.000	86.272	77.916		
	Huynh-Feldt	6722.000	99.208	67.756		
	Lower-bound	6722.000	27.000	248.963		

Post-hoc pairwise comparisons (Table 19) revealed statistically significant increases from rotation 1 to rotation 2 (5.464(95% CI, .829 to 10.100), p=0.023), rotation 2 to rotation 3 (5.929(95% CI, 1.801 to 10.056), p=0.007), and rotation 3 to rotation 4 (4.393(95% CI, 1.626 to 7.160), p=0.003). Although the self-competency self-assessment score increased from rotation 4 to rotation 5 and rotation 5 to rotation 6, the increase was not statistically significant.

Table 19

Pairwise Comparisons

Measure: Self-Competency Self-Assessment (SCSA) Sum Score

(I) SCSA Sum	(J) SCSA Sum	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	-5.464*	2.259	.023	-10.100	-.829
	3	-11.393*	1.572	.000	-14.619	-8.167
	4	-15.786*	2.148	.000	-20.193	-11.378
	5	-18.893*	2.262	.000	-23.534	-14.251
	6	-22.464*	2.448	.000	-27.487	-17.441
2	1	5.464*	2.259	.023	.829	10.100
	3	-5.929*	2.012	.007	-10.056	-1.801
	4	-10.321*	2.116	.000	-14.664	-5.979
	5	-13.429*	1.375	.000	-16.249	-10.608
	6	-17.000*	2.248	.000	-21.613	-12.387
3	1	11.393*	1.572	.000	8.167	14.619
	2	5.929*	2.012	.007	1.801	10.056
	4	-4.393*	1.348	.003	-7.160	-1.626
	5	-7.500*	1.626	.000	-10.836	-4.164
	6	-11.071*	1.525	.000	-14.200	-7.943
4	1	15.786*	2.148	.000	11.378	20.193
	2	10.321*	2.116	.000	5.979	14.664
	3	4.393*	1.348	.003	1.626	7.160
	5	-3.107	1.781	.092	-6.762	.548
	6	-6.679*	1.247	.000	-9.238	-4.119
5	1	18.893*	2.262	.000	14.251	23.534

	2	13.429*	1.375	.000	10.608	16.249
	3	7.500*	1.626	.000	4.164	10.836
	4	3.107	1.781	.092	-.548	6.762
	6	-3.571	1.749	.051	-7.160	.017
6	1	22.464*	2.448	.000	17.441	27.487
	2	17.000*	2.248	.000	12.387	21.613
	3	11.071*	1.525	.000	7.943	14.200
	4	6.679*	1.247	.000	4.119	9.238
	5	3.571	1.749	.051	-.017	7.160

Convergent Validity

When exporting the data to report the percentage of cases residents logged as independently performed, only data from the Classes of 2019 and 2020 were able to be used for analysis. Members of the Class of 2018 were beta testers for the current case logging system that members of the classes of 2019 and 2020 used. Data from the system in place for the class of 2018 was not available. Therefore, data from cases logged during the first rotation (1) of the class of 2020 and the final rotation (6) of the class of 2019 were used for correlational analysis.

Descriptive statistics of the percentage of cases logged independently (autonomy) and the self-competency self-assessment sum score for each cohort are presented in Table 20. The mean score for the percentage of cases performed independently only increased by 6 percent over the course of the residency. The mean of the self-competency self-assessment sum score increased by approximately 20 percent from 107 to 130.

Table 20

Descriptive Statistics Sum SCSA and Autonomy

Rotation		N	Minimum	Maximum	Mean	Std. Deviation
First (1)	SumSCSA	23	11.00	134.00	107.2174	29.70148
	Autonomy	19	1.06	76.97	28.9895	20.16144
	Valid N (listwise)	19				
Last (6)	SumSCSA	23	24.00	145.00	130.6957	24.32999
	Autonomy	23	17.58	61.59	35.6687	9.94745
	Valid N (listwise)	23				

Bivariate Pearson Correlation analysis between the two measures (Table 21) indicated a statistically insignificant inverse relationship between self-competency self-assessment and clinical autonomy.

Table 21

Correlations Between Sum SCSA Score and Autonomy

Rotation			Sum SCSA	Autonomy
1	Sum SCSA	Pearson Correlation	1	-.138
		Sig. (2-tailed)		.573
		N	23	19
	Autonomy	Pearson Correlation	-.138	1
		Sig. (2-tailed)	.573	
		N	19	19
6	Sum SCSA	Pearson Correlation	1	-.190
		Sig. (2-tailed)		.385
		N	23	23
	Autonomy	Pearson Correlation	-.190	1
		Sig. (2-tailed)	.385	
		N	23	23

Survey Refinement

Given the process of factor analysis and item reduction, 14 of the original 29 items remained within the survey. Four factors loaded onto these items and explained a majority of the variance in the data (Table 22).

Table 22

Remaining Items and Factor Loadings

Item	Factor			
	Patient-Centeredness (1)	Regulatory Awareness (2)	Device Evaluation (3)	Professional Responsibility (4)
Document the level of patient comprehension of instructions	0.737			
Provide effective and complete education and instructions to patients	0.664			
Develop a relationship with the patient in order to obtain necessary information	0.627			
Identify functional limitations, patient goals, and biomechanical objectives	0.508			
Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements		-0.873		
Demonstrate knowledge of billing and coding		-0.65		
Demonstrate knowledge of federal and state legislation and regulations		-0.53		-0.407

Assess the quality, structure, and appropriateness of the device			-0.892	
Provide evaluation and maintenance of devices			-0.745	
Evaluate the fit and function of the device			-0.564	
Document clinical chart notes, legal compliance, and insurance issues				-0.847
Understand management of ethical and legal responsibilities related to patient management				-0.714
Make a determination of referrals as necessary				-0.45
Demonstrate the ability to form a comprehensive treatment plan				-0.426

Additionally, consideration for anchor revision was made given the limited frequency of the use of all five anchors on the scale and an inability to distinguish between ‘very unable’ and ‘unable.’ Considering the underlying paradigm that competency relates to clinical autonomy, the author adjusted the rating scale to align with the Zwisch scale (George et al., 2014) of clinical autonomy, a validated scale used in surgical education. The resulting items, with suggested adjusted language and anchors, are presented in Table 23.

Table 23

Suggested Revisions to Survey Items and Anchors

Items Remaining	Question	Suggested Revisions

Make a determination of referrals as necessary	3.1	Refer patients to other healthcare providers.
Develop a relationship with the patient in order to obtain necessary information	3.4	Build rapport with the patient.
Identify functional limitations, patient goals, and biomechanical objectives	4.2	Develop a treatment plan which incorporates biomechanical objectives and patient goals.
Demonstrate the ability to form a comprehensive treatment plan	4.4	Develop a comprehensive orthotic and prosthetic treatment plan.
Assess the quality, structure, and appropriateness of the device	5.3	Determine if device construction and design meets patient needs.
Evaluate the fit and function of the device	5.4	Evaluate the fit of orthotic and prosthetic devices.
Provide effective and complete education and instructions to patients	5.6	Educate the patient on appropriate use of the device.
Document the level of patient comprehension of instructions	5.7	Check for the patient's understanding of care instructions.
Provide evaluation and maintenance of devices	6.1	Perform routine maintenance on orthotic and prosthetic devices.
Demonstrate knowledge of billing and coding	7.1	Identify L-codes for orthotic and prosthetic devices.
Demonstrate knowledge of federal and state legislation and regulations	7.2	Describe legal regulations affecting orthotic and prosthetic practice.
Document clinical chart notes, legal compliance, and insurance issues	7.3	Demonstrate compliance with healthcare documentation standards.
Understand management of ethical and legal responsibilities related to patient management	7.4	Articulate professional code of conduct.
Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements	7.5	Articulate insurance requirements which may affect patient care.
Anchors Used		Suggested Revised Anchors
Very Unable, Unable, Neutral, Able, Very Able		Observation Only, Assistance Required, Indirect Supervision Required, Indepence with Indirect Supervision

Chapter V

Discussion and Conclusion

The primary purpose of this study was to examine the validity and reliability of a self-competency self-assessment tool used in one orthotics and prosthetics clinical education program. The secondary purpose was to refine the survey instrument by reducing the number of items and defining the common latent factors being measured. The results indicate that the survey is a reliable instrument (Cronbach's alphas of 0.927 with 29 items and 0.879 with 14 items) and, after item reduction, measures four common latent factors related to orthotic and prosthetic clinical practice. The survey also demonstrated responsiveness, with sum scores increasing over the course of the clinical residency. Autonomy in clinical residency, as it was measured in this study, does not, however, appear to be convergent with self-competency.

The mean scores for the items on the survey indicated fairly high competency self-assessment ratings, with all items having mean ratings over 3.0/5. The lowest mean score (3.42) was for knowledge of state and federal guidelines. The highest mean score (4.73) was for exemplifying professional responsibility and ethical conduct. Respondents answered only nine of the 29 items using the full scale of the anchors. Two items were only rated from three to five, and one item was only rated from four to five (the highest mean). Given the descriptions of the lowest anchors, 'very unable' and 'unable', adjusting the anchors to a four-point or a behavior-based scale may result in responses across all choices and increased reliability (Bartlett et al., 2015).

The items in this self-competency self-assessment survey were taken from the list of NCOPE orthotic and prosthetic residency objectives (Education, 2018). These objectives are divided into subcategories which align to the ABC Practice Analysis: patient evaluation and assessment, formulation of treatment plan, implementation of treatment plan, follow up, practice management, and personal and professional development. These subcategories also inform the design of the credentialing exam on which board-eligible clinicians are tested in each domain (American Board for Certification in Orthotics, 2017). The preliminary analysis in this study indicates that the current domains used by NCOPE and ABC may not be the most appropriate delineation of orthotic and prosthetic clinical practice.

The structure of the self-assessment survey followed the aforementioned domains; this organization of items may have had an effect on responses, as has been seen in other studies (Ro, Merson, Lattuca, & Terenzini, 2015). Although the survey items were delineated to indicate their theorized relatedness, a large portion of linked items did not load onto similar factors. Only one of the four factors in the final model contained loading items which were previously categorized to be within the same domain: regulatory awareness. Items from the domains of 'patient evaluation and assessment,' 'formulation of the treatment plan,' and 'practice management' loaded strongly on to the professional responsibilities factor; items from the domains of 'patient evaluation and assessment,' 'formulation of the treatment plan,' and 'implementation of the treatment plan' loaded onto the patient-centeredness factor; and, items from 'implementation of the treatment plan' and 'follow up' loaded on to the device evaluation factor. The shifting of these items away from their specified domains indicates that the current structure used to demarcate aspects of orthotic and prosthetic clinical practice may be imprecise.

While the resulting model indicated four latent common factors, the initial confirmatory factor analysis and final exploratory analysis demonstrated one latent factor accounting for a large portion (40%) of the variance, possibly from a halo effect (Pike, 1999). The self-assessment survey was one of many surveys completed by the clinical residents after each rotation, and the length of the survey increases the probability of survey fatigue and high inter-item correlation. In addition, numerous items in the survey represent similar aspects of patient care, yet they are revisited within the different domains. The reduction of these items may reduce the halo effect, the potential for survey fatigue, and resulting measurement error (Peytchev & Paytcheva, 2017).

Overall, consideration was made to the reliability of each item, the redundancy of each item, and the specificity of each item when considering these decisions. These decision-making factors align with the recommendations of survey development in healthcare research (Rattray & Jones, 2007). The current domains of practice describe aspects of patient care that may transpire in each clinical visit. Given that some aspects may occur regardless of visit type, it is reasonable to include fewer items assessing a similar behavior or competency. According to Pett, Lackey, and Sullivan (2003), at least three items loading on to a singular factor should be retained in order to increase the ability of the instrument to capture true latent common factors. In this study, each factor contains at least three items which load strongly onto the factor.

The items which were retained for analysis were compared to the timeliness and criticality factor as reported in the ABC Practice Analysis. In that survey, respondents were asked to indicate the percentage of time they typically spent on a given domain within the last twelve months and how critical the domain was for optimizing outcomes for patients, caregivers, and health providers (1= Not critical, 5=Highly critical). Notably, the lowest time spent (7.5%) and the least critical to practice (3.1/5) was the domain of 'Promotion of Competency and Enhancement of Professional Practice' (American Board for Certification, 2015, p. 14). In the initial rounds of this self-assessment survey analysis, items related to the 'Promotion of Competency and Enhancement of Professional Practice' domain were dropped from the survey.

The purpose of the self-assessment tool is important to define. In the context of this study, the tool is a measure through which clinical residents can self-assess the competency on vetted tasks describing clinical practice. Boud and Falchikov (1989) define self-assessment as "the identification of criteria or standards to be applied to one's work, and the making of judgements about the extent to which work meets these criteria" (p. 529). While the tool in the context of this study addresses the former, ABC's use of such a tool is to define the latter by determining which aspects of work should be tested on the board certifying exams (ABC, 2015, p.16). Consideration should be made, however, for the numerous items which contain multiple descriptors. Respondent ratings for those questions may be misleading. For example, 'Demonstrate understanding of Medicare requirements, L-Code usage, and third-party payer requirements,' describes three distinct areas of knowledge. Answers to those questions may, therefore, be less meaningful. Does the respondent answer according to all three subsets of the question, or just one?

Despite limitations in the original items, the initial survey did reflect growth in competence over time, a measure of responsiveness, from the first to the final three-month rotation. There were significant differences in the self-assessment sum score from rotation one to rotation four, with non-significant increases during rotation 5 and 6. Changes in responses most often made significant jumps over the course of two rotations (6 months), indicating that this length of time may be needed in order to detect meaningful difference in competency attainment. The changes also appeared to decrease in magnitude and significance toward the last six months of residency. Post-hoc analysis of the self-assessment summative scores with only the remaining 14 items indicated a similar trend. Current NCOPE requirements specify mandatory completion of quarterly evaluations (Education, 2018). The timing of these evaluations may be well-suited to measure the change in self-assessment of clinical competency and should be considered valuable indicators of resident growth, particularly in the first two-thirds of the 18-month clinical residency.

In this study, the research used the percentage of cases that a resident logged as performed as representation of clinical autonomy. Previous work has demonstrated that the percentages of cases a resident in this program logs as performed increases over time, although not significantly (Mullen, 2019). As such, it was hypothesized that increases in clinical autonomy would parallel increases in self-competency self-assessment. The percentage of cases the residents logged as performed increased from rotation 1 (28.99±20.16) to rotation 6 (35.67±9.95). However, correlation analysis indicated a non-significant and negative relationship between self-competency and clinical autonomy. Although in this study the researcher only examined autonomy during a rotation, the results align with earlier findings that the percentage of cases a resident logs as performed do not correlate significantly with the final self-competency self-assessment (Mullen, 2019). In higher education, researchers have noted dissonance between student self-report of gains and objective measures of gains over time (Bowman, 2010). In this case, however, no research has connected clinical autonomy in orthotics and prosthetics with competence. Despite a common goal of clinical education being to progress a resident to complete autonomy (Hashimoto et al., 2016) autonomy by itself may not represent competence.

As a resident gains competence, they will likely be entrusted with more complex patients and devices (Ten Cate & Carraccio, 2019). It is possible that this increase in more difficult case load results in diminished self-perception of competency. This effect may not be problematic, as it could reflect the residents' ability to reconsider competency based upon changing contexts. Researchers have documented the presence of social construction in the definition of competency (Whitehead, Kuper, Hodges, & Ellaway, 2015) and the possibility that self-assessment of competence, or the assessment of competence should change based upon clinical experience is not foreign to clinical autonomy. Therefore, autonomy may not be the most appropriate measure with which to align self-competency or to determine external validity of the instrument. Boe and Gardner (2019) demonstrated that the self-assessment scores of recent orthotic and prosthetic graduates do align with the ratings on the same scale submitted by employers of those graduates. Importantly, the instrument used in that study was also based upon the ABC Practice Analysis and was almost identical to the one used in this study. Additional research is certainly needed to determine the alignment of these self-assessment ratings to those of third-parties, such as clinical preceptors, certification exam proctors, and employers.

Despite a lack of statistical relationship between self-competency and clinical autonomy, monitoring self-assessment of competence may be of interest to clinical educators. Researchers have shown a positive relationship between self-assessment and satisfaction with educational experiences (Bowman, 2010; Pike, 1993). Furthermore, the use of multisource feedback in physician education and training includes self-assessment as a tool for continued learning (Caverzagie, Shea, & Kogan, 2008). Where multisource feedback, including self-assessment, can present a well-rounded picture of clinical practice, it can also represent the biases of those completing the evaluations (Roberts, Campbell, Richards, & Wright, 2013). Yet, according to Kane's framework the validity of an instrument is, in part, supported by its implications on practice (Ferguson, Wakeling, & Bowie, 2014). While this study has sought to take the initial steps in validating a self-assessment instrument, that instrument (which in this study only approaches validity) is only be one piece of the evaluation puzzle.

The results of this study indicate a need to re-examine the guiding frameworks through which we view orthotic and prosthetic clinical practice. A recent literature review on the educational framework for orthotic and prosthetic education indicated three spheres of orthotic and prosthetic education situated within patient-centered care: the state of functioning, disability, and health, O&P technical properties, procedures, and appropriateness; and professional service as part of O&P interventions (Spaulding et al., 2019). The final self-competency self-assessment survey model in this study indicated four latent common factors aligning to regulatory awareness, professional role, patient centeredness, and device evaluation. These latent common factors mirror closely the framework suggested by Spaulding et al., adding specific recognition of the ever growing burden of state, federal, and insurance regulations. In consideration of these findings, in addition to the robust research on self-assessment as a part of contemporary medical practice and evaluation, orthotic and prosthetic clinical educators should consider adopting self-assessment tools to their regular inventory of assessments. These surveys may provide insight into learner or resident growth, satisfaction, and competency within modern frameworks of healthcare practice. Ultimately, what may be more important than the survey itself is its potential for use as a tool to guide clinical education objectives and experiences.

Future research should evaluate the use of the self-competency self-assessment tool in its shortened form and with a larger sample size of both clinical residents and practicing clinicians. Additionally, evaluation of the impact of clinical education experiences and practice settings on item responses will aid in determining the application of the tool across the spectrum of orthotic and prosthetic clinical practice and residency programs. Within the residents in this study, many varieties of practice settings were represented, but only one type of residency program. Evaluation of the self-competency self-assessment tool's alignment with clinical supervisor ratings and other metrics of clinical success will aid in supporting its use in clinical residency.

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Appendix A

Original Self-Competency Self-Assessment Survey

Q3. Patient Evaluation and Assessment					
	Very Unable (1)	Unable (2)	Neither Able nor Unable (3)	Able (4)	Very Able (5)
Perform comprehensive assessment (1)	○	○	○	○	○
Make a determination of referrals as necessary (2)	○	○	○	○	○
Document assessment, treatment plan, and fabrication requirements to meet third-party payer standards (3)	○	○	○	○	○
Develop a relationship with the patient in order to obtain necessary information (4)	○	○	○	○	○
Q4 Formulation of Treatment Plan					
	Very Unable (1)	Unable (2)	Neither Able nor Unable (3)	Able (4)	Very Able (5)
Integrate foundational knowledge and evidence from the literature (1)	○	○	○	○	○
Identify functional limitations, patient goals, and biomechanical objectives (2)	○	○	○	○	○
Design an orthotic-prosthetic treatment plan in collaboration with the patient to meet objectives (3)	○	○	○	○	○
Demonstrate the ability to form a comprehensive treatment plan (4)	○	○	○	○	○
Q5 Implementation of Treatment of Plan					
	Very Unable (1)	Unable (2)	Neither Able nor Unable (3)	Able (4)	Very Able (5)

	Very Unable (1)	Unable (2)	Neither Able nor Unable (3)	Able (4)	Very Able (5)
Perform assessment and fabrication procedures as necessary (1)	○	○	○	○	○
Discern the use of the device as corrective or accommodative (2)	○	○	○	○	○
Assess the quality, structure, and appropriateness of the device (3)	○	○	○	○	○
Evaluate the fit and function of the device (4)	○	○	○	○	○
Perform and provide transfer, gait training, and mobility instructions (5)	○	○	○	○	○
Provide effective and complete education and instructions to patients (6)	○	○	○	○	○
Document the level of patient comprehension of instructions (7)	○	○	○	○	○

Q6 Follow Up

	Very Unable (1)	Unable (2)	Neither Able nor Unable (3)	Able (4)	Very Able (5)
Provide evaluation and maintenance of devices (1)	○	○	○	○	○
Develop a follow up plan (2)	○	○	○	○	○
Educate the patient on the follow up plan (3)	○	○	○	○	○
Document interaction with patient and caregivers (4)	○	○	○	○	○
Utilize outcome measures (5)	○	○	○	○	○

Q7 Practice Management

	Very Unable (1)	Unable (2)	Neither Able nor Unable (3)	Able (4)	Very Able (5)
Demonstrate knowledge of billing and coding (1)	○	○	○	○	○

	Very Unable (1)	Unable (2)	Neither able nor unable (3)	Able (4)	Very Able (5)
Demonstrate knowledge of federal and state legislation and regulations (2)	○	○	○	○	○
Document clinical chart notes, legal compliance, and insurance issues (3)	○	○	○	○	○
Understand management of ethical and legal responsibilities related to patient management (4)	○	○	○	○	○
Demonstrate understanding of Medicare requirements, L-code usage, and third-party payer requirements (5)	○	○	○	○	○

Q8 Professional and Personal Development

	Very Unable (1)	Unable (2)	Neither able nor unable (3)	Able (4)	Very Able (5)
Articulate the importance of personal development in relation to lifelong learning, community service, and service to the profession (1)	○	○	○	○	○
Pay attention to personal well-being (2)	○	○	○	○	○
Exemplify professional responsibility and ethical conduct (3)	○	○	○	○	○
Provide advocacy for and engagement in research (4)	○	○	○	○	○

Appendix B

IRB Correspondence

APPROVAL OF SUBMISSION

February 9, 2020

Ashley Mullen

ahmullen@uh.edu

Dear Ashley Mullen:

On February 9, 2020, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title of Study:	Evaluation of an instrument to self-assess competency in clinical education.
Investigator:	Ashley Mullen
IRB ID:	STUDY00002106
Funding/ Proposed Name:	Education
Funding:	
Award ID:	
Award Title:	
IND, IDE, or HDE:	None
Documents Reviewed: •	• self-assessment protocol, Category: IRB Protocol; BCM Letter, Category: Letters of Cooperation/Permission
Review Category:	• Exempt
Committee Name:	Not Applicable
IRB Coordinator:	Sandra Arntz

The IRB approved the study on February 9, 2020 ; recruitment and procedures detailed within the approved protocol may now be initiated.

As this study was approved under an exempt or expedited process, recently revised regulatory requirements do not require the submission of annual continuing review documentation. However, it is critical that the following submissions are made to the IRB to ensure continued compliance:

- Modifications to the protocol prior to initiating any changes (for example, the addition of study personnel, updated recruitment materials, change in study design, requests for additional subjects)
- Reportable New Information/Unanticipated Problems Involving Risks to Subjects or Others

- Study Closure

Unless a waiver has been granted by the IRB, use the stamped consent form approved by the IRB to document consent. The approved version may be downloaded from the documents tab.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system.

Sincerely,

Research Integrity and Oversight (RIO) Office
University of Houston, Division of Research
713 743 9204
cphs@central.uh.edu
http://www.uh.edu/research/compliance/irb-cphs/