REVIEW

Do Student Self-Assessments of Confidence and Knowledge Equate to Competence?

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Objective. To review the literature related to potential associations between self-assessed perceptions of knowledge and/or confidence with actual competence.

Findings. A literature search was completed using PubMed and Google Scholar for articles containing the initial search terms of “student” + “competence” + “confidence” + “correlation”. Articles were pulled from 2000-2020 which resulted in 484 total articles. Screening involved identifying abstracts and articles that attempted to correlate competence and confidence. 22 articles involving a variety of disciplines, including undergraduate studies, dentistry, medicine, and pharmacy were included following the screening process. Most studies focused on student self-reported confidence compared to competency assessed by a formative examination. Only a handful of studies were centered around pharmacy education.

Summary. Educational research that evaluates student learning should employ measures of competency as the primary outcome rather than student perceptions. Student perceptions should be avoided as the primary measure of student learning but may have some utility as an adjunct to competency data.

Keywords: confidence; competence; correlation; education; perception

INTRODUCTION

Competency based outcomes have long been the standard measuring stick used to evaluate pharmacy and other curricular programs. As students’ progress through a Doctor of Pharmacy (PharmD) degree curricula, the goal is that they attain, at a minimum, baseline knowledge and skills that will allow them to be effective professionals upon graduation. The Accreditation Council for Pharmacy Education (ACPE) publishes standards that must be met in order for colleges and schools of pharmacy to achieve and maintain accreditation status. These standards include key elements ranging from formative and summative assessments to outcomes for student achievement. Colleges and schools must be able to demonstrate that students have achieved a certain level of competency as they progress through Doctor of Pharmacy degree programs.

Researchers have long employed measures of competence such as pre/post tests and examination scores as endpoints in their evaluation of educational interventions. Recently, some have begun to increasingly concentrate on students’ perceptions as a surrogate endpoint for educational research rather than more traditional competence metrics. There may be a number of reasons for this phenomenon including but not limited to the relative ease with which perceptions data can be collected as well as an increasing emphasis within academia on student satisfaction. These investigations often focus on changes related to self-perceived knowledge of or confidence in a particular subject or task. In order to gain confidence, a learner must accumulate a certain level of presumed competence. Educators may feel more comfortable using more traditional evaluations of student learning when determining the impact of a course. However, some may argue that student perceptions are important to consider when evaluating coursework. Many studies in higher education now consider both perceptions and more tangible data points (eg, pre/post testing, examination scores, final course grades, etc.) when evaluating an intervention within a curricula. This has led some to question the reliability of confidence and perceptions data when considered in isolation. This manuscript intends to review the available literature with regards to the potential pros and cons of utilizing student perceptions as a surrogate endpoint for competence within education research.

Evaluating Confidence

Some may contend that confidence is a valuable and meritorious trait that health care practitioners should possess. However, a unilateral relationship between confidence and competency is not well established. As studies appear to
increasingly utilize perceptions data, it is fair to question the reliability of confidence self-assessments. Dunning and Kruger observed that individuals with less understanding of a particular topic were more likely to overestimate their own abilities while proficient individuals were able to more accurately discern their own competencies. Overconfidence is a bias that can be especially disruptive in health care. Hypothetically, an overconfident practitioner could deliver suboptimal patient care more often than not as they fail to recognize their incompetencies. A 2016 study of 251 medical students enrolled in the Buenos Aires University School of Medicine evaluated student performance on a multiple-choice examination. Researchers aimed to assess performance on the examination using objective outcomes data along with measures of student confidence. Results indicated that 12% of students demonstrated overconfidence in their abilities. Of note, those that performed poorly on the examination displayed a higher incidence of overconfidence than those who performed well while underconfidence was more prevalent in high performing students. Moreover, people often tend to attribute success to internal factors while failures are often attributed to external factors. This bias was detailed by Karpen in 2017 when he observed that people tend to overestimate their abilities when asked to conduct a self-assessment. If most populations tend to overestimate their ability to perform, one might reason that pharmacy students may as well be biased in the perceptions of their own learning and knowledge.

ACPE Standard 4.1 focuses on self-evaluation, stating “the graduate is able to examine and reflect on personal knowledge, skills, abilities, beliefs, biases, motivation, and emotions that could enhance or limit personal and professional growth.” As students’ progress through a PharmD curriculum they must learn to accurately reflect and self-assess. This is highlighted by the aforementioned “Dunning-Kruger” effect which acknowledges that individuals who have yet to master a subject, such as matriculating pharmacy students, are not likely to be accurate self-evaluators. While not extensively examined in pharmacy students, the results are not likely unique to any particular cohort of learners. A 2017 meta-analysis investigated studies that attempted to evaluate the possible relationship between physician self-assessments and their performance on an external measure (e.g., an objective structured clinical examination (OSCE)). The authors found that 65% of studies suggested that physicians were unable to reliably self-assess their knowledge, skills, or performances when compared to an external evaluation of these performance measures. However, the analysis included only 20 studies with a variety of comparisons and measures which might have led to inconsistent conclusions when analyzed together. If students and professionals struggle to accurately evaluate themselves, questions may be raised as to the validity of using these measures as markers of competence or knowledge attainment. Correlations between competence and confidence have not been extensively studied at the undergraduate level, however slightly more data is available with regards to professional programs.

**Studies of Dental Students**

A common goal across professional health care programs is for students to achieve a certain level of competence and self-confidence before entering their respective practices. While the data for undergraduate studies is lacking, professional schools have begun to evaluate potential links between the two. A 2004 study conducted at the University of Peradeniya in Sri Lanka involving 212 dental students found that self-assessed confidence correlated well (p<0.0001, Tau Rank Test) with exposure time to specific skills. The study followed 5 different student cohorts (n=212) and had them report their confidence on a three point scale across 46 skills related to dental practice. As exposure to particular skills increased, so did confidence ratings. The authors did not specifically evaluate relationships between student competence and confidence, but rather only examined exposure time. A study by Stacey et al. observed that clinical teachers scored final year dental students differently in regards to clinical competency than students scored themselves via self-assessment. Students and their clinical teachers completed a questionnaire that evaluated six aspects of clinical competency for each student from semester one to semester two. Student results were then compared directly to those from clinical instructors to evaluate any possible differences in each groups assessment of student competency. The study found that clinical instructors assigned much lower scores than the students gave themselves, suggesting that students were often overconfident in their abilities. This finding was corroborated by Emam et al, who followed 111 dental students at The Ohio State University. Students were enrolled in the second year of the dental curriculum within an internal medicine course that was directed by the Division of Oral and Maxillofacial Surgery (OMFS). The authors found, on average, that students overestimated their ability by 12.5% as compared to instructor feedback on a medical competency examination. A 2015 study from a dental school in Turkey found that second year dental students ability to self-assess closely mirrors the findings reported by Dunning and Kruger. Students were asked to self-evaluate their performances as well as that of a classmates following preclinical examinations on tooth restorations. Student self-evaluation, classmate evaluations, as well as graded examination scores were then compared. Overconfidence was more prevalent in poor performing students while underconfidence plagued higher performing second year students. Interestingly, this study also evaluated third year students.
and found that, in these cases, self-assessments were more consistent with examination scores. Nevertheless, this was a small cohort of 75 dental students and involved international students making generalizations to US cohorts difficult.

**Studies of Medical Students**

Studies in medicine have not only involved medical students but also post-graduate trainees and practitioners. A 2004 study conducted at Monash University evaluated 352 medical students in their final academic year. The researcher examined student attitudes towards clinical consultations and their confidence in performing them as well as 28 core skills associated with general practice consultation. Students were assigned a composite score including their 5th and 6th year individual examination scores, case scores, as well as their 6th year Objective Structured Clinical Examination (OSCE) score. Students were also asked to complete pre and post-assessment self-evaluations. While attitudes toward a particular subject seemed to play a role, the study found that feeling confident was not associated with student performance. Research conducted by Brinkman et al. in 2015 at the Vrije Universiteit (VU) Medical Center in the Netherlands reinforced these findings. The study followed 403 fourth year medical students who were given a formative examination covering several prescribing skills while being also asked to self-assess their abilities. Self-reported confidence did not correlate well with individual results ($r^2 = 0.2$). This study’s response rate was a limiting factor in interpreting results as only 61% of eligible students participated.

Postgraduate trainees are expected to have a clearer understanding of content as they progress to the intern and residency phases of their medical training. Considering the Dunning-Kruger effect, it might be assumed that as a given individual’s knowledge base continues to grow, they would become more reliable evaluators in terms of their own self-efficacy and competence. The Department of Medical Education at University of Sydney first attempted to confirm this hypothesis in 2004. They evaluated 30 first year medical interns (PGY1) to assess their self-reported confidence and their observed competence across seven clinical skills. Barnsley et al. found that there was no correlation between self-reported confidence and competency assessment scores. Some may argue that physicians in postgraduate training programs may not yet qualify as “experts” and therefore may not be as well equipped to self-evaluate. This premise is supported by the findings of Ganni et al. who compared the self-assessments of 150 medical residents to expert evaluations of laparoscopic cholecystectomy procedures. The researchers found a strong correlation ($r^2 > 0.5; p < .001$) in all categories of assessment with the exception of “tissue handling.” These results seem to further confirm Dunning and Kruger’s findings. However, a more recent 2018 study from East Carolina University that followed 21 medical residents from PGY1 to PGY5 found no correlation between confidence and quality of anastomoses procedures ($p = .9$). While these results differ from those of Ganni et al., it should be noted that the study was limited by a very small sample size.

**Studies of Pharmacy Students**

The earliest study investigating correlations between competence and confidence among pharmacy students was conducted in 2006 at the University of Colorado School of Pharmacy where 108 second-year (P2) pharmacy students were queried regarding their knowledge of various topical areas. Specifically, the study assessed student confidence and competence regarding patients with hypertension and dyslipidemia and found that student knowledge decreased from pre-to post-testing while self-confidence was consistently rated as moderate-high. This study was limited by its focus on a single cohort of students across a narrow topic area. A more recent study conducted in 2014 examined a cohort of students within an elective class in toxicology. The authors from South University observed 45 pharmacy students across two classes that enrolled in the elective and noted that, while there was no correlation between knowledge and confidence at baseline, there was moderate correlation ($r^2 = 0.63$) upon completion of the course. Notably, this study only enrolled 45 participants. As mentioned previously, it has been suggested that as one becomes increasingly educated with regards to a particular subject, they will also likely gain better self-awareness and their perceptions may become more reliable. With this in mind, one could reason that senior pharmacy students are better equipped to accurately self-assess their abilities. A 2016 study conducted at the University investigated 177 third-year pharmacy students’ experiences in an Advanced Cardiovascular Life Support (ACLS) simulation laboratory and found that there were no improvements in knowledge or confidence along with no correlation, pre- or post-exposure to the experience ($r^2 = 0.031$ and $r^2 = 0.13$, respectively), with knowledge and confidence.

One consistency across a majority of studies which have been conducted in higher education includes the lack of a comparator group. A recent study by Persky et al. was designed to compare pharmacy students against other college-aged students. Persky and colleagues studied 277 student pharmacists who were between 18 and 25 years of age and from one of four pharmacy programs. The comparator group of college-aged students was recruited via Amazon’s Mechanical Turk (a crowdsourcing marketplace that allows tasks to be outsourced and conducted virtually while being compensated for their participation). Students were first asked to provide their perceptions of self-knowledge regarding four topics (bats, prions, ozone, and “sweet tracks”) and their confidence to perform well on a possible quiz over these topics. Students from both...
cohorts completed a pre-quiz prior to an instructional intervention and then a final post-instruction quiz to assess their learning. The researchers then analyzed the data to determine if there were any correlations between student learning and self-perceptions of their learning. The majority of correlations between student learning and self-perceptions of learning were not statistically significant. Post-quiz scores did have a statistically significant, but weak, correlation ($r_s<0.4$) to student’s self-assessed perceptions of their learning. The topical areas assessed here were generalized and not particular to pharmacy in order to improve generalizability. However, considerations might be given to a study design that incorporates topics that pharmacy students are more familiar with, such as pharmacotherapy and pharmacology, to more reliably measure pharmacy student learning and metacognition.

DISCUSSION

Educators can ill afford to undertake pedagogic interventions in a time of curricular shift in pharmacy education that will fail to significantly impact student knowledge. Perceptions data appears to be limited in terms of providing statistically significant correlations regarding a student’s ability to meet competency expectations, a crucial component of ACPE’s first four standards for pharmacy programs. Confidence improvements likely do not reflect the quality of most interventions. If students are not learning, but only feel as though they are learning, the result might lead individuals as well as educators to reach unfounded conclusions with regards to various interventions. Therefore, researchers should avoid relying upon perceptions data alone as a possible surrogate for student competency measures. Researchers intent on including perceptions data should make an effort to triangulate those findings with outcomes data to provide a more comprehensive picture. When designing studies aimed at assessing the impact of educational intervention, researchers should aspire to include competency or knowledge-centric data as the primary outcome used to evaluate the value of such projects. A summary of the articles reviewed is provided in Table 1.

There are several limitations that must be considered when evaluating the research that has been conducted in this area. First, there is limited data available directly examining correlations between confidence and competence. Without a plethora of data, it is difficult to arrive at definitive conclusions. Additionally, many studies are from international sources or from health care professions not specific to pharmacy. While this improves the generalizability of the data to students across higher education, it cannot be ruled out that these programs are inherently different from pharmacy education. Lastly, many of the studies contained in this review had fairly small sample sizes and/or limited diversity within the sample in terms of experience. The majority of studies focused on one class or one specific cohort of students in a given program and often lacked comparator groups to determine if the interventions made had significantly different results from before its inclusion into a given curriculum. Future studies should include a pre-intervention comparator groups to give the results more context.

CONCLUSION

Competence remains a critical element in evaluating educational interventions. This holds true across many forms of professional education. While student confidence is something that continues to be evaluated, it should be accompanied by more traditional learning outcomes data that allows interventions to be placed into perspective. As students’ progress through curricula they should naturally improve their knowledge base and ability to self-assess. As they improve as self-evaluators, the reliability of that data should improve with it. Professional students may be at cross-roads where they are not competent enough at abaseline, and even post-graduation in some fields, to accurately and reliably self-evaluate. Because of this, educators should reconsider the use of confidence data as the primary measure when evaluating learning outcomes.

REFERENCES

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<th>Author, Year</th>
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<td>Wanigasooria N, 2004</td>
<td>Dental Students</td>
<td>Participants across 5 cohorts responded to a questionnaire regarding confidence in 46 skills</td>
<td>Student confidence significantly correlated with student’s increased exposure time to each skill</td>
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<td>Stacey MA, et al., 1998</td>
<td>Dental Students</td>
<td>Students self-assessed their clinical skills and confidence. These scores were then compared to their clinical teachers evaluation of student competence</td>
<td>Clinical teachers consistently rated students much lower than student’s self-assessed scores, regardless of self-confidence in clinical skills</td>
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<td>Tuncer D, et al., 2015</td>
<td>Dental Students</td>
<td>Students evaluated their own and their classmates performances on preclinical examinations</td>
<td>Overconfidence occurred more often in students that performed poorly while underconfidence was more prevalent among students that performed well</td>
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<td>Liddell MJ, Davidson SK., 2004</td>
<td>Medical Students</td>
<td>Students self-evaluated their clinical skills regarding general practice consultation which were then compared directly to their performance on examinations</td>
<td>Confidence was found to not be associated with student performance</td>
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<td>Brinkman DJ, et al., 2015</td>
<td>Medical Students</td>
<td>Fourth year students were given a formative prescribing skills assessment and those scores were compared to their own self-assessments</td>
<td>Self-reported confidence in a subject did not correlate well with student performance on the formative assessments</td>
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<td>Barnsley L, et al., 2004</td>
<td>Medical Interns</td>
<td>Interns were evaluated across 7 clinical skills and asked to compare their assessment scores to their own self-assessments in each category</td>
<td>No correlation between an interns confidence in their ability to perform a clinical skill and their respective score in the skill assessment</td>
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<td>Ganni S, et al., 2017</td>
<td>Medical Residents</td>
<td>Residents were asked to self-assess their ability to perform laparoscopic cholecystectomy procedures</td>
<td>A strong correlation was observed between resident confidence and their ability to perform</td>
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<tr>
<td>Shah D, et al., 2018</td>
<td>Medical Residents</td>
<td>Residents were assessed with regards to their confidence and ability to perform anastomoses procedures</td>
<td>No correlation was found between resident performance and confidence in their abilities</td>
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<td>Valdez CA, et al., 2006</td>
<td>Pharmacy Students</td>
<td>Second year students were queried about their knowledge and confidence regarding hypertension and dyslipidemia</td>
<td>Student knowledge decreased from pre- to post-test while confidence remained moderate-high on the pre- and post-test assessments</td>
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<td>Thomas MC, Macias-Moriarity LZ., 2014</td>
<td>Pharmacy Students</td>
<td>Evaluated student knowledge and confidence across two different classes of students enrolled in a toxicology elective course</td>
<td>No correlation was observed at baseline, however moderate correlation between student confidence and knowledge upon completion of the course was noted</td>
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<td>Maxwell WD, Mohorn PL, Haney JS, et al., 2016</td>
<td>Pharmacy Students</td>
<td>Evaluated third year pharmacy students before and after completion of an ACLS simulation course to determine the impact of the activity</td>
<td>Student knowledge and confidence did not improve between pre- and post-course nor could a correlation be demonstrated between the two</td>
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<tr>
<td>Persky AM, Lee E, Schlesselman LS., 2020</td>
<td>Pharmacy Students</td>
<td>Pharmacy students and college-aged students were assessed regarding their perceptions of knowledge and confidence prior to and upon completion of learning modules</td>
<td>Correlations between student learning and student self-perceptions were not statistically significant, outside of post-quiz scores which had a weak correlation to student perceptions</td>
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