Sudarshan Publications

Available online at https://s-epub.in/index.php/trp/index

Pharma Research

An International Peer Reviewed, Indexed Journal

10.62655/s-epub.2021.v13.i01.pp39-48

PHARMACY CURRICULUM AND INDUSTRY READINESS: A SURVEY OF GRADUATES AND EMPLOYERS

QUENTIN CHASTAIN[1]*, USHA JOSHI[2], CARMEN ETXEBERRIA[3]

Affiliation

[1]Department of Regulatory Affairs, Loire Valley Institute of Pharmacy, Saumur, France
[2]Department of Regulatory Affairs, Sahyadri Institute of Pharmaceutical Education, Karad, India
[3]Department of Regulatory Affairs, Navarre Plain Institute of Pharmacy, Pamplona, Spain

*Corresponding author: Quentin Chastain, q.chastain@lvip.fr
ORCID iD: Quentin Chastain 0000-0001-0167-3467; Usha Joshi 0000-0001-2254-7929; Carmen Etxeberria 0000-0001-3223-9057

Article info

Received date:10-10-2020
Accepted date:13-02-2021
Published date:04-05-2021
ISSN;0975-8216

Keywords:

Pharmacy education, Industry readiness, Employability, Competency frameworks, Survey methods

Abstract

Pharmacy graduates are often described as strong in theory but not ready for the pharmaceutical industry. This narrative review examines published evidence on the fit between pharmacy curricula and industry readiness, with attention to surveys of graduates and employers. It outlines competency frameworks and national differences, summarises what employers in manufacturing, quality, regulatory and clinical research roles are reported to want, considers graduate views and teaching methods, and reviews common weaknesses in survey design. The literature points to gaps in practical, documentation and communication skills, yet pharmacy-specific evidence is thin and rarely validated. No new survey data are reported.

1. INTRODUCTION

Ask a hiring manager at a pharmaceutical plant what new pharmacy graduates lack, and the answer is rarely a gap in pharmacology. It is more often the ability to work to a written procedure, document what was done, talk to a colleague in another department, or stay calm when a batch deviates from specification. Ask the graduates, and many say they were taught a great deal of theory and shown very little of the industry they were about to enter. The distance between these two views has been described for decades in education research, yet it persists, and it is felt most sharply in countries where the number of pharmacy graduates has grown faster than the number of structured entry-level posts [1, 2].

This review looks at what the published literature says about the fit between pharmacy curricula and industry readiness, with particular attention to how that fit has been measured through surveys of graduates and employers. It is a narrative synthesis of work

by others. No survey was carried out for this article and no new data are reported. The question is a practical one, because curriculum committees, regulators and employers all make decisions on the strength of survey findings, and those findings are only as good as the instruments and samples behind them [3, 4].

The scale of the problem is not small. Pharmacy is among the larger health professions, and global workforce estimates show wide variation in numbers and distribution of pharmacists, with some countries producing many more graduates than the formal sector can absorb [1]. Where community pharmacies have been moving from supply towards a wider care role, as described in work on chronic disease management, the demand for particular skills has shifted too [5]. An education system that trains for a fixed picture of practice will struggle to keep pace with such change, and industry is one of the places where mismatch becomes visible first.

The article proceeds in stages. It first outlines the curriculum frameworks that shape what pharmacy programmes teach, then what employers in industry-facing roles say they want, then how graduates describe their preparation. A section on survey methods follows, since the strengths and weaknesses of the evidence depend on them. The final sections cover practical responses, among them structured placements and assessment reform, and the limits of the present evidence [6, 7]. Readers who want only the main message can go straight to the table and the closing paragraphs.

Terminology causes some confusion, and it is worth settling. Readiness here means the capacity to perform the tasks of an entry-level role with reasonable independence and appropriate supervision, not the possession of all the knowledge a mature professional would hold. Employability is a broader idea that includes attitudes, networks and the ability to find and keep work, and it is not wholly within the control of a degree programme [8, 9]. Many published surveys blur the two, which is part of why their conclusions sometimes seem to contradict each other.

2. CURRICULUM FRAMEWORKS AND COMPETENCY

Pharmacy education has changed direction over the past half century. Programmes built around chemistry and the preparation of medicines were gradually joined by clinical sciences, and the idea of pharmaceutical care, set out in 1990, moved the profession towards patient outcomes and away from product supply [10, 11]. Industry roles were not the main concern of that shift. Graduates who go into manufacturing, quality or regulatory work often find that what they studied in the early years of the degree, such as pharmaceutics and analysis, matters more than the clinical modules that dominate the later years.

International bodies have tried to give the field a common language. The World Health Organization, UNESCO and the International Pharmaceutical Federation (FIP) convened a taskforce on pharmacy education, and the competency framework later published by the federation lists clusters that include pharmaceutical public health, pharmaceutical care, organisation and management, and professional and personal competencies [7, 12, 13]. These frameworks are widely cited in curriculum documents. They are written, however, with practice in community and hospital pharmacy more clearly in mind, and the industry-facing competencies are present but sketched in less detail.

National systems differ greatly. In India, undergraduate and diploma programmes regulated through the Pharmacy Council of India (PCI) have produced very large numbers of graduates, and the Doctor of Pharmacy (Pharm.D) degree introduced in 2008 added a clinical route [2, 14]. European programmes follow a harmonised minimum under the Bologna process and directive requirements, and the United Kingdom has moved to integrated master's degrees with extensive practice placement [15]. In several Middle Eastern countries, clinical degrees were adopted quickly to meet practice needs [16]. A survey of graduates in one setting cannot simply be generalised to another.

Learning outcomes are the point of contact between a framework and a classroom. Bloom's taxonomy distinguishes

remembering and understanding from applying, analysing, evaluating and creating, and outcomes written at the lower levels invite examinations that test recall [17]. Constructive alignment asks that if a programme wants graduates who can analyse a failing batch, the outcome should say so, the teaching should give practice in it and the assessment should check it [18]. Inspection of published syllabi suggests that outcomes for industry-facing skills, where they appear at all, are often phrased in general terms.

Competence is usually described in layers. Miller's pyramid separates knowing, knowing how, showing how and doing, and Epstein and Hundert's account of professional competence adds the habitual and judicious use of communication, knowledge, reasoning and values [19, 20]. Most written examinations reach only the lower layers. A graduate can score well on a pharmaceutics paper and still be unable to set up a dissolution test, interpret an out-of-specification result or write a clear deviation report, and these are the activities employers see on the first day. Closing that distance requires practice, not additional lectures.

3. WHAT EMPLOYERS ASK FOR

The pharmaceutical sector is not one employer. Manufacturing, quality control and quality assurance, research and development, regulatory affairs, clinical research, pharmacovigilance and medical or commercial roles each draw on different mixes of skills. Quality systems built on ICH Q10 and the quality-by-design approach to pharmaceutical development assume staff who understand risk-based thinking, while good manufacturing practice (GMP), as set out by the World Health Organization, makes documentation and traceability part of every task [21, 22, 23]. Clinical research roles require familiarity with good clinical practice (GCP) [24]. A survey that asks employers generally about graduate quality therefore mixes quite different expectations.

Where studies have asked employers across fields, the most frequent complaints concern generic skills, not technical ones. European work on graduate employability found that employers rated communication, teamwork, problem solving and the ability to learn quickly alongside, and sometimes above, discipline knowledge [9, 25]. These findings come from business and general graduate employment, not pharmacy specifically, and should be read as a prompt for pharmacy studies and not a substitute. Even so, comments recorded in pharmacy-facing reports echo them closely, especially the call for graduates who can write clearly and present their reasoning.

Technical expectations are real, though. Employers in manufacturing and quality functions look for hands-on experience of chromatography, dissolution testing, spectroscopy and basic statistics, and for familiarity with data integrity principles and good documentation practice [21, 23]. Regulatory affairs recruiters expect awareness of dossier structure and the main guidelines. Many graduates have seen these topics only in lectures, and the professional laboratory work they did was often a set of fixed exercises designed to reach a known answer. Students rarely meet an analytical method that fails, which is what the working week of an analyst usually consists of. Troubleshooting is learned by doing it, and a curriculum that always supplies a clean chromatogram withholds the experience.

Regulatory expertise is a case in point. Many companies report difficulty recruiting people who understand the structure of a common technical document, the logic of quality by design or the expectations of inspectors, and graduates with a Master's-level specialisation in regulatory affairs are in demand in some markets [22, 24]. Undergraduate programmes mention these topics, but seldom require students to read a guideline from beginning to end or draft a section of a dossier. A student who has done this once, even for a mock product, will be at an advantage in an interview and in the first month of work.

Hiring practice itself affects what employers say. Companies that recruit mainly for a narrow range of technical roles may ask for experience that few new graduates could have, then lower their expectations in practice once candidates arrive. Statements in a survey about desired skills may therefore differ from

decisions actually made at interview. Studies that observe or reconstruct hiring decisions, and not only ask about preferences, would give a more reliable account of what counts [9, 25]. Those studies are rare, and the stated-preference survey remains dominant.

A mismatch of timing also appears. Employers say they want graduates who can contribute quickly, but most companies also run induction and in-house training that cover site procedures, since no university can teach those. Induction content such as site safety, local standard operating procedures and in-house systems is a legitimate employer responsibility. The practical question is therefore which skills should be in place on arrival and which can be taught on site. Frameworks for entrustable activities, developed in medical education, give one way to define the tasks a new recruit can safely do with limited supervision, and the idea carries over naturally to quality laboratories and regulatory teams [26, 27].

Findings from pharmaceutical and related employer surveys are collected in table 1, together with the frameworks and methodological points relevant to interpreting them. The distribution of entries across the themes of competency frameworks, employer expectations, teaching approaches and survey method is shown in fig. 1. As the table makes clear, the published base on pharmacy employers specifically is thin, and several rows draw on higher education research more broadly. Readers should treat the entries as pointers to the underlying sources and not as a quantitative summary, since the rows differ in design, country and date.

Table 1: Published frameworks, employer expectations, teaching approaches and survey issues relevant to industry readiness

Topic	Reported finding or feature	Ref.
Global competency framework FIP	Lists competency clusters for the profession, with practice-based emphasis and less detail on industry roles.	[12, 13]
Education taskforce WHO, UNESCO, FIP	Called for outcome-based, competency-oriented pharmacy education tied to workforce needs.	[6, 7]
Pharmacy education in India regulation	Rapid expansion of programmes and graduates; clinical Pharm.D route added in 2008.	[2, 14]
Graduate employability European study	Employers rate soft skills alongside, or above, subject knowledge in general graduate hiring.	[9, 25]
Quality systems ICH and WHO texts	Industry roles rest on risk management, documentation and GMP principles rarely practised in coursework.	[21, 22, 23]
Clinical research roles GCP	Entry roles assume familiarity with good clinical practice expectations and record keeping.	[24]
Entrustable tasks work-based training	Defines tasks a trainee can do with limited supervision; transferable to laboratory settings.	[26]
Active learning STEM courses	Higher examination performance and lower failure rates than lecture-only teaching.	[28, 29]
Experiential placements Kolb cycle	Value depends on supervision and structured reflection, not on placement time alone.	[27, 30]
Questionnaire development AMEE guide	Piloting, item testing and reliability checks are needed before fielding an instrument.	[4]
Non-response survey error	Low response rate may or may not bias results; depends on how responders differ.	[3, 31]

Expectations also differ by company size. Large multinational firms run graduate programmes with rotations and structured mentoring, so they can absorb a wider range of entrants. Small and mid-sized manufacturers, which employ a large share of graduates in many countries, have fewer training resources and tend to want people who can be useful at once [1, 2]. A survey that pools both kinds of employer may obscure a real difference in what "ready" means. Reporting results separately for large and small employers, and for different functional areas, would be a simple improvement. Few papers do so.

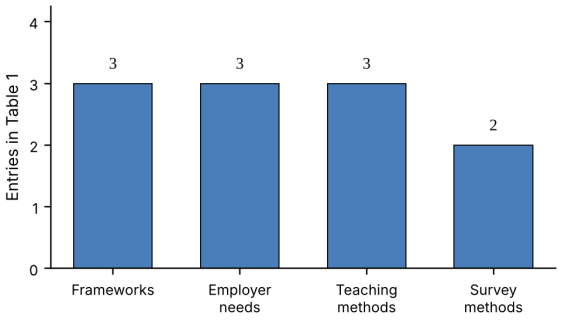


Fig. 1: Number of entries in table 1 by theme

4. THE GRADUATE VIEW AND TEACHING METHODS

Graduates describe their preparation differently from employers. When surveyed, newly qualified professionals in many fields tend to rate their theoretical knowledge higher than their practical and workplace skills, and they ask for more placements, more laboratory exposure and earlier contact with working professionals [6, 32]. Those views are shaped by recent experience of examinations, which reward recall, and by limited knowledge of what a job requires. Self-rated confidence is also not the same as demonstrated skill, a distinction that surveys of graduates alone cannot resolve. Some graduates rate themselves modestly because they have only just discovered how much there is to know.

Experiential learning offers one answer. Kolb's cycle of experience, reflection, conceptualisation and experiment is a familiar model for placements and projects, and the practice component of pharmacy degrees in several countries rests on it [15, 30]. In industry-facing settings, an industrial placement or summer project lets the student meet real constraints such as limited time, shared equipment and regulated records. The learning gained depends heavily on supervision and on structured reflection, and unsupervised placements may reduce to observing from the sidelines.

The first year at work shapes how readiness is judged. Most graduates are placed with a mentor or in a rotation, and organisations differ widely in how much support they give. A new analyst with a patient supervisor and a clear training plan can appear very ready, while an equally capable colleague placed in a stretched team may look unprepared [26, 27]. Surveys that ask employers to rate new graduates without recording the support given can therefore attribute to the curriculum what belongs to the workplace. This is another reason to ask about context and not only about scores.

Active learning in the classroom has a respectable evidence base outside pharmacy. Reviews of engineering and science teaching found that methods requiring students to work problems, discuss and apply ideas raised performance relative to straight lecturing, and a meta-analysis of undergraduate STEM courses reported both higher examination scores and lower failure rates [28, 29]. Case-based teaching of deviations, root cause analysis or formulation failure would be a natural application for pharmaceutical sciences. Few of the published reports of such teaching in pharmacy, though, followed their graduates into employment. Most measure satisfaction or examination marks within the course, which leaves the main question open.

Career awareness is a quieter source of mismatch. Many pharmacy students enter the degree expecting to work in community or hospital practice, and exposure to roles in quality, regulatory affairs or research is limited, particularly where teaching staff come from clinical backgrounds [1, 5]. Graduates who then take industry posts may feel unprepared partly because they never planned for them. Early talks from industry professionals, short visits to plants and laboratories, and project options linked to industrial questions can help students choose with more information, and can also make the later coursework feel relevant.

Continuing development schemes show how an expectation of lifelong learning can be built in. Reflection on practice, personal learning plans and recorded activities are now part of registration in a number of countries [33]. Graduates who meet these ideas early, through portfolios and reflective logs in their degree, find the transition into work smoother. The principle that development continues after qualification also helps to put realistic limits on what a degree should deliver, and it gives employers a shared vocabulary with new recruits for talking about gaps without blame.

Assessment reform is the other half of the argument. Students study what is examined, and a programme that wants industry readiness has to assess it, with practical examinations, portfolios, observed tasks and reports that resemble workplace documents [19, 34]. Assessment designed to support long-term learning asks students to judge their own work and to act on feedback, which are habits employers value. Redesign is costly in staff time, especially for large cohorts, and this is a recurrent reason why reform proposals are agreed in principle and then diluted in implementation.

5. SURVEY DESIGN AND ITS PITFALLS

Surveys of graduates and employers are popular because they are cheap, fast and give numbers that committees understand. They are also easy to do badly. The wording of questions, the order of items, the response scale and the way the invitation is framed all affect what people say, and guidance on questionnaire development, including the guide from the Association for Medical Education in Europe (AMEE), stresses piloting, cognitive testing of items and checks on reliability before a survey is fielded [3, 4]. Many curriculum surveys use home-made instruments with no reported validation, and the reader is left unable to tell whether a low score for practical skills reflects a real gap or an ambiguous question.

Scales deserve a comment. The five-point agreement format derived from Likert's work is the workhorse of this literature, and it is perfectly sensible for measuring attitudes, but responses are bounded and often cluster at the positive end [35]. Means are frequently reported to two decimal places for ordinal data and compared across groups without much thought about the distribution. When employers rate graduate attributes as "good" on average, the more informative piece of the survey may be the free-text comments, which are rarely analysed in a systematic way.

Sampling is the next problem. Employer surveys usually rely on convenience lists, personal contacts or the companies that already host the university's students, and those employers are likely to be better disposed to the programme. Graduate surveys reach those who stay in touch with alumni offices, who are perhaps more successful or more satisfied. Those who left the field entirely, perhaps because they found the transition too hard, are almost never heard from, and their absence flatters the picture. Response rates are frequently low, and the argument that a low rate need not imply bias is true only some of the time, depending on how responders differ from non-responders on the question at hand [3, 31].

Qualitative methods fill the gaps that questionnaires leave. Interviews and focus groups with employers allow them to explain what they mean by terms like "practical skills" or "commercial awareness", which closed items cannot do, and a set of short vignettes or work-sample tasks can show what graduates actually do when faced with a realistic problem [19, 20]. Mixed designs that combine a broad questionnaire with a smaller number of in-depth interviews are more costly, though they allow the numbers to be interpreted. Analysis should follow a stated method and not rest on selected quotations.

Reporting standards for educational surveys would raise the quality of the whole literature. At a minimum, papers should state the sampling frame, the number invited and the number who responded, the instrument and any validation, and how missing data and free-text answers were treated [3, 4, 31]. Providing the questionnaire as supplementary material allows others to reuse or criticise it. These requests are modest, and many authors comply already, but they are far from universal in the pharmacy education literature as it stands. Common method bias is a further concern, in particular when one respondent reports both a predictor and an outcome in the same questionnaire. A graduate who feels positive about the course may rate both the course and their own skills favourably for the same reason [36]. Linking survey data to objective measures, such as time to first job, retention after one year, or supervisor-rated performance on defined tasks, offers a way out, yet such linkage is uncommon in published pharmacy work.

Comparisons across countries add another layer of difficulty. A questionnaire written for

one education system may not translate cleanly into another, since terms such as industrial training, internship or practice school describe different arrangements in different places [2, 15]. Translated instruments should be checked by forward and back translation and tried out on a few respondents from the target group before use [3, 4]. Even then, scores from different systems are not strictly comparable when the curricula, licensing rules and employer expectations behind them differ. For this reason, reviews that pool findings across regions should say so openly and treat the pooled picture as a set of local stories with some common threads, not as a single estimate.

Timing makes interpretation harder. A graduate surveyed six months after qualifying remembers the programme differently from one surveyed after five years, and employers evaluate current recruits against a changing labour market. Cross-sectional surveys can describe views at a point in time but cannot show whether curriculum changes improved readiness [31]. Repeated surveys of defined cohorts would answer that question better. Panel designs of this kind are demanding, as participants drop out over the years, but even partial follow-up is informative.

6. CLOSING THE GAP IN PRACTICE

Several responses recur in the literature. The first is closer partnership between universities and employers: advisory boards with industry members, guest teaching by practising professionals, jointly supervised projects and structured placements with defined learning outcomes [6, 7]. Such partnerships work best when both sides state what they expect in writing, because informal goodwill fades when personnel change. They also give academics an opportunity to see current practice, which is a quiet but real benefit. The second is to teach the regulatory and quality foundations earlier and more concretely. Sessions on good manufacturing practice, data integrity, quality risk management and the structure of a marketing authorisation dossier can be built around real or realistic documents and exercises, drawing on the ICH and WHO texts that industry actually works with [21, 22, 23, 24]. This does not require a new course. Much of it can be woven into existing pharmaceutics, analysis and law modules, so long as someone takes responsibility for coherence across them.

Evaluation of any change should be planned from the start. A useful scheme asks four questions in sequence: whether students liked the new element, whether they learned what was intended, whether they behave differently in practice, and whether employers see a difference. Most published educational reports stop at the first two, because the last two take years and require partnership with employers outside the university [30, 34]. Even modest follow-up, such as a short structured survey of supervisors at six and twelve months, would make the evidence stronger than a satisfaction questionnaire completed at the end of a module.

The third is the explicit teaching and assessment of communication, teamwork and professional behaviour. These skills are sometimes assumed to develop by themselves. Evidence from higher education suggests they respond to deliberate teaching, practice and feedback, as other skills do, and employers repeatedly list them as priorities [8, 25, 27]. Group projects with defined roles, mock audits, written reports in a standard format and oral presentations to non-specialists are practical ways of doing it. Resources, not only ideas, limit what can be done. Staff who teach pharmaceutics and analysis often carry heavy workloads, equipment is costly to maintain and large cohorts make small-group laboratory work difficult. Industry-facing teaching also needs staff who have worked in the sector, and they are not always easy to recruit into academic posts. Faculty development, secondments to industry and visiting practitioners help, and they make reform more durable than a change of syllabus alone [5, 6]. Pragmatic proposals acknowledge this and phase changes over several cohorts, evaluating each before moving on.

Curriculum mapping is a modest first step that many programmes skip. Each module's stated outcomes are laid against a competency framework [12, 13], and the resulting grid shows at a glance where an industry-relevant competence is taught, where it is assessed and

where it is absent. Mapping against the quality system and good manufacturing practice texts used by employers [21, 23] is more revealing still, because documentation, deviation handling and change control often turn out to appear nowhere in the written outcomes. The exercise costs staff time but little else, and it gives a department something concrete to discuss with an advisory board. Its limit is that a map records what is intended and not what students experience, so it needs to be paired with samples of student work and some conversation with recent graduates [18]. Done once and then filed, it is of little use. Done every few years, it makes drift visible.

Progression through a degree can be planned so that students move from guided to more independent work and meet increasingly realistic tasks, an approach consistent with competency-based education and the idea of staged entrustment [13, 17, 26]. The curriculum then reads as a sequence in which each year has a different relationship to practice. Students are also better informed about career pathways, including industry, which are often presented in an uneven way when most teaching staff have a clinical or academic background [1, 5].

7. LIMITATIONS AND FUTURE DIRECTIONS

Equity and context deserve a place in future work as well. Graduates from well-resourced institutions with industry links and good laboratories may be rated differently from those whose programmes lack equipment, simply because of what they were able to practise. Surveys that report results without breaking them down by institution type, class size or access to placements can hide those differences [1, 2]. Reports that include the characteristics of the programme alongside the findings would let readers judge how far results might apply to their own setting. The evidence has limits that the reader should keep in mind. Much of the cited literature comes from general higher education or from medical education, and not from pharmacy industry settings. Published pharmacy surveys are often single-institution, descriptive and without validated instruments, so their findings are best read as local observations [4, 31]. Because publication favours reports of successful reforms, there is likely to be a body of unreported experience, including programmes that changed little despite effort.

The role of employers in producing evidence should not be overlooked. Companies hold a good deal of data on the performance, retention and training needs of new recruits, but these are seldom shared with universities in a form that could inform curricula, and confidentiality concerns are understandable. Agreed, anonymised summaries, perhaps through professional bodies or industry associations, could allow trends to be tracked across years. Professional development records kept after graduation could also feed back into programme design, linking the early curriculum to what practitioners later say they needed to learn [6, 33]. Definitions vary between studies. Readiness, competence, employability and satisfaction are measured with different items, so pooling results is not feasible, and this review has relied on narrative comparison for that reason [8, 20]. Nor can the findings reported for one country be applied directly to another, given the differences in curriculum structure, labour markets and the status of the profession described earlier [2, 15, 16].

Several research directions would improve matters. Validated instruments for industry readiness in pharmacy, developed with employers and tested for reliability, would give comparable results across institutions [4]. Mixed methods designs that pair surveys with interviews and with objective outcomes could separate perception from performance [19, 36]. Longitudinal tracking of cohorts through the first years of employment, and trials of specific teaching interventions with predefined outcomes, would show whether the changes proposed in the literature actually work [28, 29].

8. CONCLUSION

The published record agrees on a few points. Pharmacy programmes are organised around competency frameworks that give limited space to industry roles. Employers in a range of sectors ask for communication, teamwork and the ability to learn quickly, together with

hands-on exposure to analytical work, documentation and quality systems [13, 21, 23, 25]. Graduates, for their part, report that the practical side of preparation lags behind the theoretical one, although self-reported readiness is an imperfect guide to actual performance.

What is less secure is the size of the gap and the best way to close it. Surveys are mostly local, use unvalidated instruments and rely on convenience samples [3, 4, 31]. Teaching methods with a good evidence base elsewhere, among them active learning, structured placements and workplace-style assessment, deserve testing in pharmacy with employment-linked outcomes [28, 30, 34]. Until such studies appear, curriculum decisions will rest on informed judgement more than on data, and that judgement is best exercised jointly by teachers, graduates and the employers who hire them.

9. ABBREVIATIONS

FIP-International Pharmaceutical Federation, GCP-Good clinical practice, GMP-Good manufacturing practice, ICH-International Council for Harmonisation, PCI-Pharmacy Council of India, STEM-Science, technology, engineering and mathematics, UNESCO-United Nations Educational, Scientific and Cultural Organization, WHO-World Health Organization, Pharm.D-Doctor of Pharmacy, AMEE-Association for Medical Education in Europe

10. FUNDING

Nil

11. AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

12. CONFLICT OF INTERESTS

Declared none

13. REFERENCES

1. Bates I, John C, Bruno A, Fu P, Aliabadi S. An analysis of the global pharmacy workforce capacity. Hum Resour Health 2016;14:61.
2. Basak SC, Sathyanarayana D. Pharmacy education in India. Am J Pharm Educ 2010;74:68.
3. Dillman DA, Smyth JD, Christian LM. Internet, phone, mail, and mixed-mode surveys: the tailored design method. 4th ed. Hoboken: Wiley; 2014.
4. Artino AR, La Rochelle JS, Dezee KJ, Gehlbach H. Developing questionnaires for educational research: AMEE Guide No. 87. Med Teach 2014;36:463–74.
5. Mossialos E, Courtin E, Naci H, *et al.* From retailers to health care providers: transforming the role of community pharmacists in chronic disease management. Health Policy 2015;119:628–39.
6. Frenk J, Chen L, Bhutta ZA, *et al.* Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. Lancet 2010;376:1923–58.
7. Anderson C, Bates I, Beck D, *et al.* The WHO UNESCO FIP Pharmacy Education Taskforce. Hum Resour Health 2009;7:45.
8. Yorke M. Employability in higher education: what it is, what it is not. York: Higher Education Academy; 2006.
9. Tomlinson M. Graduate employability and student attitudes and orientations to the labour market. J Educ Work 2007;20:285–304.
10. Hepler CD, Strand LM. Opportunities and responsibilities in pharmaceutical care. Am J Hosp Pharm 1990;47:533–43.
11. van Mil JWF, Schulz M, Tromp TFJ. Pharmaceutical care, European developments in concepts, implementation, teaching, and research: a review. Pharm World Sci 2004;26:303–11.
12. Bruno A, Bates I, Brock T, Anderson C. Towards a global competency framework. Am J Pharm Educ 2010;74:56.
13. International Pharmaceutical Federation. FIP global competency framework, version 1. The Hague: FIP; 2012.
14. Pharmacy Council of India. Doctor of Pharmacy (Pharm.D) regulations 2008. New Delhi: PCI; 2008.
15. Sosabowski MH, Gard PR. Pharmacy education in the United Kingdom. Am J Pharm Educ 2008;72:130.
16. Kheir N, Zaidan M, Younes H, El Hajj M, Wilbur K, Jewesson PJ. Pharmacy education and practice in 13 Middle Eastern countries. Am J Pharm Educ 2008;72:133.
17. Bloom BS. Taxonomy of educational objectives: the classification of educational goals. Handbook 1: cognitive domain. New York: McKay; 1956.

18. Biggs J. Enhancing teaching through constructive alignment. High Educ 1996;32:347–64.
19. Miller GE. The assessment of clinical skills/competence/performance. Acad Med 1990;65:S63–7.
20. Epstein RM, Hundert EM. Defining and assessing professional competence. JAMA 2002;287:226–35.
21. ICH Harmonised Tripartite Guideline. Pharmaceutical quality system Q10. Geneva: ICH; 2008.
22. Garcia T, Cook G, Nosal R. PQLI key topics: criticality, design space, and control strategy. J Pharm Innov 2008;3:60–8.
23. World Health Organization. WHO good manufacturing practices for pharmaceutical products: main principles. WHO Technical Report Series No. 986, Annex 2. Geneva: WHO; 2014.
24. ICH Harmonised Guideline. Integrated addendum to ICH E6(R1): guideline for good clinical practice E6(R2). Geneva: ICH; 2016.
25. Andrews J, Higson H. Graduate employability, soft skills versus hard business knowledge: a European study. High Educ Eur 2008;33:411–22.
26. ten Cate O. Entrustability of professional activities and competency-based training. Med Educ 2005;39:1176–7.
27. Eraut M. Developing professional knowledge and competence. London: Falmer Press; 1994.
28. Freeman S, Eddy SL, McDonough M, *et al.* Active learning increases student performance in science, engineering, and mathematics. Proc Natl Acad Sci USA 2014;111:8410–5.
29. Prince M. Does active learning work? A review of the research. J Eng Educ 2004;93:223–31.
30. Kolb DA. Experiential learning: experience as the source of learning and development. Englewood Cliffs: Prentice-Hall; 1984.
31. Groves RM, Peytcheva E. The impact of nonresponse rates on nonresponse bias: a meta-analysis. Public Opin Q 2008;72:167–89.
32. Cooke M, Irby DM, Sullivan W, Ludmerer KM. American medical education 100 years after the Flexner report. N Engl J Med 2006;355:1339–44.
33. Rouse MJ. Continuing professional development in pharmacy. Am J Health Syst Pharm 2004;61:2069–76.
34. Boud D, Falchikov N. Aligning assessment with long-term learning. Assess Eval High Educ 2006;31:399–413.
35. Likert R. A technique for the measurement of attitudes. Arch Psychol 1932;140:1–55.
36. Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J Appl Psychol 2003;88:879–903.