

RESEARCH ARTICLE

Bridging the theory-practice gap in pharmacy education using an authentic learning approach: A cross-sectional study

Clare Depasquale , Gwen Gray 

School of Pharmacy & Life Sciences, Robert Gordon University, Aberdeen, United Kingdom

Keywords

Learning
Patient safety
Pharmacy
Pharmacy education
Simulated-based learning
Theory-practice gap

Correspondence

Gwen Gray
School of Pharmacy & Life Sciences
Robert Gordon University
Aberdeen
United Kingdom
g.m.gray@rgu.ac.uk

Abstract

Background: Authentic learning environments highlight real-world relevance to students, contributing to readiness for practice. This study evaluated the impact of an educational activity on student pharmacist learning and personal/professional development. **Methods:** An activity similar to that used by practising pharmacy professionals to record errors during dispensing was included in simulated community pharmacy workshops delivered to Year-2 students as part of a Professional Practice Module. Students were instructed to complete entries when academic staff identified errors during final accuracy checks. Student evaluation surveys were analysed at the end of terms one and two of the academic year. Descriptive statistics were used for closed questions, and thematic analysis for open-ended responses. **Results:** Of the 75 student pharmacists who completed both evaluation surveys, 64% (n=48) recorded fewer errors in term two. Respondents considered the exercise helpful in highlighting the need for more attention to detail and identifying negative trends in their dispensing process. A positive response to personal/professional development was noted, with student pharmacists commenting that the activity facilitated reflection. **Conclusion:** This activity has allowed students to experience real-world working situations, extending their learning experience, facilitating personal/professional development, and encouraging best practices.

Introduction

Published literature has established authentic learning in healthcare education as an approach that bridges the theory-practice gap and prepares graduates for the increasing complexity of modern health and social care systems (Lee *et al.*, 2022). With its roots embedded in situated learning theory, authentic learning, defined as “a pedagogical approach that situates learning tasks in the context of real-world situations” (Herrington *et al.*, 2014), highlights real-world relevance to students and contributes to their readiness for practice (Swartz, 2016). Research has shown that authentic learning fosters the development of higher-order thinking skills, leading to competent, independent practitioners and lifelong learners (Chabeli *et al.*, 2021). A systematic review of the effectiveness of authentic learning methods in undergraduate healthcare education

reported that authentic learning strengthens student performance skills, communication skills, knowledge, motivation, cognitive load, confidence, perception, and critical thinking (Lee *et al.*, 2022). A framework intended to guide the design of student-centred learning approaches identifies nine elements considered to be essential characteristics of an authentic learning environment (Herrington & Oliver, 2000). These include authentic context, authentic activities, expert performances, multiple roles and perspectives, collaborative construction of knowledge, reflection, articulation, scaffolding, and authentic assessment. Various educational methods, such as simulation-based, case-based, and problem-based learning, are used to create authentic learning environments in undergraduate healthcare curricula (Herrington *et al.*, 2014; Lee *et al.*, 2022).

The implementation of simulation-based learning in undergraduate healthcare curricula is well-reported (Korayem *et al.* 2022). Although its development in pharmacy education has evolved at a slower pace when compared to medical and nursing education, the past two decades have seen growing evidence of its use in pharmacy education (Lloyd *et al.*, 2018; Tremblay & Boivin, 2019). Several authors reported examples of innovative approaches used to enhance student pharmacists' development of various skills in undergraduate curricula (Seybert *et al.*, 2019; Korayem *et al.*, 2022). In 2009, a study described the introduction of a laboratory session into the first-year pharmacy curriculum to provide authentic learning experiences in recognising, resolving, and preventing medication errors (Kiersma *et al.*, 2009). Research has also examined the relevance of simulation-based learning in both postgraduate and undergraduate pharmacy education and its potential application in clinical pharmacy settings to support the development of learners' technical, cognitive, and non-technical skills (Lloyd *et al.*, 2018). One potential application involves a medication safety scenario intended to raise students' awareness of the causes of medication errors and their ability to recognise possible error-provoking conditions.

Dispensing medication is a complex process that involves the use of clinical, technical, and non-technical skills by members of the pharmacy team. Errors can occur at any stage throughout the dispensing process, with potentially dangerous consequences to patient safety (Ashcroft *et al.*, 2005; James *et al.*, 2009). Patient safety relies on an open and honest culture supported by an ethos of reporting and learning from patient safety incidents (Royal Pharmaceutical Society, 2016). Professionalism and a culture of candour are essential for patient safety; thus, pharmacy professionals have a critical role to play in identifying risk factors within the dispensing process, reflecting on errors, learning, and sharing learning points to ensure the delivery of safe and effective person-centred care while building a "just safety culture" (Phipps *et al.*, 2020).

In the United Kingdom (UK), the General Pharmaceutical Council's "Standards for pharmacy professionals" (2017) specify the need for pharmacists to "speak up when they have concerns or when things go wrong" and encourage reporting and learning from errors. In practice, pharmacy professionals are expected to complete an entry into a Near-Miss Error Log every time an error is recorded; this tool was developed as a resource to support clinical governance in practice (Royal Pharmaceutical Society, 2024). It is believed that a link exists between recording and learning from near misses and implementing changes in professional practice to protect patients (Robinson, 2015). However, there is limited published evidence of

its use as an authentic educational tool in undergraduate pharmacy programmes to support student pharmacists' personal and professional development.

Research aim

This evaluation study was conducted in the context of curricular development that aimed to strengthen student pharmacists' patient safety learning and personal and professional development. It involved designing and integrating an activity, including a reflective exercise, into the Professional Practice curriculum and was followed by an evaluation of the activity's impact on student pharmacist learning and how completing the activity influenced their personal and professional development.

Methods

Activity design and implementation

Year-2 student pharmacists in the four-year Master of Pharmacy (MPharm) programme at Robert Gordon University engaged in nineteen weekly 1.5-hour workshops, simulating a community pharmacy environment. The sessions involved scenarios requiring prescription dispensing, encompassing different medicines from various prescribers such as doctors, dentists, non-medical prescribers, and veterinary surgeons. During the final accuracy check, academic staff involved in the delivery of these workshops identified several errors student pharmacists made during the dispensing process, such as wrong labels, drugs, strengths, and quantities. In response, a decision was made to enhance student pharmacist learning by introducing a reflective exercise at the end of the dispensing process. This activity aimed to simulate real world situations, develop reflective practitioners, support professional growth, and instil best practices in a professional capacity.

A Near-Miss Error Log, similar to the one used by practising pharmacy professionals in the UK, was included as part of the dispensing activities (Royal Pharmaceutical Society, 2024). This log was intended to identify the following: (1) what went wrong, (2) why it happened, (3) actions to be taken to prevent reoccurrence, and (4) further changes, if necessary. All staff involved in workshop delivery were briefed on the intended value of the activity and clear instructions on its use, mainly instructing student pharmacists to complete an entry into the log if an error was identified during the final accuracy check of the dispensed medication and asking them to reflect on this error to

identify any contributing factors and modifications that could prevent the same error from reoccurring. An initial introductory session was delivered to student pharmacists at the beginning of term one to outline activity learning outcomes (Table I) and address any queries. During activity design, the principles of constructive alignment (Biggs & Tang, 2011) were applied, mapping workshop learning outcomes to module learning outcomes intended to support the development of competencies assessed during Direct Observation of Practical Skills (DOPS).

Table I: Workshop learning outcomes

Learning outcomes
To encourage identification of any causative factors leading to the error
To identify any trends leading to errors in the dispensing process
To encourage reflection and implementation of changes to reduce future re-occurrence
To allow familiarisation with error reporting procedures used in practice
To encourage learning from errors, good practice, and development of a "just-culture"

Sampling

A purposive sampling approach was employed. During the 2018/19 academic year, Year-2 student pharmacists (n=101) were invited to participate in the study. Taking part was voluntary, and no incentives were offered to potential participants.

Activity evaluation

Evaluation surveys were developed by academic staff members with extensive experience in pharmacy practice and pharmacy education. The surveys included both open-ended questions and closed questions relating to the number and type of errors recorded, key learning points, and the impact of the activity on personal and professional development, leading to changes in practice and improved patient safety. Closed questions involved single or 5-point Likert scale answers (strongly disagree, disagree, unsure, agree, and strongly agree). Student pharmacists were asked to complete the survey twice – once at the end of term one and again at the end of term two. On both occasions, surveys were distributed and collected during the last ten minutes of class time. An identification code was assigned to every student pharmacist to allow for both surveys to be linked. Responses from paper surveys were transcribed into a Microsoft Excel spreadsheet; this process was checked for accuracy. The data generated were exported to

SPSS v29.0 (IBM Corp, Armonk, NY). Analysis guided by the research aim included descriptive statistics presented as numbers and frequencies; the non-parametric Wilcoxon Signed Ranks Test was performed to compare the group responses for terms one and two. Thematic analysis was employed to analyse data from responses to open-ended questions. This process involved familiarisation with the data, coding, and identification of themes, aligning with the research aim (Creswell & Creswell, 2023), and was completed by one author (CD), with emerging themes discussed and finalised after discussion with the second author (GG). This work was classed as a service evaluation, and an ethics review by the School of Pharmacy and Life Sciences Ethics Review Committee was not required.

Results

Eighty-four student pharmacists (83%) completed the evaluation survey in term one; 220 errors were recorded, with 9 (11%) student pharmacists making no dispensing errors. In term two, 86 (85%) student pharmacists completed the survey; 139 errors were recorded in total, and 28 (33%) student pharmacists made no errors. Table II presents the types of errors recorded in both terms.

Table II: Type and number of near-miss records

Code	Type of near miss	Number recorded in term one*	Number recorded in term two**
D	Wrong drug	11	15
E	Out of date product	7	4
F	Wrong form	10	11
L	Wrong label	88	34
M	Missing item	0	3
N	Wrong patient name	19	16
P	Misread prescription	27	16
Q	Wrong quantity	26	17
S	Wrong strength	27	20

*** some missing data

Generally, the majority of respondents expressed high levels of agreement with statements on the positive impact of the activity on student pharmacists' learning in patient safety and their personal and professional development. In term two, 89.4% (n=76) of respondents either strongly agreed or agreed that the near-miss error log was a valuable learning resource in the undergraduate curriculum.

Table III: Term 2 survey responses recording activity impact on student pharmacist learning

Statements	Total responses	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
		n (%)	n (%)	n (%)	n (%)	n (%)
Keeping a near-miss error log has made me more vigilant when dispensing.	85	19 (22.4)	45 (52.9)	15 (17.6)	3 (3.5)	3 (3.5)
Reflecting on my near misses has allowed me to identify trends in my dispensing errors.	85	15 (17.6)	49 (57.6)	15 (17.6)	5 (5.9)	1 (1.2)
I have changed my dispensing process to prevent errors.	84	18 (21.4)	48 (57.1)	13 (15.5)	4 (4.8)	1 (1.2)
I have learnt from all near misses that I have made.	83	24 (28.9)	42 (50.6)	13 (15.7)	3 (3.6)	1 (1.2)
A near-miss error log should be used by all pharmacy students when dispensing.	85	37 (43.5)	39 (45.9)	6 (7.1)	3 (3.5)	0
Use of a near-miss error log will help me succeed in my dispensing test.	84	29 (34.5)	40 (47.6)	11 (13.1)	4 (4.8)	0

Of the 75 (74%) student pharmacists who completed evaluation surveys in both terms, 64% (n=48) made fewer errors in term two than in term one. Student pharmacists performed better in dispensing exercises during term two, with the Wilcoxon test indicating a statistically significant improvement ($p < 0.001$).

Three themes were identified from responses to open-ended questions; these are presented as a narrative description.

Theme 1: Key learning points for student pharmacists

Most comments referred to the inclusion of the Near-Miss Error Log as generally highlighting the need for more attention to detail throughout the dispensing process.

“Being more cautious when dispensing prescriptions and being more aware/vigilant”. (ER70)

“I usually rush the process so need to slow down and double check”. (ER96)

“Need to look at prescription more attentively”. (ER40)

“Observing information more clearly”. (ER104)

Student pharmacists also stated that the near-miss error log helps identify some trends in their dispensing process, thereby allowing them to find specific ways to avoid making similar errors in future.

“Most of my near misses are label errors. I need to exercise more caution reading the label against the prescription”. (ER97)

“To make sure I re-read the computer screen before printing the final label”. (ER16)

“Learned to use a checklist approach when reading prescription and again after dispensing to ensure it is right”. (ER49)

“Need to expand on wording for label to ensure patient fully understands instructions”. (ER102)

“Must take more time and don’t rush. Must double check prescriptions and watch for similar designed packs”. (ER58)

Theme 2: Student pharmacists’ perceived value of activity

Exploring student pharmacists’ views of their personal and professional development has shown an overall positive response, with student pharmacists reporting that this activity enhanced learning and reflection opportunities.

“A good learning tool; makes you think about why it happened and ways to prevent”. (ER24)

“Very useful, good for reflection; also, good that it isn’t looked at/assessed so you can be honest and use it properly”. (ER97)

“Good idea to help students be more careful with the dispensing”. (ER9)

“Near-miss error log is really helpful in reducing mistakes”. (ER35)

“I forgot to fill it in – please remind us/make more of a fuss over it”. (ER50)

Theme 3: Bridging the theory-practice gap

Student pharmacists considered the exercise as an effective way of bridging the theory-practice gap and supporting the development of a “just-culture” approach to practice.

“I think it is a good idea to keep an error log as a student as I will have to do it as a pharmacist”. (ER24)

“I think it is beneficial as in a pharmacy they are used. It also helps take away the stigma of making a mistake as it will happen and by making them you can learn”. (ER29)

Discussion

This study reported an authentic learning approach in undergraduate pharmacy education through an activity delivered in a simulated community pharmacy setting, allowing student pharmacists to experience dispensing scenarios in a safe and supportive environment and good practice procedures specified in the regulatory standards for pharmacy professionals and used by practising pharmacists in the UK (General Pharmaceutical Council, 2017; Royal Pharmaceutical Society, 2024).

This paper adds to the body of evidence of approaches highlighting real-world relevance to students in supporting their readiness for practice. The evaluation of student pharmacists’ responses to the surveys completed across the two terms of the academic year has confirmed the appropriateness of this “learning by doing” approach for the intended stakeholder group. The results show an overall positive response to personal and professional development, with student pharmacists commenting that the exercise had facilitated reflective learning and helped bridge the theory-practice gap. Findings from this analysis corroborate those of a qualitative study that used focus groups to explore Year-3 student pharmacists’ attitudes towards completing a similar dispensing error register (Morecroft, 2011) and add another perspective. By using a survey approach for data collection in two terms of the academic year, this evaluation study has added another perspective to findings from

Morecroft’s study; mainly a measure of the direct impact completion of this exercise has had on student learning and development. By gathering a clear picture of the type of errors recorded and taking time to reflect on any causative factors, student pharmacists have employed effective risk-reducing strategies, as evidenced by the reduced number of logged errors in term two. The UK regulator overseeing the initial education and training of pharmacists, i.e. the General Pharmaceutical Council, specifies in its standards the need for developing student pharmacists’ risk management competencies by providing opportunities for them to “actively take part in the management of risks” (General Pharmaceutical Council, 2021). The opening for student pharmacists to complete this activity is one step in meeting this requirement.

Findings from this research show that the most commonly logged error in both terms was “wrong labels”, consistent with those of a previous study of dispensing errors among first-year student pharmacists reporting similar results regarding label directions, including errors in the route of administration, formulation, and frequency of dosing (Chuang *et al.*, 2021). A systematic review exploring the incidence and types of dispensing errors and contributing factors in hospital pharmacies identified wrong medicines, wrong strengths, and wrong dosage forms as the most frequently reported dispensing errors (Aldhwaihi *et al.*, 2016), with the majority of included studies focusing on investigating dispensing error types while overlooking contributing factors or strategies to reduce medication error occurrence. Similarly, another literature review of the incidence, types, and causes of dispensing errors in community and hospital pharmacies identified the wrong drugs, strengths, forms, quantities, or labelling as the most common errors (James *et al.*, 2009). Interestingly, although the present study was conducted in a different setting, i.e. a simulated community pharmacy environment, the most commonly logged errors were similar to those recorded in practice settings, thereby supporting the use of this pedagogical approach as an effective learning method in the general pharmacy curriculum, more specifically in patient safety learning and skill acquisition (Regan *et al.*, 2014; Frenzel *et al.*, 2018).

The factors described as contributing to dispensing errors in hospital and community pharmacy practice settings include heavy workload, distractions, look-alike/sound-alike medicines, and failure to follow standard operating procedures (James *et al.*, 2009; Aldhwaihi *et al.*, 2016; Abdel-Qader *et al.*, 2021). Other factors, such as increased workload and staffing issues, could lead to under-reporting of errors by hospital pharmacists (Noureldin & Noureldin, 2021). Although this study did not formally collect data on contributing

factors to student pharmacists' dispensing errors, the answers to open-ended questions indicate that workload and time pressures were potential reasons. Student pharmacists were set multiple dispensing tasks within the 1.5-hour workshops to present a realistic community pharmacy setting, particularly a "high-fidelity" approximation of the fast-paced nature of this context; rushing to complete all set tasks was noted as leading to dispensing errors.

Several authors highlighted how pedagogical approaches in pharmacy curricula can support student pharmacists' professional identity formation. In 2014, Noble and colleagues (2014) challenged pharmacy educators to consider how pedagogical content and curriculum structure support professional identity formation by allowing student pharmacists to connect their current learning to future practice. In their study of pharmacy undergraduates' learning strategies and acquisition of a professional identity, Taylor and Harding (2007) underscored the importance of ensuring that curricular content reflects real-world experiences to increase student pharmacists' motivation and engagement. A scoping review of how curricular content can support professional identity formation highlighted the need for pharmacy educators to move away from focusing solely on the provision of knowledge and skills to provide authentic learning activities and interactions with practising pharmacists to support professional identity formation (Noble *et al.*, 2019). In the present study, the inclusion of this reflective exercise into the simulated activity has extended learning opportunities for student pharmacists beyond the development of practical dispensing skills, facilitating reflective practice and learning from errors whilst also highlighting expectations of good practice and cultural norms to support patient safety and a "just safety culture".

The positive response from student pharmacists who participated in this evaluation has been encouraging and supported further integration of the activity into the curriculum. Although this was delayed due to the global COVID-19 pandemic, the new online approach to curriculum delivery adopted by higher education institutions during this time led to modifications not previously considered by academic staff. Campus-based dispensing workshops in the simulation pharmacy were replaced with online dispensing exercises using MyDispense (Mak *et al.*, 2021). Student pharmacists were encouraged to use the "Near-Miss Error Log" to record any errors encountered whilst completing these online dispensing scenarios, highlighting the versatility of this activity in the curriculum. Upon its introduction, the "Near-Miss Error Log" was included in the Student Record Book given to individual student pharmacists at the start of the

academic year to log activities completed during workshops delivered as part of the Professional Practice curriculum. However, academic staff took the step to develop a separate booklet since most student pharmacists enrolled on MPharm programmes in the UK independently secure part-time employment in community pharmacy and hospital settings at an early stage in their studies and throughout the four-year programme of study. This booklet included the "Near-Miss Error Log" and was followed by a reflective cycle (Report-Learn-Share-Act-Review) to further enhance student pharmacist learning and development. The intended purpose of this approach was to allow student pharmacists the opportunity to use it both during simulated dispensing workshops on campus, when undertaking practice-based placements included as part of the experiential learning (EL) curriculum of the MPharm programme and during part-time work opportunities. The purpose and appropriate use of the booklet, including the importance of patient anonymity, were explained to student pharmacists, and reflection on near-miss errors was encouraged and used to produce unplanned or planned continuous professional development records, a mandatory component of the Professional Practice curriculum. The activity has since been extended to the Year-1 curriculum, enabling student pharmacists to learn and develop skills at an earlier stage in their studies.

Future longitudinal research over the two years of the Professional Practice curriculum could better evaluate the impact of this activity on student pharmacists' learning in patient safety and personal and professional development. A deeper examination of contributing factors to dispensing errors would also be valuable. Further research exploring how student pharmacists are using the error log while on placements in practice settings and the input of EL facilitators (preceptors) to support patient safety learning would be beneficial to identify areas for future development and EL facilitator training. In 2019, a noteworthy model was developed where student pharmacists complete a required medication safety assignment to identify medication safety and error reporting practices at their EL site and initiate discussion with their preceptors (Darbishire *et al.*, 2019). Finally, the findings from this study have already guided academic staff to further develop the patient safety curriculum. A workshop on Human Factors/Ergonomics principles and practices has been introduced to further extend the learning of student pharmacists who must fulfil a set of tasks aimed to explore the "prescription journey", thereby completing a Hierarchical Task Analysis of the dispensing process with the intention of identifying where patient safety could be compromised and ways of mitigating risks within the process (Stanton, 2006).

Strengths and limitations

A strength of the study is the high response rate and the inclusion of open-ended questions, enabling the assessment of student pharmacists' views. However, a possible limitation is the lack of in-depth exploration through focus group discussions. Another limitation may be response bias due to an under-reporting of errors. The importance of academic staff encouraging and supporting student pharmacists to complete the task of logging errors has been previously highlighted (Morecroft, 2011). This point was identified in student pharmacists' responses to open-ended questions. Regular academic staff training will continue to emphasise the importance of encouraging the completion of logs during workshops. Finally, the results may lack generalisability outside the UK context as the Near-Miss Error Log has been developed by the Royal Pharmaceutical Society in the UK (Royal Pharmaceutical Society, 2024).

Conclusion

This activity enabled students to experience real-world working situations, allowing them to develop as reflective practitioners. It has extended their learning experience while facilitating professional development and encouraging best practices in their professional capacity to improve patient safety and advocate a positive safety culture. In addition, the research design allowed for a clearer understanding of how this approach has impacted student learning and future practice and guided further development of the patient safety curriculum.

Ethics approval

Ethics review by the School of Pharmacy and Life Sciences Ethics Review Committee at Robert Gordon University was not required as this was classed as a service evaluation.

Acknowledgements

The authors would like to thank Linda Adams for her contribution to the integration of this activity into the curriculum.

Conflict of interest

The authors declare no conflict of interest.

Source of funding

The authors did not receive any funding.

References

- Abdel-Qader, D. H., Al Meslamani, A. Z., Lewis, P. J., & Hamadi, S. (2021). Incidence, nature, severity, and causes of dispensing errors in community pharmacies in Jordan. *International Journal of Clinical Pharmacy*, *43*(1), 165–173. <https://doi.org/10.1007/s11096-020-01126-w>
- Aldhwaihi, K., Schifano, F., Pezzolesi, C., & Umara, N. (2016). A systematic review of the nature of dispensing errors in hospital pharmacies. *Integrated Pharmacy Research and Practice*, *5*, 1–10. <https://doi.org/10.2147/iprp.s95733>
- Ashcroft, D. M., Quinlan, P., & Blenkinsopp, A. (2005). Prospective study of the incidence, nature and causes of dispensing errors in community pharmacies. *Pharmacoepidemiology and Drug Safety*, *14*(5), 327–332. <https://doi.org/10.1002/pds.1012>
- Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university* (4th edition). Maidenhead: Open University Press.
- Chabeli, M., Nolte, A., & Ndawo, G. (2021). Authentic learning: a concept analysis. *Global Journal of Health Sciences*, *13*(4), 12–23. <http://dx.doi.org/10.5539/gjhs.v13n4p12>
- Chuang, S., Grieve, K.L., & Mak, V. (2021). Analysis of dispensing errors made by first-year pharmacy students in a virtual dispensing assessment. *Pharmacy (Basel)*, *9*(1), 65. <https://doi.org/10.3390/pharmacy9010065>
- Creswell, J. W., & Creswell, J. D. (2023). *Research Design. Qualitative, quantitative and mixed methods approaches*. 6th edition. SAGE Publications Inc.
- Darbishire, P. L., Zhao, J. C., Sodhi, A., & Anderson, C. M. (2019). Student observations of medication error reporting practices in community pharmacy settings. *Research in Social and Administrative Pharmacy*, *15*(7), 902–906. <https://doi.org/10.1016/j.sapharm.2019.02.009>
- Frenzel, J. E., Skoy, E.T., & Eukel, H.N. (2018). Use of simulations to improve pharmacy students' knowledge, skills, and attitudes about medication errors and patient safety. *American Journal of Pharmaceutical Education*, *82*(8), Article 6644. <https://doi.org/10.5688/ajpe6644>
- General Pharmaceutical Council. (2017). *Standards for pharmacy professionals*. General Pharmaceutical Council. Retrieved May 3, 2023, from https://www.pharmacyregulation.org/sites/default/files/standards_for_pharmacy_professionals_may_2017_0.pdf

- General Pharmaceutical Council. (2021). *Standards for the initial education and training of pharmacists*. General Pharmaceutical Council. Retrieved February 6, 2024, from <https://www.pharmacyregulation.org/initial-training>
- Herrington, J. & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development*, **48**(3), 23–48. <https://doi.org/10.1007/BF02319856>
- Herrington, J., Reeves, T. C., & Oliver, R. (2014). Authentic learning environments. In J.M. Spector (Eds.), *Handbook of research on educational communications and technology* (4th ed., pp. 401 – 412). Springer Science + Business Media.
- James, K. L., Barlow, D., McCartney, R., Hiom, S., Roberts, D., & Whittlesea, C. (2009). Incidence, type and causes of dispensing errors: A review of the literature. *International Journal of Pharmacy Practice*, **17**(1), 9–30. <https://doi.org/10.1211/ijpp.17.1.0004>
- Kiersma, M. E., Darbishire, P. L., Plake, K. S., Oswald, C., & Walters, B. M. (2009). Laboratory session to improve first-year pharmacy students' knowledge and confidence concerning the prevention of medication errors. *American Journal of Pharmaceutical Education*, **73**(6), 99. <https://doi.org/10.5688%2Faj730699>
- Korayem, G. B., Alshaya, O. A., Kurdi, S. M., Alnajjar, L. I., Badr, A. F., Alfahed, A., & Cluntun, A. (2022). Simulation-based education implementation in pharmacy curriculum: a review of the current status. *Advances in Medical Education and Practice*, **13**, 649–660. <https://doi.org/10.2147/amep.s366724>
- Lee, J., Campbell, S., Choi, M., & Bae, J. (2022). Authentic learning in healthcare education: A systematic review. *Nurse Education Today*, **119**, 105596. <https://doi.org/10.1016/j.nedt.2022.105596>
- Lloyd, M., Watmough, S., & Bennett, N. (2018). Simulation-based training: Applications in clinical pharmacy. *Clinical Pharmacist*, **10**(9). <https://doi.org/10.1211/PJ.2018.20205302>
- Mak, V., Fitzgerald, J., Holle, L., Vordenberg, S.E., & Kebodeaux, C. (2021). Meeting pharmacy educational outcomes through effective use of the virtual simulation MyDispense. *Currents in Pharmacy Teaching and Learning*, **13**(7), 739–742. <https://doi.org/10.1016/j.cptl.2021.03.003>
- Morecroft, C. W. (2011). Engaging in reflection: error logs and developing students' skills. *Pharmacy Education*, **11**(1), 172–176. <https://pharmacyeducation.fip.org/pharmacyeducation/article/view/318>
- Noble, C., Coombes, I., Shaw, P. N., Nissen, L. M., & Clavarino, A. (2014). Becoming a pharmacist: The role of curriculum in professional identity formation. *Pharmacy Practice (Granada)*, **12**(1), 380. <https://doi.org/10.4321/s1886-36552014000100007>
- Noble, C., McKauge, L., & Clavarino, A. (2019). Pharmacy student professional identity formation: A scoping review. *Integrated Pharmacy Research and Practice*, **8**, 15–34. <https://doi.org/10.2147/ijprp.s162799>
- Noureldin, M., & Noureldin, M. A. (2021). Reporting frequency of three near-miss error types among hospital pharmacists and associations with hospital pharmacists' perceptions of their work environment. *Research in Social and Administrative Pharmacy*, **17**, 381–387. <https://doi.org/10.1016/j.sapharm.2020.03.008>
- Phipps, D., Ashour, A., Riste, L., Lewis, P., & Ashcroft, D. (2020). Reducing risk and managing dispensing errors. *The Pharmaceutical Journal*, **305**(7944). <https://doi.org/10.1211/PJ.2020.20208595>
- Regan, K., Harney, L., Goodhand, K., Strath, A., & Vosper, H. (2014). Pharmacy simulation: A Scottish, student-led perspective with lessons for the UK and beyond. *Pharmacy (Basel)*, **2**(1), 50–64. <https://doi.org/10.3390/pharmacy2010050>
- Robinson, S. (2015). Near miss error tools for pharmacists launched. *The Pharmaceutical Journal*, **295**(7876/7). <https://doi.org/10.1211/PJ.2015.20069108>
- Royal Pharmaceutical Society. (2016). *Professional standards for the reporting, learning, sharing, taking action and review of incidents*. Royal Pharmaceutical Society. Retrieved May 3, 2023 from <https://www.rpharms.com/Portals/0/RPS%20document%20library/Open%20access/Professional%20standards/Error%20Reporting/rsr-standards-nov-2016.pdf>
- Royal Pharmaceutical Society. (2024). *Errors and near misses: Pharmacy guide*. Royal Pharmaceutical Society. Retrieved February 5, 2024, from <https://www.rpharms.com/resources/pharmacy-guides/errors-and-near-misses>
- Seybert, A. L., Smithburger, P. L., Benedict, N. J., Kobulinsky, L. R., Kane-Gill, S. L., & Coons, J. C. (2019). Evidence for simulation in pharmacy education. *Journal of the American College of Clinical Pharmacy*, **2**, 686–692. <https://doi.org/10.1002/jac5.1167>
- Stanton, N. A. (2006). Hierarchical task analysis: Developments, applications and extensions. *Applied Ergonomics*, **37**(1), 55–79. <http://dx.doi.org/10.1016/j.apergo.2005.06.003>
- Swartz, M. K. (2016). Promoting authentic learning for our students. *Journal of Pediatric Health Care*, **30**(5), 405. <https://doi.org/10.1016/j.pedhc.2016.06.003>
- Taylor, K. M. G., & Harding, G. (2007). The pharmacy degree: The student experience of professional training. *Pharmacy Education*, **7**(1), 83–88. <https://pharmacyeducation.fip.org/pharmacyeducation/article/view/238/210>
- Tremblay, M. L., & Boivin, M. C. (2019). Chapter 31—Simulation for pharmacy. In G. Chiniara (Ed.), *Clinical Simulation (Second Edition)* (pp. 441–453). Academic Press. <https://doi.org/10.1016/B978-0-12-815657-5.00031-0>