# Impact of a gamified simulation on pharmacy students' self-assessed competencies

## Author

Hope, Denise L, Grant, Gary D, Rogers, Gary D, King, Michelle A

## Published

2022

## Journal Title

Currents in Pharmacy Teaching and Learning

## Version

Accepted Manuscript (AM)

## DOI

10.1016/j.cptl.2022.07.020

## Rights statement



## Downloaded from



## Griffith Research Online

**Impact of a gamified simulation on pharmacy students' self-assessed competencies**

Denise L Hope, BPharm, MMedRes, GradCertHigherEd [corresponding author]
School of Pharmacy and Medical Sciences
Griffith University
Gold Coast QLD, Australia
+61 7 5552 7339
d.hope@griffith.edu.au

Gary D Grant,BPharm, PhD, GradCertHigherEd
School of Pharmacy and Medical Sciences
Griffith University
Gold Coast QLD, Australia
+61 7 5552 9213
g.grant@griffith.edu.au

Gary D Rogers MBBS, MGPPsych, PhD
School of Medicine
Deakin University
Geelong VIC, Australia
+61 3 522 78229
g.rogers@deakin.edu.au

Michelle A King BPharm, PhD (Med)
School of Pharmacy and Medical Sciences
Griffith University
Gold Coast QLD, Australia
+61 7 5552 9739
michelle.a.king@griffith.edu.au

**Impact of a gamified simulation on pharmacy students' self-assessed competencies**


## Abstract

### Introduction

Competency-based pharmacist education develops robust professional identities and prepares graduates for future practice to ensure optimal patient outcomes. An extended gamified simulation was developed as a capstone activity for a new Australian Bachelor of Pharmacy (BPharm) program. The simulation was designed to consolidate students' knowledge, skills, and behaviors from prior learning. This research aimed to explore whether participation in an extended gamified simulation could influence pharmacy students' perceptions of their professional competencies.

### Methods

Data were collected over three years to compare a superseded Master of Pharmacy (MPharm) program with an incoming BPharm program. Final year students were invited to self-assess their professional competencies at the start and end of their final semester of study, using a digital self-assessment tool which replicated Australia's *National Competency Standards Framework for Pharmacists*. Participants rated their own competency against the 26 competency standards, across five domains, on a 5-point Likert Scale (not at all competent to very competent). This provided pre- and post- data to compare the simulation (BPharm intervention) and a traditional semester (MPharm comparison), in addition to final course grades.

### Results

From 2016 to 2019, 85 (90.4%) of 94 intervention and 50 (83.3%) of 60 comparison students completed the self-assessment of professional competencies. Participation in the gamified simulation significantly improved students' pharmacotherapeutics grades and pre-post change scores for seven of the 26 competency standards, two of the five domains, and all domains combined of the National Competency Standards.

### Conclusion

An extended, gamified simulation enhances the development of pharmacy students' self-assessed professional competencies.



### Keywords

Pharmacy education; gamification; simulation; competence; competency-based education; professional development.

**Conflict of Interest**

The authors have no conflicts of interest to declare.

**Disclosures**

Preliminary findings of this study were iteratively presented at the 2017 Health Services Research and Pharmacy Practice (HSRPP) Conference, Nottingham, UK, the 2018 Australian and New Zealand Association for Health Professional Educators (ANZAHPE) Conference, Hobart, Australia, and the 2019 European Association of Faculties of Pharmacy (EAFP) Conference, Krakow, Poland.

## Introduction

Competence to practice as a health professional is a necessary goal to ensure appropriate professional and patient health outcomes. Competence was defined by Koster et al (2017)[1] as the complement of individual competencies, which are the components of knowledge, skills, attitudes and other attributes. Emerging literature on pharmacy education has described implementation of competency-based curricula[1-3] and assessment models.[4] Contemporary academic discussion has highlighted the use of competency standards or frameworks to inform both pharmacist education[5, 6] and professional pharmacy practice.[7-12]

Australian pharmacy practice is supported by the *National Competency Standards Framework for Pharmacists in Australia.*[13] Competence is an essential requirement of registration to practice as a health professional in Australia[14] and must be evidenced at the time of first registration and annual re-registration.[5, 6, 15] Australian pharmacist education is accredited by the Australian Pharmacy Council (APC), and their Standards endorse the National Competency Standards as the definitive professional standards in Australia.[16]

To satisfy annual registration criteria and to meet the requirements of the Continuing Professional Development (CPD) Registration Standard,[15] Australian pharmacists must regularly reflect on their role and services against the professional competencies of the National Competency Standards. They must also plan CPD activities to address the self-assessed professional development needs identified. Some research has suggested that health professionals have limited ability to self-assess,[17-23] however, it is an important mainstay of professional practice.[17, 20, 21] Self-assessment is a vital skill for health care professionals' self-regulation, lifelong learning and professional development, from student to qualified professional.[18, 20]

A program change at an Australian School of Pharmacy required development of a 4-year undergraduate Bachelor of Pharmacy (BPharm) degree program, to replace an equivalent but superseded 4.5-year program, which comprised an articulated 3-year undergraduate Bachelor of Pharmaceutical Science and 1.5 year post-graduate Master of Pharmacy (MPharm). A capstone activity was sought for the new degree program to address identified gaps in the previous program. Its aim was to consolidate prior learning,[24] based on the concept of a spiral curriculum.[25] As a result, a full-environment, immersive, gamified pharmacy simulation was implemented as a capstone activity into the final semester of the new BPharm degree from 2016,[26] aligned with a competency-based approach.[2]

The simulation was adapted from the concept of the Pharmacy Game, developed at the University of Groningen, Netherlands,[27, 28] aligned with self-determination theory.[29] The gamified simulation involved student teams competitively managing their own simulated pharmacies, which encouraged collaboration and teamwork, and provided an opportunity for repeated authentic practice in a safe environment. Student participants assumed the role of autonomous pharmacists in the daily management of all pharmacy-related tasks, including medicines dispensing, verbal and written counselling, pharmaceutical care planning, prescriber interaction and resolution of medication-related problems, simulated patient cases, a research project and other assignments. Regular debriefing and personal reflection were undertaken, as they are important aspects of simulation and experiential learning.[30] Overall, the simulation aimed to consolidate students' knowledge, skills, and behaviors from prior learning, and improve confidence and competence. While this type of gamified simulation has been adapted and implemented in other universities,[1, 28] there is a dearth of research on outcomes of the intervention, and nothing reported on student competencies.

This research explored whether participation in an extended gamified simulation influenced senior pharmacy students' perceptions of their professional competencies.

**Material and Methods**

Institutional ethical approval was obtained from the Griffith University Human Research Ethics Committee (2016/594). The Standards for QUality Improvement Reporting Excellence in Education (SQUIRE-EDU) guided the preparation of this manuscript.[31]

The gamified simulation was conducted full-time by BPharm students for three weeks toward the end of their final 12-week semester. Full-time participation involved eight hours per day, for five days each week, with no other timetabled classes. Continuous assessment was conducted for all daily tasks with scores regularly being posted to the gamified simulation website. Positive scores reflected legal and professional actions whereas negative scores reflected illegal practice or potential harm to patients. A detailed description of the intervention has been published elsewhere.[26]

A University change from a 4.5-year articulated Bachelor of Pharmaceutical Science/MPharm degree program to a 4-year BPharm program enabled a comparative trial to be conducted. The final-year, final-semester students for the first three years (2016 to 2018) of the new BPharm program (intervention group) were compared with those from the last three years (2017 to 2019) of a superseded MPharm program (comparison group) as it was phased out. Both degree programs had the same entry requirements, provided comparable content delivered by the same academic staff and were accredited with the APC to deliver equivalent graduate outcomes. The major difference in the programs was that final semester MPharm students undertook an extended group research project and a pharmacy management course, in addition to the final pharmacy practice and pharmacotherapeutics courses. The MPharm research and management learning outcomes (e.g., teamwork and collaboration, research skills, management of time, task, team and self) were incorporated into BPharm program within the gamified simulation, which spanned both the final pharmacy practice and pharmacotherapeutics courses. The final 12-week semester of each program was designed to deliver the same outcomes. Therefore, these semesters were targets for a comparison, where one cohort participated in the 3-week gamified simulation and the other did not.

The BPharm and MPharm cohorts had no common competency-based assessment during their final semesters that could have enabled direct comparison of student competency-based outcomes. It was therefore determined that students' self-assessment of competency against the *National Competency Standards Framework for Pharmacist in Australia*[13] would provide the most appropriate comparator. The competency standards are ubiquitous in Australian professional practice and education, for self and external evaluation. A digital self-assessment tool using the competency standards was developed in 2016 to enable students to self-assess online. Students were asked to rate their own level of competency, on a 5-point Likert scale (1 = not at all competent to 5 = very competent) against the 26 competency standards of the *National Competency Standards Framework for Pharmacist in Australia,*[13] across the five domains. Each standard had component enabling competencies that could be viewed by participants, by hovering the cursor over each standard, to inform each standard's meaning. The functionality of the JotForm® interface was tested by pharmacist academic staff.

The student cohorts were staggered due to BPharm students graduating at the end of the calendar year and MPharm students graduating mid-year. Comparative data were collected until no further MPharm students remained in the superseded degree program. All participants were invited to self-assess their professional competencies at the start and end of their final semester of study. Pre-test data were collected for both cohorts in Weeks 1 and 2 and post-data were collected in Weeks 12 and 13 (study week). This equated to pre- and post-participation in the gamified simulation for BPharm intervention students, and the start and end of a traditional semester for the MPharm comparison students. Incentives were offered to students for completion of each pre- and post-assessment; and an additional incentive provided if both pre- and post-assessments were completed.

Pre- and post- Likert scale means were calculated for each cohort, against each standard and domain, to determine whether differences in self-assessment were apparent at the start and end of each cohort's final semester. To address the aims of the study, the evaluation then focused on individual students' changes in their self-assessment over the course of their final semester and comparison of such change between cohorts. Pre- and post-self-assessments were linked by student name and identification number, to enable measurement of individual change. Once linked, data were de-identified and coded, using a consecutive numbering system for participants, e.g., P001. Raw Likert scale data and calculated changes were analysed using SPSS version 25 (IBM). Measured change in standards and domains between intervention and comparison groups was compared using independent t-tests. For non-parametric data, significance was confirmed using Mann-Whitney U tests. A significance level of $p < 0.05$ was adopted.

To supplement the quantitative findings, a sample of students from each 2018 cohort was asked to reflect on their completion of the competencies self-assessment and then asked to explain what they thought about when rating their own competency. Students' comments were recorded with consent, de-identified and transcribed verbatim. The purpose of the qualitative component was to determine whether the intervention and comparison groups had similar approaches to self-assessment of competencies.

Furthermore, for the three years of the study, mean course grades were compared for both cohorts for the common final semester courses, namely pharmacy practice and pharmacotherapeutics. The aim of investigating these data was to determine whether students' final results might be influenced by their participation in the gamified simulation.

**Results**

From 2016 to 2019, three years of quantitative data were collected from each participating cohort (Table 1). Overall, 87.7% of students (n=135) participated: 90.4% (n=85) BPharm intervention (game) students and 83.3% (n=50) MPharm comparison (non-game) students completed the self-assessment at the commencement and the close of their respective final semesters. The majority of participants identified as female, which aligned with the distribution of students in the two programs.

Table 1: Participant Demographics

| **Demographic Characteristic** | | BPharm [a] Enrolled N | BPharm [a] **Game [b]** n (%) | MPharm [c] Enrolled N | MPharm [c] **No Game [b]** n (%) |
|---|---|---|---|---|---|
| **Gender** | Male | | 22 (25.9) | | 19 (38.0) |
| | Female | | 63 (74.1) | | 31 (62.0) |
| **Year of Participation** | 2016 | 27 | 26 (96.3) | - | - |
| | 2017 | 34 | 28 (82.4) | 34 | 29 (85.3) |
| | 2018 | 33 | 31 (93.9) | 16 | 13 (81.3) |
| | 2019 | - | - | 10 | 8 (80.0) |
| | **Total** | **94** | **85 (90.4)** | **60** | **50 (83.3)** |

[a] Bachelor of Pharmacy

[b] Number and percentage of self-assessment completions

[c] Master of Pharmacy

In pre-testing, MPharm comparison students' Likert scale means were higher for competence in 17 (65.4%) of the 26 Competency Standards. Four standards were significantly higher (Standards 3.2, 3.4, 3.5 and 3.6). The MPharm cohort generated higher overall pre-test means for four of the five domains, with Domains 1 and 3 significantly higher, and for all domains combined ($p$<0.001). In contrast, in post-testing the BPharm intervention students' Likert scale means were higher for 22 (84.6%) of the 26 standards. Four standards were significantly higher (Standards 1.3, 4.4, 4.6 and 4.7). The BPharm cohort generated higher overall post-test means for all five domains, with Domains 1, 2 and 4 significantly higher, and for all domains combined ($p$<0.001).

When comparing overall change, participation in the extended immersive simulation game was associated with significantly greater improvement in senior pharmacy students' perceptions of their professional competencies for seven of the 26 standards (Standards 1.3, 3.2, 3.4, 3.5, 3.6, 4.6 and 4.7) and two of the five domains (Domains 1 and 3), compared to the intervention group. The most significant change ($p$ < 0.001) was observed for Domain 3 *Medicines management and patient care*. The cumulative difference in mean change for all competencies was also statistically significant (Table 2).

Table 2: Comparison of mean pre- and post-Likert responses and mean change of individual Likert responses in senior pharmacy student competencies

| | | BPharm [a] **Game** | | | | | MPharm [b] **No Game** | | | | BPharm [a] **Game** | | MPharm [b] **No Game** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Likert Pre- | | Likert Post- | | | Likert Pre- | | Likert Post- | | Likert Pre-Post Change | | Likert Pre-Post Change | | Change Diff.[c] | Change Diff. 95% CI |
| | n | M | SD | M | SD | n | M | SD | M | SD | M | SD | M | SD | | |
| ***Domain 1 Professionalism and ethics*** | *83* | *3.69* | *0.65* | *4.25* | *0.61* | *48* | *3.78* | *0.65* | *4.15* | *0.64* | *3.41* | *2.90* | *2.13* | *2.73* | ***1.26*** | ***(0.27, 2.30)*** [d] |
| Standard 1.1 Uphold professionalism in practice | 85 | 4.01 | 0.50 | 4.41 | 0.56 | 49 | 4.08 | 0.53 | 4.34 | 0.59 | 0.40 | 0.64 | 0.27 | 0.61 | 0.14 | (-0.09, 0.36) |
| Standard 1.2 Observe and promote ethical standards | 84 | 3.72 | 0.67 | 4.29 | 0.57 | 48 | 3.88 | 0.53 | 4.24 | 0.48 | 0.56 | 0.73 | 0.35 | 0.64 | 0.14 | (-.0.05, 0.46) |
| Standard 1.3 Practise within applicable legal framework | 85 | 3.68 | 0.68 | 4.26 | 0.58 | 49 | 3.76 | 0.66 | 4.04 | 0.64 | 0.58 | 0.71 | 0.29 | 0.74 | **0.29** | **(0.04, 0.55)** [d] |
| Standard 1.4 Maintain and extend professional competence | 85 | 3.73 | 0.61 | 4.27 | 0.54 | 49 | 3.76 | 0.63 | 4.20 | 0.61 | 0.54 | 0.70 | 0.43 | 0.71 | 0.12 | (-0.14, 0.36) |
| Standard 1.5 Apply expertise in professional practice | 84 | 3.44 | 0.65 | 4.05 | 0.71 | 50 | 3.62 | 0.60 | 4.00 | 0.64 | 0.61 | 0.82 | 0.38 | 0.73 | 0.23 | (-0.05, 0.51) |
| Standard 1.6 Contribute to continuous improvement in quality and safety | 85 | 3.54 | 0.65 | 4.22 | 0.64 | 50 | 3.64 | 0.63 | 4.10 | 0.61 | 0.68 | 0.86 | 0.46 | 0.68 | 0.22 | (-0.06, 0.50) |
| ***Domain 2 Communication and collaboration*** | *79* | *3.84* | *0.62* | *4.37* | *0.66* | *49* | *3.82* | *0.78* | *4.26* | *0.63* | *2.06* | *2.55* | *1.67* | *2.08* | *0.39* | *(-0.47, 1.25)* |
| Standard 2.1 Collaborate and work in partnership for the delivery of patient-centred, culturally responsive care | 84 | 3.91 | 0.59 | 4.40 | 0.64 | 50 | 3.90 | 0.74 | 4.24 | 0.59 | 0.50 | 0.81 | 0.34 | 0.72 | 0.16 | (-0.12, 0.44) |
| Standard 2.2 Collaborate with professional colleagues | 82 | 3.76 | 0.59 | 4.43 | 0.61 | 50 | 3.88 | 0.85 | 4.30 | 0.58 | 0.66 | 0.84 | 0.42 | 0.81 | 0.24 | (-0.06, 0.53) |
| Standard 2.3 Communicate effectively | 84 | 3.94 | 0.64 | 4.38 | 0.68 | 49 | 3.80 | 0.74 | 4.18 | 0.70 | 0.45 | 0.74 | 0.45 | 0.77 | 0.00 | (-0.26, 0.27) |
| Standard 2.4 Apply interpersonal communication skills to address problems | 84 | 3.76 | 0.63 | 4.25 | 0.71 | 50 | 3.76 | 0.72 | 4.28 | 0.61 | 0.49 | 0.95 | 0.52 | 0.74 | -0.03 | (-0.34, 0.28) |
| ***Domain 3 Medicines management and patient care*** | *80* | *3.51* | *0.72* | *4.18* | *0.66* | *47* | *3.78* | *0.74* | *4.12* | *0.74* | *4.06* | *2.96* | *2.17* | *2.36* | ***1.89*** | ***(0.89, 2.90 )*** [f] |
| Standard 3.1 Develop a patient-centred, culturally responsive approach to medication management | 85 | 3.59 | 0.71 | 4.27 | 0.68 | 47 | 3.79 | 0.66 | 4.22 | 0.65 | 0.68 | 0.88 | 0.45 | 0.83 | 0.24 | (-0.07, 0.55) |
| Standard 3.2 Implement the medication management strategy or plan | 84 | 3.27 | 0.68 | 4.19 | 0.66 | 50 | 3.58 | 0.79 | 4.06 | 0.74 | 0.92 | 0.92 | 0.48 | 0.76 | **0.44** | **(0.13, 0.74)** [e] |
| Standard 3.3 Monitor and evaluate medication management | 85 | 3.16 | 0.69 | 4.11 | 0.62 | 50 | 3.28 | 0.70 | 3.98 | 0.71 | 0.94 | 0.85 | 0.70 | 0.81 | 0.24 | (-0.05, 0.54) |
| Standard 3.4 Compound medicines | 85 | 3.62 | 0.80 | 3.92 | 0.71 | 50 | 3.98 | 0.80 | 4.00 | 0.81 | 0.29 | 0.84 | 0.02 | 0.59 | **0.27** | **(0.03, 0.52)** [d] |
| Standard 3.5 Support Quality Use of Medicines | 82 | 3.69 | 0.58 | 4.18 | 0.61 | 50 | 3.96 | 0.61 | 4.16 | 0.65 | 0.50 | 0.74 | 0.20 | 0.67 | **0.30** | **(0.05, 0.55)** [d] |
| Standard 3.6 Promote health and well-being | 84 | 3.74 | 0.64 | 4.41 | 0.60 | 50 | 4.00 | 0.61 | 4.32 | 0.65 | 0.68 | 0.73 | 0.32 | 0.62 | **0.36** | **(0.11, 0.60)** [e] |
| ***Domain 4 Leadership and management*** | *80* | *3.28* | *0.89* | *3.95* | *0.75* | *49* | *3.36* | *0.87* | *3.74* | *0.91* | *4.74* | *4.90* | *3.41* | *4.10* | *1.33* | *(-0.33, 2.99)* |
| Standard 4.1 Show leadership of self | 82 | 3.73 | 0.77 | 4.15 | 0.67 | 50 | 3.76 | 0.77 | 4.06 | 0.71 | 0.40 | 0.90 | 0.30 | 0.76 | 0.10 | (-0.20, 0.41) |
| Standard 4.2 Manage professional contribution | 85 | 3.69 | 0.77 | 4.16 | 0.63 | 50 | 3.72 | 0.67 | 3.98 | 0.69 | 0.47 | 0.92 | 0.26 | 0.83 | 0.21 | (-0.10, 0.52) |
| Standard 4.3 Show leadership in practice | 84 | 3.38 | 0.78 | 3.99 | 0.78 | 49 | 3.32 | 0.77 | 3.90 | 0.92 | 0.61 | 0.90 | 0.57 | 0.89 | 0.04 | (-0.28, 0.36) |
| Standard 4.4 Participate in organisational planning and review | 85 | 3.25 | 0.86 | 4.05 | 0.74 | 50 | 3.18 | 0.98 | 3.74 | 0.88 | 0.80 | 1.06 | 0.56 | 0.97 | 0.24 | (-0.12, 0.60) |
| Standard 4.5 Plan and manage physical and financial resources | 85 | 2.96 | 0.92 | 3.75 | 0.82 | 50 | 2.92 | 0.92 | 3.58 | 0.86 | 0.79 | 1.03 | 0.66 | 1.06 | 0.13 | (-0.24, 0.49) |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard 4.6 Plan, manage and build human resource capability | 85 | 2.86 | 0.89 | 3.67 | 0.84 | 50 | 2.76 | 0.80 | 3.20 | 0.95 | 0.81 | 1.02 | 0.44 | 1.03 | **0.37** | **(0.01, 0.73)** [d] |
| Standard 4.7 Participate in organisational management | 84 | 3.06 | 0.86 | 3.91 | 0.61 | 50 | 3.00 | 0.90 | 3.46 | 0.84 | 0.85 | 0.93 | 0.46 | 0.99 | **0.39** | **(0.05, 0.72)** [d] |
| ***Domain 5 Education and research*** | *81* | *2.96* | *0.88* | *3.79* | *0.71* | *50* | *3.11* | *0.93* | *3.76* | *0.77* | *2.49* | *2.58* | *1.88* | *2.18* | *0.61* | *(-0.25, 1.48)* |
| Standard 5.1 Deliver education and training | 84 | 2.82 | 0.88 | 3.74 | 0.76 | 50 | 2.82 | 0.98 | 3.58 | 0.88 | 0.93 | 1.06 | 0.76 | 1.08 | 0.17 | (-0.21, 0.55) |
| Standard 5.2 Research, synthesise and integrate evidence into practice | 82 | 3.20 | 0.84 | 3.82 | 0.71 | 50 | 3.40 | 0.86 | 3.84 | 0.68 | 0.61 | 0.93 | 0.44 | 0.86 | 0.17 | (-0.15, 0.49) |
| Standard 5.3 Participate in research | 85 | 2.86 | 0.88 | 3.80 | 0.65 | 50 | 3.08 | 0.83 | 3.84 | 0.66 | 0.94 | 0.97 | 0.68 | 1.02 | 0.26 | (-0.09, 0.61) |
| ***All Domains*** | *67* | *3.48* | *0.81* | *4.12* | *0.70* | *44* | *3.58* | *0.83* | *3.99* | *0.79* | *17.00* | *13.00* | *11.45* | *8.61* | ***5.55*** | ***(1.14, 9.96)*** [d] |

[a] Bachelor of Pharmacy
[b] Master of Pharmacy
[c] Change Diff. = mean of the difference (post- minus pre-) of each individual's Likert scale scores
[d] $p < 0.05$; [e] $p < 0.01$; [f] $p < 0.001$.

In 2018, ten students (five BPharm intervention and five MPharm comparison students) provided comments regarding their processes for self-assessing competency. Students in both groups described self-assessing competency in terms of reflecting on past actions and current abilities, while also connecting to their future vision of their practice:

*It's mostly based on how I worked and how I see myself working in the future.* P120 MPharm

*I've… been able to reflect back, but also reflect forward and, sort of, have a goal that in the future I'd like to be even better than where I am now.* P157 BPharm

*I think about how I am currently but I think at the same time I'm reflecting on how I was and where I want to be.* P158 BPharm

Overall, there were no obvious differences detected between the intervention and comparison groups in their approaches to self-assessment of competency.

Mean course grades were compared for the pharmacy practice and pharmacotherapeutics courses in the final semester for each cohort. The BPharm intervention students earned higher mean grades for each course for every year of the study. The differences in grades were statistically significant ($p$<0.001) for the pharmacotherapeutics courses in all three years but were not significant for pharmacy practice (Table 3).

Table 3: BPharm and MPharm Mean Grades for Final Semester Courses

| | Pharmacy Practice | | | | Pharmacotherapeutics | | | |
|---|---|---|---|---|---|---|---|---|
| | BPharm | | MPharm | | BPharm | | MPharm | |
| | **Game** | | **No Game** | | **Game** | | **No Game** | |
| | M | SD | M | SD | M | SD | M | SD |
| Year 1: 2016-2017 | 6.08 | 0.86 | 5.86 | 1.07 | 5.96 | 0.69 | 4.91 | 0.92 |
| Year 2: 2017-2018 | 5.65 | 1.09 | 5.16 | 1.08 | 5.83 | 0.81 | 4.75 | 1.03 |
| Year 3: 2018-2019 | 6.10 | 0.56 | 5.53 | 1.25 | 6.10 | 0.60 | 4.59 | 1.06 |

Course grades out of 7 with the range between 4 and 7 corresponding to 50% to 100%

## Discussion

Participation in an extended, immersive, gamified simulation positively influenced pharmacy students' perceptions of their professional competencies to a greater extent than those undertaking a traditional final semester of study. The competencies enhanced by students' education and experience are those qualities, including skills, attitudes, values and beliefs, that they will carry into the pharmacy profession, enabling them to practice effectively.[2] The gamified simulation may have also enhanced students' learning and outcomes, as demonstrated by higher mean course grades earned by the BPharm intervention cohort for pharmacy practice and pharmacotherapeutics courses in all years of the study. The study's findings add robust evidence to support gamified simulation, or serious gaming, as an ideal mode of competency-based teaching and assessment in pharmacy programs and reinforces the efficacy of the specific gamified simulation adapted from the University of Groningen.[1, 27, 28]

The pre- and post- assessment demonstrated that the MPharm comparison students had higher self-assessed perceptions of their competence at the start of the final semester, which reversed by the end of semester, at which time the BPharm intervention students had higher self-assessed perceptions of their competence. Perhaps the MPharm students initially considered themselves more confident as they would have been an older cohort, as necessitated by enrollment in a post-graduate degree. However, as the greatest difference between the programs was the inclusion of the gamified simulation in the BPharm program, the greater change in the BPharm cohort can be attributed to their immersion in the extended simulation. This demonstrates the alignment with the intended learning outcomes of the activity, which include enhanced competence, confidence, communication and collaboration[26, 30] and is consistent with the outcomes of the Pharmacy Game implemented in other universities.[1, 28]

When comparing the means for intervention and comparison groups, based on the change in individual students' Likert scale responses, the intervention group demonstrated statistically significant improvement in their self-assessed competence for all domains combined, two of the five domains and seven of the 26 competency standards. Examining the individual change scores assisted in identifying areas where the greatest benefits of the simulation were reported for the population under evaluation. The impact of this change on the students flowed through to enhanced work readiness and improvements in confidence, communication and collaboration, which were outcomes supported by complementary research.[30] The BPharm students also demonstrated higher mean change for 24 of the 26 competency standards, compared to MPharm students. The greatest improvement in the intervention group's competencies was for Domain 3: *Medicines management and patient care*, with positive improvement in four of its six standards. These were focused on implementing medication plans (3.2), compounding medicines (3.4), supporting the quality use of medicines (3.5), and promoting health and well-being (3.6). These outcomes could be linked to both planned and *ad hoc* component activities of the gamified simulation, and the very nature of student participation. For example, greater improvement in competence to implement medication plans likely resulted from students' exposure to different complex clinical cases and pharmaceutical care planning each day in the simulation. This aligns with previous research in physiotherapy education, which identified a full-time, immersive simulation-based activity as a beneficial environment for exposing students to complex clinical cases, facilitating the transition from university-based education to professional clinical work.[32] Greater improvement in supporting quality use of medicines and promoting health and well-being emerged from the authenticity of the simulation and the autonomy that individuals and teams had when making decisions and planning activities inside the simulation. Students having autonomy to practice is motivating and aligns with self-determination theory, creating an environment for competence to develop.[1, 33] *Ad hoc* student-led activities that evolved in the simulation included health promotion activities that aligned with the game context, such as development of influenza prevention posters or meningococcal awareness brochures by the team, when such cases presented in the simulation. This finding reinforces research that identified games and simulation as potential learning tools to support a health promotion pedagogy.[34] Furthermore, the nature of student participation in the gamified simulation enhanced active learning and required participants to push themselves to behave like pharmacists and teach others, performing to a higher level of competence when viewed in the context of Miller's (1990)[35] framework for clinical assessment.

The Domain 4: *Leadership and management* standards that revealed significantly greater improvement in the intervention group were related to human resource capability (4.6) and organisational management (4.7). It appeared that the gamified simulation provided an important opportunity for students to conduct themselves in pharmacy-based teams and to learn to manage their individual human resources and overall team dynamics. These are skills enhanced by the authenticity of the simulation and might be challenging to learn in other ways. The evident opportunities to improve leadership and management competencies in the gamified simulation reinforces preliminary research conducted by the University of Nottingham, on their cogently similar pharmacy simulation.[36-39] Domain

1: *Professionalism and ethics* revealed significantly greater improvement in the intervention group for all standards combined and for the standard related to practising within a legal framework (1.3). Practicing legally is an issue that was emphasized throughout both programs, in students' respective pharmacy practice courses. The intervention students were evidently impacted to a greater degree when legal practice was authentically simulated. The gamified aspects of the activity reinforced consequences of legal practice, and any failure to comply with jurisdictional legislation in medicines provision incurred game penalties. This finding is consistent with the acknowledged advantage of serious games in pharmacy education, in that students can learn from errors without having to experience any lasting negative consequences, which provides a potentially powerful educational tool.[40]

While not statistically significant, the intervention group demonstrated numerically higher mean change scores for Domain 5: *Education and research* and its three component standards (5.1, 5.2 and 5.3), even though the comparison cohort undertook a major team-based research project for the entire duration of their final semester, whereas the intervention students undertook a minor team-based research project within the confines of the simulation. Similarly, the intervention group demonstrated higher mean change scores for Domain 2: *Communication and collaboration* and for two of its four component standards (2.1 and 2.2). Standards 2.1 and 2.2 both involved collaboration and their trends toward improvement in the intervention group potentially demonstrates that the gamified simulation may contribute to the learning outcome of enhancing participant collaboration. This is an important consideration as effective collaboration is not only a key element of the Australian and other competency frameworks but is recognized as essential to multidisciplinary practice.[8, 11, 41]

The study also explored the use of an online tool to self-assess professional competencies, which is consistent with professional expectations for Australian pharmacy graduates.[15] The tool allowed pre- and post- self-assessment by senior pharmacy students in two distinct degree programs. While previous research has questioned the value of competency self-assessment in pharmacy education and practice,[18, 19, 23] the findings of this study suggest that self-assessment against a structured competency framework may reveal insightful results. Competency self-assessment is an important skill for professional practice and lifelong learning[18] and perhaps implementation of competencies self-assessment in pharmacy students would better prepare them for more accurate and reflective self-assessment as practising professionals.

*Strengths and limitations*

A major strength of this study was the high response rate over the three-year study. The opportunity to conduct a comparative trial in education is uncommon. As the trial was conducted within the same School of Pharmacy, students had similar entry requirements. Other than the gamified simulation (in BPharm) and the semester-long team research project (in MPharm), students were exposed to comparable teaching practices and course content from the same academic staff, limiting the influence of these elements. Furthermore, the consistency of results year on year adds strength to our findings. The outcomes are broadly translatable to others, given the focus on skills and capabilities, rather than country-specific knowledge.

This study was conducted at a single Australian university, based on the *National Competency Standards Framework for Pharmacists in Australia*, and as such may have limited applicability in other contexts. That said, there is much commonality between the Competency Standards of Australia and other countries.[11, 42, 43] The Australian adaptation of the gamified simulation was designed to comply with Australian healthcare legislation, prescribing requirements and medicines availability and subsidies; therefore, these findings may not be generalisable to other countries. A further limitation of the study was the relatively small sample size. While the response rate was high, and enough students participated to generate statistically significant results in relation to some competencies, larger samples may have overcome type II errors and revealed wider impacts of the gamified learning activity. The comparison of grades between the intervention and comparison cohorts needs to be viewed with caution as the different cohorts did not undertake identical assessments. As grades are multifactorial, changes in grades can not solely be attributed to participation in the gamified simulation.

The qualitative component of the study revealed no difference in the approach to self-assessment of competencies between the intervention and comparison groups. Participants considered both current abilities and their future vision of practice when self-assessing. This is a potential area for further research, to determine whether a standardized and globally applicable self-assessment tool could be developed that might be applied at different time points of practice.

**Conclusions**

An extended, gamified pharmacy simulation, conducted as a capstone activity, allows students to learn by experience and from consequences in a safe environment, enhancing the development of their self-assessed professional competencies.

**Acknowledgements**

The researchers are grateful to the pharmacy students who participated in this study. Their time, self-reflection and honest self-assessment were most appreciated.

## References


1. Koster A, Schalekamp T, Meijerman I. Implementation of competency-based pharmacy education (CBPE). *Pharmacy*. 2017;5(1):10. doi:https://doi.org/10.3390/pharmacy5010010

2. Katoue MG, Schwinghammer TL. Competency-based education in pharmacy: A review of its development, applications, and challenges. *Journal of Evaluation in Clinical Practice*. 2020;doi:https://doi.org/10.1111/jep.13362

3. Volmer D, Sepp K, Veski P, Raal A. The implementation of pharmacy competence teaching in Estonia. *Pharmacy*. 2017;5(2):18. doi:https://doi.org/10.3390/pharmacy5020018

4. Croft H, Gilligan C, Rasiah R, Levett-Jones T, Schneider J. Current trends and opportunities for competency assessment in pharmacy education–a literature review. *Pharmacy*. 2019;7(2):67. doi:https://doi.org/10.3390/pharmacy7020067

5. Nash RE, Chalmers L, Brown N, Jackson S, Peterson G. An international review of the use of competency standards in undergraduate pharmacy education. *Pharmacy Education*. 2015;15. https://pharmacyeducation.fip.org/pharmacyeducation/article/view/324

6. Nash R, Chalmers L, Stupans I, Brown N. Developing lifelong learning skills: Using a traffic light report to promote competency standards and self-assessment among pharmacy undergraduates. *Ensuring Quality in Professional Education Volume I*. Springer; 2019:209-240.doi:https://doi.org/10.1007/978-3-030-01096-6_10

7. Bruno A, Bates I, Brock T, Anderson C. Towards a global competency framework. *American Journal of Pharmaceutical Education*. 2010;74(3)doi:https://doi.org/10.5688/aj740356

8. Bruno-Tomé A, Ortner Hadžiabdić M, Mucalo I, Rennie T. Competency (and Beyond): Think Patient. Collaborate. Develop. Evaluate. Improve. Repeat. *Pharmacy*. 2019;7(4):146. doi:https://doi.org/10.3390/pharmacy7040146

9. International Pharmaceutical Federation. Pharmacy Education Taskforce - A Global Competency Framework. Accessed 10 May 2022, https://www.fip.org/files/fip/PharmacyEducation/GbCF_v1.pdf

10. Al-Haqan A, Smith F, Bader L, Bates I. Competency development for pharmacy: Adopting and adapting the Global Competency Framework. *Research in Social and Administrative Pharmacy*. 2020;doi:https://doi.org/10.1016/j.sapharm.2020.06.023

11. Arakawa N, Yamamura S, Duggan C, Bates I. The development of a foundation-level pharmacy competency framework: An analysis of country-level applicability of the Global Competency Framework. *Research in Social and Administrative Pharmacy*. 2020;16(3):396-404. doi:https://doi.org/10.1016/j.sapharm.2019.06.007

12. Stupans I, Atkinson J, Meštrović A, Nash R, Rouse MJ. A shared focus: comparing the Australian, Canadian, United Kingdom and United States pharmacy learning outcome frameworks and the global competency framework. *Pharmacy*. 2016;4(3):26. doi:https://doi.org/10.3390/pharmacy4030026

13. Pharmaceutical Society of Australia. National Competency Standards Framework for Pharmacists in Australia. Accessed 10 May 2022, https://www.psa.org.au/wp-content/uploads/2018/06/National-Competency-Standards-Framework-for-Pharmacists-in-Australia-2016-PDF-2mb.pdf

14. Australian Health Practitioner Regulation Agency. AHPRA and National Boards - Continuing professional development. Accessed 10 May 2022, https://www.ahpra.gov.au/Registration/Registration-Standards/CPD.aspx

15. Pharmacy Board of Australia. Registration Standard: Continuing Professional Development. Accessed 10 May 2022, http://www.pharmacyboard.gov.au/Registration-Standards.aspx

16. Australian Pharmacy Council Ltd. Accreditation Standards, Performance Outcomes Framework and Supporting Documents. Accessed 10 May 2022, https://www.pharmacycouncil.org.au/resources/pharmacy-program-standards/

17. Davis DA, Mazmanian PE, Fordis M, Van Harrison R, Thorpe KE, Perrier L. Accuracy of physician self-assessment compared with observed measures of competence: a systematic review. *Journal of the American Medical Association*. 2006;296(9):1094-1102. doi:https://doi.org/10.1001/jama.296.9.1094

18. Motycka CA, Rose RL, Ried LD, Brazeau G. Self-assessment in pharmacy and health science education and professional practice. *American Journal of Pharmaceutical Education* 2010;74(5):85. doi:https://doi.org/10.5688/aj740585

19. Austin Z, Gregory PAM. Evaluating the accuracy of pharmacy students' self-assessment skills. *American Journal of Pharmaceutical Education* 2007;71(5):89. doi:https://doi.org/10.5688/aj710589

20. Colbert-Getz JM, Fleishman C, Jung J, Shilkofski N. How do gender and anxiety affect students' self-assessment and actual performance on a high-stakes clinical skills examination? *Academic Medicine* 2013;88(1):44-48. doi:https://doi.org/10.1097/ACM.0b013e318276bcc4

21. Blanch-Hartigan D. Medical students' self-assessment of performance: results from three meta-analyses. *Patient Education and Counseling* 2011;84(1):3-9. doi:https://doi.org/10.1016/j.pec.2010.06.037

22. Gordon MJ. A review of the validity and accuracy of self-assessments in health professions training. *Academic Medicine* 1991;66(12):762-9. doi:https://doi.org/10.1097/00001888-199112000-00012

23. Austin Z, Gregory PAM, Galli M. "I just don't know what I'm supposed to know": Evaluating self-assessment skills of international pharmacy graduates in Canada. *Research in Social and Administrative Pharmacy*. 2008;4(2):115-124. doi:https://doi.org/10.1016/j.sapharm.2007.03.002

24. Hirsch AC, Parihar HS. A capstone course with a comprehensive and integrated review of the pharmacy curriculum and student assessment as a preparation for advanced pharmacy practice experiences. *American Journal of Pharmaceutical Education* 2014;78(10):Article 192. doi:https://doi.org/10.5688/ajpe7810192

25. Harden RM. What is a spiral curriculum? *Medical Teacher*. 1999;21(2):141-143. doi:https://doi.org/10.1080/01421599979752

26. Hope DL, Grant GD, Rogers GD, King MA. Integration of an Extended, Immersive, Gamified Pharmacy Simulation as a Capstone Event. *Pharmacy Education*. 2021;21(1):656-669. doi:https://doi.org/10.46542/pe.2021.211.656669

27. van der Werf JJ, Dekens-Konter J, Brouwers JRBJ. A new model for teaching pharmaceutical care services management. *Pharmacy Education*. 2004;4(3-4):165-169. doi:https://doi.org/10.1080/15602210400013368

28. Fens T, Dantuma-Wering CM, Taxis K. The Pharmacy Game-GIMMICS® a Simulation Game for Competency-Based Education. *Pharmacy*. 2020;8(198):1-15. doi:https://doi.org/10.3390/pharmacy8040198

29. Deci EL, Ryan RM. Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology*. 2008;49(3):182-185. doi:https://doi.org/10.1037/a0012801

30. Hope DL, Rogers GD, Grant GD, King MA. Experiential learning in a gamified pharmacy simulation: a qualitative exploration guided by semantic analysis. *Pharmacy*. 2021;9(81):1-12. doi:https://doi.org/10.3390/pharmacy9020081

31. Ogrinc G, Armstrong GE, Dolansky MA, Singh MK, Davies L. SQUIRE-EDU (Standards for QUality Improvement Reporting Excellence in Education): publication guidelines for educational improvement. *Academic Medicine*. 2019;94(10):1461-1470. doi:https://doi.org/10.1097/ACM.0000000000002750

32. Wright A, Moss P, Dennis DM, et al. The influence of a full-time, immersive simulation-based clinical placement on physiotherapy student confidence during the transition to clinical practice. journal article. *Advances in Simulation*. February 20 2018;3(1):3. doi:https://doi.org/10.1186/s41077-018-0062-9

33. Mylrea MF, Sen Gupta T, Glass BD. Developing professional identity in undergraduate pharmacy students: a role for self-determination theory. *Pharmacy*. 2017;5(2):16. doi:https://doi.org/10.3390/pharmacy5020016

34. Oomen-Early J, Early AD. Teaching in a millennial world: Using new media tools to enhance health promotion pedagogy. *Pedagogy in Health Promotion*. 2015;1(2):95-107. doi:https://doi.org/10.1177/2373379915570041

35. Miller GE. The assessment of clinical skills/competence/performance. *Academic Medicine*. 1990;65(9):S63-7. https://journals.lww.com/academicmedicine/abstract/1990/09000/the_assessment_of_clinical.45.aspx

36. Boyd M, Solanki V, Anderson C, Sonnex K, Brydges S. Pharmacy Leadership and Management module: An evaluation of the student experience and its perceived usefulness for future employment. *Pharmacy Education*. Pharmacy Education, 2017; 17(1) 270; 2017;17(1):270. https://pharmacyeducation.fip.org/pharmacyeducation/article/view/590

37. Boyd M, Solanki V, Anderson C, Sonnex K, Brydges S. Pharmacy Leadership and Management: A new high fidelity simulation to prepare students for their future practise. *Pharmacy Education*. , 2017; 17(1) 284; 2017;17(1):284. https://pharmacyeducation.fip.org/pharmacyeducation/article/view/590

38. Solanki V, Boyd M, Anderson C, Sonnex K, Brydges S. Using performance and leadership mentors to support students during a simulated pharmacy business module. *Pharmacy Education*.

Pharmacy Education, 2017; 17(1) 291-292; 2017;17(1):291-292. https://pharmacyeducation.fip.org/pharmacyeducation/article/view/590

39. Solanki V, Boyd MJ, Sonnex K, Brydges S, Anderson C. Pharmacy Leadership and Management: student perspectives of team-working in a simulated pharmacy business module. *Pharmacy Education*. Pharmacy Education, 2017; 17(1) 185; 2017;17(1):185. https://pharmacyeducation.fip.org/pharmacyeducation/article/view/577

40. Chang YH, Poh HDY, Wong LL, Yap GJY, Yap Y-LK. Student Preferences on Gaming Aspects for a Serious Game in Pharmacy Practice Education: A Cross-Sectional Study. *JMIR Medical Education*. 05/11 2015;1(1):e2. doi:https://doi.org/10.2196/mededu.3754

41. Benson H, Lucas C, Benrimoj SI, Williams KA. The development of a role description and competency map for pharmacists in an interprofessional care setting. *International Journal of Clinical Pharmacy*. 2019;41(2):391-407. doi:https://doi.org/10.1007/s11096-019-00808-4

42. Saseen JJ, Ripley TL, Bondi D, et al. ACCP clinical pharmacist competencies. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*. 2017;37(5):630-636. doi:https://doi.org/10.1002/phar.1923

43. General Pharmaceutical Council. Standards for pharmacy education. Accessed 10 May 2022, https://www.pharmacyregulation.org/education/education-standards