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The application of reusable learning objects (RLOs) in preparation for a simulation laboratory in medication management: An evaluative study

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ABSTRACT

To enhance the preparedness of undergraduate nursing and midwifery students to participate in the safe provision of medication administration on their clinical placements, an innovative blended learning strategy was designed and developed by the authors. The blended learning strategy included a suite of online reusable learning objects specific to medication management theoretical knowledge and psychomotor skills to prepare students for a 90-minute practical face to face simulation laboratory session. Students identified that the reusable learning objects had prepared them for the simulation laboratory session and was rated as a productive learning experience. The blended learning strategy implemented to teaching and learning medication management to undergraduate nursing and midwifery students can positively influence students' acquisition of knowledge and psychomotor skills to safely administer medications prior to their practice placements in a clinical setting.

Introduction

Medication management is "patient-centered care that optimizes safe, effective, appropriate drug therapy" (Canadian Pharmacists Association et al., 2012). Medication management encompasses the way medications are procured, prescribed, stored, administered, and reviewed to administer medications in practice safely and to ensure that medicines have the desired outcomes on patient care (Roulston & Davies, 2021). Medication management care is provided through multidisciplinary professional collaboration and with the patients (World Health Organization, 2019). Over the past 10 years, medication management within the clinical practice of Nursing and Midwifery has undergone significant changes nationally and internationally. It now includes the capacity for independent prescribing and the primary responsibility for preparing and administering medicines to the patients (Nursing and Midwifery Board of Ireland, 2020).

A rise of reported medication errors has been observed, resulting in reformed medication management practices. A medication error can be defined as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer" (National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP), 2020). Medication errors can occur at any stage of administering medicines, from prescribing, dispensing, preparing, and administering medicines, to monitoring their effects, and, therefore, are a multidisciplinary issue (Pentin et al., 2016). Nurses and midwives play a central role in the medication management cycle, and they are well-positioned to identify and prevent actual and potential medication errors. The Asensi-Vicente et al. (2018) systematic review examining medication errors involving undergraduate nursing students identified a high incidence of error was observed and most commonly at the administration phase of medication management. Students reported feelings of fear, anxiety, and loss of confidence after making an error. Therefore, nursing and midwifery students must receive adequate education, training, practice experience, support, and supervision to achieve the standards associated with medication management (NMBI, 2020).

Educators have shifted from traditional didactic lectures (passive learners) to student-centered active learning techniques (experiential learning) to promote greater medication management competency in undergraduate nurses and midwives. The theory of experiential learning seeks to define education as a result of the knowledge gained through experience, emphasizing the essential role that experience plays in learning (Kolb & Kolb, 2009). The paradigm shift to student-centered active learning has resulted in

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teaching practices that align with constructivist learning theory. Piaget's (1970, as cited in Mayes & Freitas, 2004) principles of constructivism state knowledge is constructed, rather than innate, or passively absorbed. Therefore, in constructivism, students are encouraged to learn through active engagement by linking new information with existing information, to form new knowledge or understanding of the concept's meaning (O'Donnell et al., 2015).

The conceptual change in nursing and midwifery education, along with the increased use of technology, has resulted in innovative and transformative pedagogical approaches, including technology-assisted blended learning strategies and simulation-based learning. Blended learning has been defined as "any combination of face-to-face instruction with technology-mediated instruction" (Leidl et al., 2020). Recent scoping reviews (Jowsey et al., 2020; Leidl et al., 2020) describe a comprehensive and diverse range of approaches to blended learning integrating face to face interaction with technology-mediated interaction in nursing education. Most noticeably, reporting a positive impact of blended learning approaches on student engagement, satisfaction, skills acquisition, and knowledge retention.

One such application emerging in the literature in facilitating technology-assisted blended learning is reusable learning objects (RLOs). RLOs are described as digital educational resources which are self-contained and reusable (Onofrei & Ferry, 2020). RLOs are modifiable, specifically their context, content, and learning activities to meet specified learning outcomes (Wiley, 2000). RLOs deliver small units of learning that can be accessed at any time, in any location via the internet (Khan et al., 2019). RLOs involve interactive endeavors for autonomous learning, including self-test elements (Windle & Wharrad, 2010). RLOs can accommodate different learning styles by including interactive features to present theoretical content and depict real-life scenarios (Brown et al., 2019). There is a growing body of knowledge on the use of RLOs being utilized in a variety of contexts in nursing education, including pharmacology (Lymn et al., 2008), wound care (Redmond et al., 2018), and injection skills teaching (Williams et al., 2015). These studies suggest that RLOs can provide nursing students with authentic learning materials that can supplement the teaching of complex skills and promote autonomous learning.

Simulation is a learning technique that aims to replicate real-world events to help attain specific learning goals (Weller et al., 2012). It creates an opportunity to recreate and perform a task as close as possible to real-life in a safe learning environment (Rutherford-Hemming & Alfes, 2017). Simulation supports students to develop a greater understanding of how to manage an event if it occurred in clinical practice, consequently building their confidence (Labrague et al., 2019). To date, several studies have investigated the application of simulation to the field of medication management, including simulating possible medication errors rates among critically ill patients (Ford et al., 2010), simulating the use of electronic administration records (Chan et al., 2019), simulating interruptions during medication administration (Hayes et al., 2017), and simulated medication rounds (Harris et al., 2014). Results demonstrate a positive impact on student learning, creating authentic learning experiences that permit students to deepen their understanding of the concepts related to medication management through deliberate, safe practice in a controlled simulated environment.

Considering evolving pedagogical practices, revised standards for Nursing curriculum (NMBI, 2016) and medication administration (NMBI, 2018, 2020), faculty at an Irish University set out to create an effective and practical new approach to undergraduate teaching and learning medication management.

Aim of the study

The authors created an innovative blended learning program to provide Nursing and Midwifery students with the knowledge and skills to carry out safe medication management practices during their clinical experiences. The blended learning program consists of a series of online RLOs, followed by a face-to-face simulation laboratory. To the best of the authors' knowledge, no study has been conducted examining the standalone use of RLOs in preparation for a practical simulation laboratory in medication management. Therefore, to address this gap, this study sets out to examine the following research questions:

What is the students' evaluation of a blended learning strategy that utilized RLOs and simulation as an active pedagogy for medication management?

Does the application of online RLOs prepare students for a face-to-face practical simulation laboratory?

Methodology

Design and setting

Described here is a descriptive, evaluative cross-sectional pilot study. This study was undertaken in a large University in Ireland, which offered undergraduate degree programs across Nursing and Midwifery. The newly developed educational package was incorporated into a core shared module in year 2 of the programs as part of the curriculum due to new and updated guidance for medication management (NMBI, 2018, 2020) and improve student's learning experience.

Development of the RLOs

The introduction of the RLOs was intended to promote flexible and autonomous learning online to support the face-to-face simulation-based teaching on campus. One key driver for developing a suite of RLOs for this project was creating bespoke online content that complemented the knowledge and skills required to actively participate in the simulation laboratories, hopefully providing a seamless transition from theory to practice. The RLOs were designed and developed by a multidisciplinary team of instructional designers consisting of faculty members and a clinical expert. The systematic approach established by Windle and Wharrad (2010) in developing the RLOs in five phases was followed.

Phase 1: (Scoping workshop): Consisted of establishing the characteristics and potential use of RLOs. The team established the learning units (independent, self-standing learning content) required to meet the desired learning outcomes set by NMBI (2016, 2020) and agreed on each unit's specific learning goals (2–3 per unit). The team established and decided on the following learning units listed in Table 1. Discussions on the deliverables required to achieve the desired learning objectives occurred. A project timeline of 6 months was established, considering the authors' tasks, dependencies, and requirements for the teaching units for the following trimester of teaching.

Table 1
Utilization of the reusable learning objectives.

	Accessed once		Accessed more than once	
	N	%	*N*	%
1. Professional practice and legislation	151	90.4	79	47.3
2. Medication record	162	97	101	60.5
3. Oral administration	161	96.4	107	64.1
4. Intramuscular administration	159	95.2	135	80.8
5. Subcutaneous administration	160	95.8	133	79.6
6. Per rectum administration	152	91	98	58.7
7. Medication calculations	141	84.4	112	67.1

Note: This table demonstrates the utilization of the reusable learning objects by students. Indicating a high percentage of student engagement with the RLOs.

Phase 2: (Iterative development): The RLOs were then storyboarded by team members using PowerPoint. The content was derived from the latest international evidence-based professional practices (HIQA, 2015; NMBI, 2018, 2020; WHO, 2019). Each storyboard was then peer-reviewed by the team for accuracy and appropriateness of the material using the learning object review instrument (LORI) (Vargo et al., 2003). The overall design, usability, motivation, learning goal alignment, and quality of the content to ensure it was suitable for all four programs was reviewed. Along with the theoretical content, students' opportunity to engage with activities such as multiple-choice questions, drag and drop exercises to promote practice, feedback, and reflection were embedded in the RLOs. This element was also reviewed from a technical perspective by the team to ensure its feasibility and suitability.

Phase 3: (Media development stage): Creating the required media for the RLOs. Step 1 included scripting, filming, and editing a series of short procedural videos and creating computer-generated infographics and images. The authors used a combination of real equipment and theatrical film props, that is, retractable effect needle and syringe, to create authentic procedural videos without injecting the actors. Step 2 included scripting and recording the voiceover for the individual RLO slides. Step 3 required the amalgamation of all the components into a Shared Content Reference Model (SCORM) software package: Articulate©. This approach was chosen as SCORM RLO files are compatible with most major Virtual Learning Environment (VLEs; Reece, 2016).

Phase 4: (Content and quality review): All RLO units were then peer-reviewed by an external expert (BM) with the lead author (PH) during a design workshop to ensure the detail and scaffolding of content was suitable to clarify the concepts of each RLO learning objectives, and the RLO interface and user experience were optimal.

Phase 5: (Release of the RLOs): Finally, the completed SCORM units were uploaded to the VLE Brightspace© and launched for students to access. The individual units were released to the students every week for 7 consecutive weeks prior to the simulation laboratory in the module's 8-week. Each unit typically took the students 10–15 minutes to complete except for Unit 7 medication calculations which took students approximately 60 minutes to complete. Figs. 1–3 demonstrate sample screenshots from the RLOs.

Development of the simulation laboratory

The simulation scenarios' design was led by an academic with a specialist background in simulation-based education and patient safety (SB) and peer-reviewed by the remaining authors. Applying the International Nursing Association for Clinical Simulation and Learning (INACSL) (2016) framework, the authors considered design criteria such as creating a simulation experience that can achieve measurable objectives, is participant-centered and incorporates a level of fidelity that creates a perception of realism to the simulated scenario.

An online prebrief pack that identified the simulation's goals and objectives, the student's expected role and the expected role of the facilitators was designed and uploaded in the VLE before the simulation workshop. Each session lasted 1.5 hours, with a ratio of 12 students to 1 facilitator per room. The simulation commenced with a prebriefing by the facilitator. Each scenario involved a combination of clinical reasoning combining technical and nontechnical skills. Students rotated through each station and alternated between the role of patient and nurse, lasting approximately 8 minutes each time. At station one, the student had to determine what oral medications to administer, carry out drug calculations and dispense a liquid medicine and a tablet correctly. Station two involved subcutaneous medication administration for pain management, drawing up and administering the medication correctly using a task trainer and safely disposing of sharps. Station three consisted of intramuscular medication for nausea management, drawing up and administering the medication correctly using a task trainer and safely disposing of sharps. Following the simulations, a 20-minute debriefing session took place with the students, led by the facilitator using the SHARP Debrief Tool (Imperial College London, 2013).

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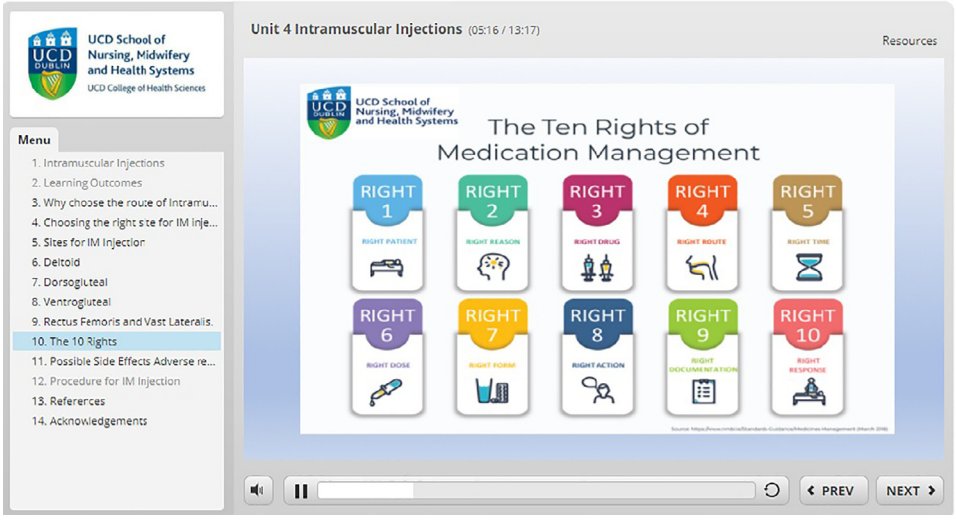

Fig. 1. Screenshot of RLO demonstrating the 10 Rights of Medication Management .

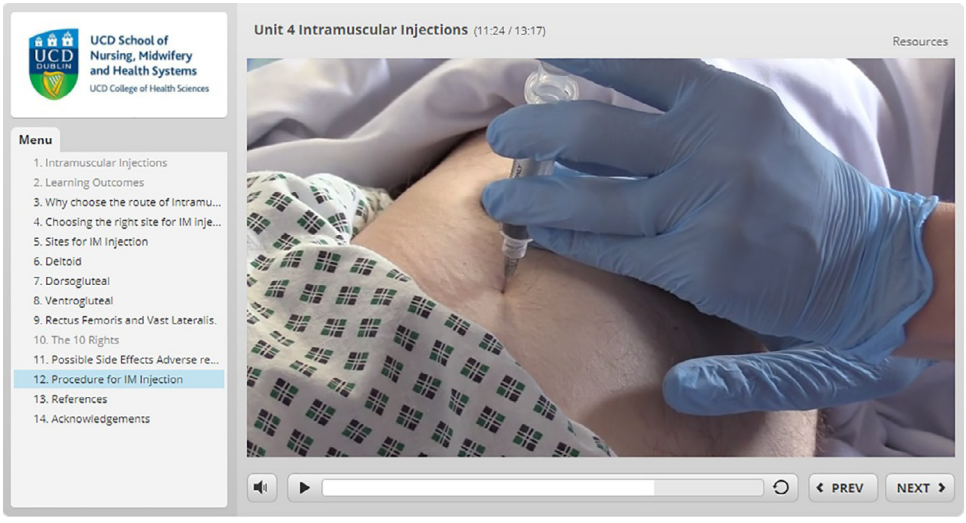

Fig. 2. Screenshot of Ventrogluteal Injection using theatrical movie props.

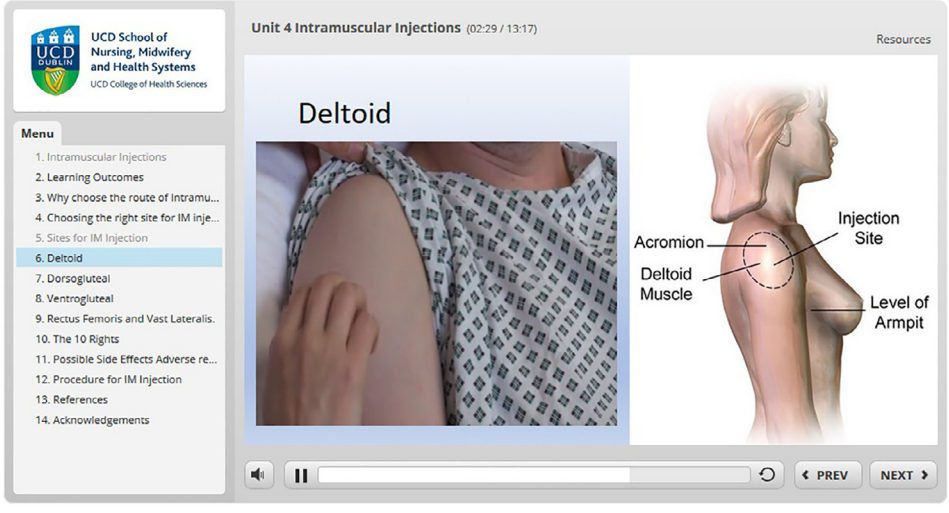

Fig. 3. Screenshot of mapping correct site for Deltoid injection.

administer, carry out drug calculations and dispense a liquid medicine and a tablet correctly. Station two involved subcutaneous medication administration for pain management, drawing up and administering the medication correctly using a task trainer and safely disposing of sharps. Station three consisted of intramuscular medication for nausea management, drawing up and administering the medication correctly using a task trainer and safely disposing of sharps. Following the simulations, a 20-minute debriefing session took place with the students, led by the facilitator using the SHARP Debrief Tool (Imperial College London, 2013).

Survey instruments and procedure

For student's evaluation, an anonymous questionnaire was created, adapting two validated tools, an Evaluation Toolkit for RLOs and Deployment of E-Learning Resources devised by the Centre for Excellence in Teaching and Learning for reusable learning objects (RLO-CETL; Wharrad et al., 2008) and Educational Practices Questionnaire (National League for Nursing, 2005). For this study, the authors adapted the questions to examine the purpose-built RLOs and simulation for medication management; for example, "The purpose and learning objectives of the medication management RLOs were clear"? The questionnaire consisted of 37 items, a mixture of both summative rating scale response options and open-ended responses. Testing of the adapted tool revealed a Cronbach alpha coefficient >0.7 for each item. For overall reliability, the internal consistency for the questionnaire was $\alpha = 0.82$. The results indicated the satisfactory level of construct validity and internal consistency of this modified questionnaire. Participants respond to each item by rating it on a five-point Likert scale (strongly disagree (1) and strongly agree (5). The mean of their replies signals the level of agreement of students to the questionnaire's statements. The questionnaire was offered to students using a web-based survey service for 1 week after exposure to the RLOs and completing the simulation laboratory.

Sample

Second year students from Bachelor of Science (BSc) General nursing, Children's and General nursing, Mental Health Nursing and Midwifery degree programs undertaking a core shared Patient Safety module in 2019 were invited to participate. Participants were encouraged to partake in the study at the end of a lecture. Students

Table 2
Attributes of the reusable learning objectives.

	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
1. Visual components, e.g., video contributed to student learning	112	71.3	43	27.4			1	0.6	1	0.6
2. Audio/commentary components contributed to student learning	91	58.3	60	38.5			4	2.6	1	0.6
3. The interactivity of the RLO's contributed to the student's learning	97	61.8	52	33.1			8	5.1		
4. The quizzes contributed to the student learning	113	72	43	27.4			1	0.6		
5. Having access anytime contributed to the student learning	124	79	33	21						
6. Having access anywhere contributed to the students learning	110	71	41	26.5			4	2.6		
7. Working at the student's own pace contributed to their learning	121	78.1	33	21.3			1	0.6		
8. Purpose and learning objectives was clear	92	56.4	66	40.5	5	3.1				
9. Learning objectives of the RLOs was pitched at the right level	78	47.6	81	49.4	4	2.4	1	0.6		
10. RLO's was easy to navigate	78	47.6	80	48.8	6	3.7				
11. RLO's introduced new concepts and language clearly	75	45.5	82	49.7	6	3.6	2	1.2		
12. RLO's allowed the student to meet the requirements of the module	86	54.1	66	41.5	4	2.5	3	1.9		
13. Using the RLO's helped the student to retain knowledge in the area of medication managemen	79	50	67	42.4	9	5.7	3	1.9		
14. Using the RLO's prepared the students for the simulation workshop	84	52.8	58	36.5	12	7.5	5	3.1		
15. Using the RLO's helped prepare the students for the administration of oral medication in the simulation workshop	76	47.8	67	42.1	16	10.1				
16. Using the RLO's helped prepare the students for the administration of injections	66	41.5	72	45.3	14	8.8	6	3.8	1	0.6

Note: This table highlights the attributes of the RLOs. Each row contains one attribute and how they rated in terms of student evaluation. Indicating a high percentage of student satisfaction with the RLOs.

were informed that their participation in the study was entirely voluntary. It would not impact their coursework or related grades for the module if they did not wish to participate. Students who did not want to partake would still receive the same educational resources as those taking part. This study comes within the category "educational evaluation" within our institution; therefore, the approval of an ethical exemption was granted by the University Ethics Committee. Students were then invited to complete an anonymous online questionnaire in which consent to partake in the study was detailed at the outset. Two hundred and ten students were offered participation in the study, with one hundred and sixty-seven students completing the questionnaire, resulting in a 79.5% response rate.

Data analysis

Quantitative data were analyzed using the Statistical Package for Social Sciences (SPSS version 24). Descriptive data analysis was utilized to examine the percentage distribution of each item based on their responses to the questionnaire's statements (PH, KC). Qualitative data were collected via open-ended responses within the survey. A deductive thematic analysis using Braun and Clarke's (2006) six-phase framework was applied: Step 1: Familiarization, Step 2: Deductive coding, Step 3: Generating themes, Step 4: Reviewing themes, Step 5: Defining and naming themes, Step 6: Writing up as a framework was applied. The authors (PH, AM, PD) applied a top-down approach to identify key themes and select key quotations to illustrate the key findings to address the research questions listed above.

Results

Demographic data

Most of the participants were Irish (90.4%), female (92.2%), aged 18–24 (82.5%). All participants were in stage two of their program, with 60.2% undertaking a General Nursing degree, 20.5% Children's and General Nursing, 9.6% Mental Health Nursing and 9.6% Midwifery program.

Evaluation of a blended learning strategy

Overall, implementing the blended learning strategy that incorporated a suite of RLOs and simulation laboratory as an educational tool for medication management was reported positively by the students. The authors will discuss the results below.

Evaluation of the RLO's

Table 1 presents the utilization of the RLOs by the students indicating a high percentage of student engagement with the RLOs. Of the sixteen attributes examined of the RLO, over 90% of students "strongly agreed or agreed" with all attributes (Table 2). The ability to access the RLOs anytime ranked the highest quality, with 79% strongly agree ($n = 124$) and 21% agree ($n = 33$). One student commented "*I enjoyed being able to work at my own pace, and I also like that I can review all the material at any time, I can take notes by just pausing the video. However, in lectures, if I miss something, I'm often too intimidated to ask for the lecturer to repeat!*." About 98% ($n = 155$) of students ranked the visual components and quizzes embedded in the RLO as positive contributors to student learning. Students evaluated the RLOs positively regarding meeting the module's learning requirements, with 54.1% strongly agree ($n = 86$), and 41.5% agree ($n = 66$). A small percentage of 2% ($n = 3$) responded negatively toward the attributes of the RLOs.

Evaluation of the simulation laboratory

Similarly, students rated attributes of the simulation laboratory positively overall. Table 3 exhibits the simulation laboratory's evaluation. About 94% ($n = 143$) reported simulation offered an assortment of methods to learn about medication management and medications administration. About 96.1% of students further testified that the simulation laboratory provided a productive learning experience with ($n = 99$) strongly agreeing and ($n = 46$) agreeing with the statement. Other positive attributes included self-reported knowledge retention and building of confidence (96.7% $n = 147$), identification of clinical strengths and weaknesses (98% $n = 149$), and the simulation laboratory was overall a valuable learning experience by 94.4% ($n = 149$). A

Table 3
Attributes of the simulation workshop.

	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
1. The learning objectives of the simulation workshop were clear and easy to understand	93	61.2	54	35	4	2.6	1	0.7		
2. The student learnt from the comments made by the facilitator before, during and after the simulation	94	61.8	50	32.9	5	3.3	3	2		
3. The simulation offered a variety of ways to learn about medication management and administration of medication	87	57.2	56	36.8	6	3.9	3	2		
4. Students found role play with their peers beneficial	95	62.5	46	30.3	8	5.3	3	2.0		
5. Simulation made students learning time more productive	99	65.6	46	30.5	4	2.6	2	1.3		
6. Simulation enhanced student confidence and retention of knowledge to preform skills in the clinical setting	95	62.5	52	34.2	4	2.6	1	0.7		
7. Students had the opportunity to reflect and discuss their performance during the debriefing session	90	59.2	56	36.8	5	3.3	1	0.7		
8. Students found reflecting and discussing the simulation enhanced their learning	84	55.3	58	38.2	9	5.9	1	0.7		
9. Simulation helped students recognize their clinical strengths and weaknesses	92	60.5	57	37.5	3	2.0				
10. The simulation activity stimulated the students' interest in learning medication management and administration	97	63.8	53	34.9	2	1.3				
11. The simulation was a valuable learning experience	94	61.8	55	32.6	3	2.0				

Note: This table highlights the attributes of the Simulation workshop. Each row contains one attribute and how they rated in terms of student evaluation. Indicating a high percentage of student satisfaction with the simulation workshop.

marginal percentage of 2% ($n = 3$) responded negatively to the simulation laboratory. Students commented positively on learning and practicing medication administration skills in the simulation laboratory instead of learning in the online environment. "*I certainly would prefer to have more clinical hands-on experience with the equipment. I do not feel I learn as well online*." One student was very direct in their preference for learning in the simulation laboratory versus the online environment, "*more labs less video*." There were no comments from students saying the online environment could substitute learning in the simulation laboratory. The live experience element was articulated by several students (7.1% $n = 12$) again concerning receiving feedback on their skills. Having the facilitator present, providing feedback on the spot was valuable for students. One student commented, "*To be told what you're doing wrong as you go along so you know it's specific to you.*"

Using RLOs for preparation for simulation laboratory

Overall, most of the students 89.3% ($n = 142$) reported the RLOs prepared them for the simulation laboratory, with 89.9% ($n = 143$) of students reporting the RLOs helped prepare them for oral medication administration, and 86.8% ($n = 138$) reporting the RLOs helped prepare them for the administration of injections. Students said that learning about medication management through the RLO made it easier to put the theoretical information into practice in the simulation laboratory, "*It was great to apply the knowledge we acquired through the information and videos online*." However, a minority of 4.4% ($n = 7$) students either disagreed or strongly disagreed that the RLOs prepared them for administering an injection in the simulation laboratory. While the students had an opportunity to watch the skills associated with medication management through the RLOs, some students (8.9% $n = 15$) reported that they would still like the skill to be demonstrated again in real-time in the simulation laboratory before they undertake the skill. Some of the comments included: "*Completing one run-through of each station by the instructor to help reassure students*" and "*the live demonstrations would assist the students with aspects such as positioning of patients*." One student commented on the difference between watching a video and the live situation of watching someone hold the equipment; "*I feel that a practice clinical skills lab is needed as it is very different to handle equipment, then it is to watch someone else on a video do it*." "*I felt like we needed to be thought [taught] in a lab setting how actually to use the needles, i.e., taught about what to use when*. . .." Some students indicated that video demonstrations could not replace the live experience of seeing the skill demonstrated in front of them. Another student suggested, *"Provide a demonstration after the students first attempt at injections to ensure the correct practice is carried out then allow the student to practice."* Students could test their knowledge of medication administration via the RLOs interactive quizzes before coming to the simulated laboratory; however, they expressed a need for live feedback of their psychomotor skills.

Discussion

Medication management is an integral aspect of patient safety (World Health Organization, 2017). Students must incrementally develop their medication management competency as they progress through their undergraduate program (Nursing and Midwifery Board of Ireland, 2016). Nevertheless, for many students, a comprehensive understanding of medication management can be challenging to achieve due to the complexity of knowledge and skills required, including medication administration, medication calculations and pharmacology (Lee & Quinn, 2019; Mackie & Bruce, 2016; Thomas & Schuessler, 2016). Often leading to stress and a lack of confidence in the student's ability to perform safe medication practices (Goodwin et al., 2019; Moloney et al., 2020). Nurse educators, therefore, have a responsibility to provide effective educational interventions that promote the development of nursing and midwifery students' knowledge and skills for medication management.

Overall, the students responded positively to integrating the RLOs as part of the module, reporting the RLOs provided a suitable educational tool to effectively meet the learning outcomes of the individual units created by the authors. Similar results were established by Redmond et al. (2018) and Williams et al. (2015), in which students perceived learning gains in terms of achieving the prescribed learning outcomes and retention of knowledge following the active participation with the RLOs. In this study, attributes of the RLOs, such as the interactivity and self-test elements, rank high in terms of the students learning. These findings support previous research by Redmond et al. (2018) and Williams et al. (2015) which also found that the assessment/self-test exercises embedded in the RLOs contributed positively to students' development of knowledge and nursing skills. It allows students to assess their understanding and knowledge as they progress through the RLOs (Clinton, 2018). Equally, students highly valued the opportunity to repeatedly access the RLOs either at home or on campus, working in their own time in this study. The flexibility for students to actively engage in their studies at a time

and pace that suits them through the application of RLOs has also been observed in several studies to have a positive impact on their learning (Blake, 2010; Lymn et al., 2008; Onoferi & Ferry, 2020). In general, the evidence from this study and the wider literature suggests the implementation of RLOs as a positive student-centered pedagogy in nursing education.

Byrant et al. (2020) maintain that simulation as a pedagogy enhances students' opportunity to consolidate and apply theoretical content and develop essential skills such as clinical judgment and decision-making skills, which are essential in performing safe medication management practices. Therefore, implementing simulated scenarios based on medication management and patient safety is essential to develop safe medication management practices among students. Overall, the implementation of the simulation laboratory as a teaching strategy for medication management was evaluated positively and a valuable learning experience by the students who participated in this study, a finding similar to others that adopted this approach (Chan et al., 2019; Edwards et al., 2019; Ford et al., 2010; Harris et al., 2014; Hayes et al., 2017; Sarfati et al., 2019). Furthermore, students reported a building of confidence in their knowledge and skills by identifying clinical strengths and weaknesses during the simulation experiences. Comparable results have been found by Chan et al. (2019), Edwards et al. (2019), Ford et al. (2010), Sarfati et al. (2019), who reported that students felt the simulation had a positive impact on their confidence and their perceived ability to carry out safe medication administration. However, further research is required to examine if the students perceived level of confidence transpires into the clinical practice setting. In this study, some students stated that the simulation laboratories were an excellent means of reinforcing their understanding of the material covered in the RLOs.

Finally, this study examines students' perceived preparedness for a simulation laboratory on medication management following engagement with a series of bespoke RLOs. To the best of the authors' knowledge, this study provides a unique insight into the blended learning approach to medication management. Overall, most students reported high levels of satisfaction and readiness to actively participate in the simulation laboratories following engagement with the online RLOs. The findings suggest that RLOs positively impacted their knowledge, with the majority reporting that the RLOs helped prepare the students for the simulated experience of administering medication either orally or by injection. These findings support previous research by Redmond et al. (2018) that implemented a series of RLOs as a blended learning tool in conjunction with a traditional clinical skills workshop on wound care. Students reported an increase in their ability to grasp subject material covered in the clinical skills labs following engagement with the RLOs.

Interestingly, analysis of the qualitative data gathered suggested that a minority of students did not feel prepared for the simulation laboratory after completing the RLOs. Despite exposure to online learning, a minority of students felt nothing could replace the simulation laboratory's live engagement in terms of demonstration and feedback. Therefore, while the medication management RLOs were positively received and students reported a perceived preparedness for the simulation laboratory, the authors would recommend implementing RLOs as a supplement and not a substitute for face-to-face teaching. A blended learning strategy, including online teaching in conjunction with simulation-based education, is recommended by the authors for medication management education and training. This supports similar findings by Williams et al. (2015) that advocate integrating RLOs into the curriculum as an additional educational tool to support face-to-face teaching. This teaching strategy promotes active student-centered learning that permits students to work in their own time in conjunction with a face-to-face experiential learning experience.

Limitations

This was a moderate scale descriptive cross-sectional pilot study centered on a convenience sample from one university that relied on students self-reporting. Objective measures of knowledge and skills improvement were not gathered, and no control group was implemented to compare receiving traditional didactic lectures to RLOs on preparedness for simulation laboratories. Given that students were recruited from year 2 of the program, it is possible that students from years 3 or 4 could evaluate the educational package differently following increased exposure to medication management during their clinical experiences. Further research is required before the generalization of results. The authors also acknowledge that the lack of end-user (student representative) in the design process for both the RLOs and simulation is a limitation to the design approach. Student involvement in the design process could have provided greater insight into students' existing knowledge and feedback on the interface and user experience. Notwithstanding these limitations, this pilot study offers valuable insights into students' perspective of engaging with the unique blended learning strategy. Furthermore, it informs the planning and design of a larger-scale study.

Conclusion

Medication management is an integral part of nursing and midwifery practice and involves the safe and effective use of medicines in clinical practice. Hence, it is essential to consider the educational preparation of nursing and midwifery students in medication management. This study's findings support using a blended learning strategy that incorporates a suite of RLOs and a practice simulation laboratory for medication management teaching and learning. With universities worldwide redesigning the curriculum's delivery due to the COVID-19 pandemic, blended learning is becoming a new normal. The authors of this project have continued to implement the blended learning approach of online RLOs, followed by face-to-face simulation or clinical skills workshop throughout the global pandemic to date with positive results. The authors believe blended learning will continue to play a significant part in nursing education.

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Ethical approval

This study comes within the category “educational evaluation” within our institution; therefore, ethical exemption approval was granted by the University ethics committee (Reference NO: LS-E-19-138-Hardie).

Declaration of Competing Interest

None.

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