

การรับรู้วัตถุประสงค์การเรียนรู้และความพึงพอใจของนักศึกษาเภสัชศาสตร์ต่อการฝึกงาน การควบคุมคุณภาพ/การประกันคุณภาพรูปแบบออนไลน์ แบบที่แหล่งฝึก และแบบผสม

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บทคัดย่อ

การรับรู้วัตถุประสงค์การเรียนรู้และความพึงพอใจของนักศึกษาเภสัชศาสตร์ต่อการฝึกงานการควบคุมคุณภาพ/การประกัน
คุณภาพรูปแบบออนไลน์ แบบที่แหล่งฝึก และแบบผสม

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การระบาดโรคติดเชื้อไวรัสโคโรนา 2019 (COVID-19) ส่งผลกระทบต่อการศึกษาเภสัชกรรมอุตสาหกรรม ซึ่งมีการปรับรูปแบบของกิจกรรมตามเงื่อนไขของนักศึกษาและอาจารย์แหล่งฝึก การบรรลุวัตถุประสงค์ของการฝึกงานมีความบกพร่องได้ การศึกษานี้มีวัตถุประสงค์เพื่อทำความเข้าใจประสบการณ์การฝึกงานในช่วงการระบาดของโรคติดเชื้อไวรัสโคโรนา 2019 (COVID-19) คณะเภสัชศาสตร์จำเป็นต้องปรับรูปแบบการฝึกงานด้านเภสัชกรรมอุตสาหกรรมให้สอดคล้องกับสถานการณ์และข้อจำกัดของแหล่งฝึก ที่ส่งผลต่อการรับรู้การบรรลุวัตถุประสงค์การเรียนรู้และความพึงพอใจของนักศึกษา **วิธีดำเนินการวิจัย:** สุ่มแบบภาคตัดขวางดำเนินการจากนักศึกษาที่ฝึกงานด้านการควบคุมคุณภาพ/การประกันคุณภาพ (QA/QC) ในปีการศึกษา 2563 – 2564 ซึ่งเป็นช่วงที่ได้รับผลกระทบจากการแพร่ระบาดของโรค คัดเลือกกลุ่มตัวอย่างตามสะดวก (Convenience Sampling) นักศึกษาฝึกงานจาก 5 สถาบันที่ตอบแบบสำรวจแบ่งออกเป็นฝึกงานออนไลน์ ($n = 31$) ฝึกงานที่แหล่งฝึก ($n = 118$) และฝึกงานแบบผสม ($n = 155$) แบบสอบถามประเมินการฝึกงาน QA/QC ใน 3 ด้าน ดังนี้ ด้าน 1 คือ ความรู้และความเข้าใจของระบบประกันคุณภาพ กฎหมาย แนวปฏิบัติที่ดี และมาตรฐานสากล ด้าน 2 คือ ความรู้ความเข้าใจของคุณสมบัติ การตรวจสอบ และการสอบเทียบ และด้าน 3 คือ การควบคุมคุณภาพตลอดกระบวนการการผลิต วิธีการวิเคราะห์ การตรวจสอบคุณภาพยาตามตำรับยา และเครื่องมือสำหรับตรวจสอบคุณภาพ วิเคราะห์ข้อมูลการศึกษาด้วยสถิติเชิงพรรณนา และวิเคราะห์สถิติโดยใช้ One-way ANOVA และ Chi-Square test **ผลการวิจัย:** การฝึกงานออนไลน์เป็นการฝึกแบบพึ่งคำบรรยาย แต่การฝึกงานที่แหล่งฝึกและแบบผสมสามารถดำเนินการฝึกแบบมีส่วนร่วมและได้ฝึกปฏิบัติด้วยตนเอง ซึ่งสอดคล้องการรับรู้ในระดับสูงของการบรรลุวัตถุประสงค์การฝึกงาน การรับรู้การบรรลุวัตถุประสงค์การเรียนรู้ 17 ข้อ ในจำนวน 18 ข้อ ของด้าน 1 และทุกวัตถุประสงค์การเรียนรู้ของด้าน 2 และ 3 ได้รับผลกระทบอย่างมีนัยสำคัญ ($p < 0.05$) จากความแตกต่างกันของรูปแบบการฝึก การรับรู้การบรรลุวัตถุประสงค์ของการฝึกงานโดยรวม (ตั้งแต่ระดับเข้าใจถึงระดับประเมินได้) การฝึกงานของด้าน 1 อยู่ที่ 0.0% - 66.7%, 0.0% - 31.9% และ 0.0% - 38.8% จากการฝึกงานออนไลน์ ฝึกงานที่แหล่งฝึก และแบบผสม ตามลำดับ การรับรู้การบรรลุวัตถุประสงค์การฝึกงานของด้าน 2 อยู่ที่ 0.0% - 33.3%, 0.0% - 39.0% และ 0.0% - 38.8% จากการฝึกงานออนไลน์ ฝึกงานที่แหล่งฝึก และแบบผสม ตามลำดับ การรับรู้การบรรลุวัตถุประสงค์การฝึกงานของด้าน 3 อยู่ที่ 0.0% - 20.7%, 0.0% - 36.8%, และ 0.0% - 40.1% ของการฝึกงานออนไลน์ ฝึกงานที่แหล่งฝึก และแบบผสม ตามลำดับ นักศึกษามีความพึงพอใจไม่แตกต่างกันอย่างมีนัยสำคัญทางสถิติระหว่างการฝึกงานที่แหล่งฝึกและแบบผสม อย่างไรก็ตาม นักศึกษาที่ฝึกงานออนไลน์ส่วนใหญ่มีความพึงพอใจต่ำกว่านักศึกษาที่ฝึกงานที่แหล่งฝึกและแบบผสม อย่างมีนัยสำคัญทางสถิติ ($p < 0.05$) **สรุปผลการวิจัย:** นักศึกษาที่มีรูปแบบการฝึกงานที่ต่างกันส่งผลต่อการรับรู้การบรรลุวัตถุประสงค์การฝึกงานและความพึงพอใจ

คำสำคัญ: การฝึกงาน, โควิด-19, เภสัชกรรมอุตสาหกรรม, การรับรู้, ความพึงพอใจ



The perceived achievement of learning objectives and satisfaction among pharmacy students during control/quality assurance clerkships based on online, on-site, and hybrid platforms

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Abstract

The perceived achievement of learning objectives and satisfaction among pharmacy students during control/quality assurance clerkships based on online, on-site, and hybrid platforms

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The COVID-19 pandemic affected industrial pharmacy clerkships and the activities were adjusted regarding student and preceptor conditions. The achievement of clerkship learning objectives may be impaired. This study aimed to understand how the training experience during the pandemic affected the perception of achievement of learning objectives and student satisfaction. **Method:** A cross-sectional survey of students enrolling in quality control/quality assurance (QA/QC) clerkships during the 2020 – 2021 academic years that were affected by the pandemic was performed. Students from 5 institutions who responded to the survey were divided into online clerkships ($n = 31$), on-site ($n = 118$), and hybrid ($n = 155$), regarding convenience sampling. Questionnaires were designed to address three different domains of QA/QC clerkship, including D1, Knowledge and understanding of the quality assurance system, law, good practice guidelines, and international standards; D2, Knowledge and understanding of qualification, validation, and calibration, and D3, Quality control throughout the manufacturing process, analytical methods, pharmacopeia quality checks, and quality inspection instruments. Data were analyzed by descriptive statistics, and the statistics were analyzed using one-way ANOVA and the Chi-Square test. **Results:** Online clerkships can offer lecture-based clerkships, but on-site and hybrid clerkships can offer participation and hands-on training, which is associated with a higher perception of achievement of training objectives. Seventeen out of eighteen topics in D1 and all topics in D2-D3 of training-objective achievements were impacted significantly ($p < 0.05$) by different clerkship platforms. The overall perceptive achievement of the training objective of D1 (from understanding to evaluation) was 0.0% - 66.7%, 0.0% - 31.9% and 0.0% - 38.8% for online, on-site, and hybrid clerkship, respectively. The perceptive achievement of the training objective of D2 was 0.0% - 33.3%, 0.0% - 39.0% and 0.0% - 38.8% and those were in the range of 0.0% - 20.7%, 0.0% - 36.8%, and 0.0% - 40.1% for D3, based on online, on-site, and hybrid clerkships respectively. Student satisfaction is not significantly different between on-site and hybrid clerkships. However, student satisfaction with online clerkships in most aspects was lower than with on-site and hybrid clerkships, showing a statistically significant difference ($p < 0.05$). **Conclusion:** Different clerkship platforms impact students' perception of training objective achievement and satisfaction.

Keywords: clerkship, COVID-19, industrial pharmacy, perception, satisfaction



Introduction

The coronavirus (COVID-19) outbreak has had an impact on pharmaceutical education, including on-campus classes and clerkship training (Ashiq, Bajwa and Ashiq, 2021; Gavazva and Grekova, 2022). According to the Thai pharmacy program, the industrial pharmacy student clerkship takes place during the sixth academic year and aims to build skills and experiences in pharmaceutical manufacturing. Videos, online discussions, simulations, role-plays, and briefings were used in place of experiential learning sessions during the COVID-19 pandemic (Almetwazi *et al.*, 2020; Hope *et al.*, 2022; Nik Mohamed *et al.*, 2021). Addressing the impact of online clerkships during the COVID-19 pandemic would help provide the required preparation for continuing pharmacy education.

The pharmacy has accumulated 2000 practice hours. The five types of training required for industrial pharmacy clerkships include pharmaceutical production, quality control/assurance, research and development, registration of pharmaceuticals and health products, and research and development of herbal products. Practical training in pharmaceutical production and quality assurance/quality control (QA/QC) is compulsory under the Pharmacy Education Consortium of Thailand (PECT) administration. QA/QC clerkship aims for students to achieve knowledge and understanding of quality system guidelines, methods qualification, validation, calibration analysis, and quality inspection for manufacturing drugs and products. For a career in the pharmaceutical industry, the above-mentioned clerkships are essential for developing knowledge, skills, and confidence in the field, and understanding roles, duties, and responsibilities.

Online and face-to-face learning techniques were similarly beneficial for students learning basic patient counseling skills. Pharmacy students indicated that they preferred the blended learning strategy (Lean *et al.*, 2020). In another case, student clerks could meet the objectives of the online clinical pharmacy clerkship only regarding the retrospective case. Learning interpersonal skills with other

healthcare professionals was not feasible (Sha'aban *et al.*, 2020). Most students believed that face-to-face instruction would effectively convey the necessary skills from practical learning (Sha'aban, 2020). Although online learning was implemented during the COVID-19 pandemic, some learning objectives could not be achieved, especially interpersonal skills.

Training sites could not admit students for practice during the academic year 2020 – 2021 due to the COVID-19 pandemic. However, some students' clerkship used an online platform, where preceptors provided training for manual-related exercises similar to on-site practical training. All Thai institutions with pharmacy programs adhered to the same standards of practice set by the PECT. The QA/QC clerkship covered three domains: (1) the general regulation and good practices for QA/QC of pharmaceuticals and other health products; (2) qualification, validation, and calibration; and (3) production quality control, including equipment and product inspection. The effects of the COVID-19 pandemic on learning and clerkships should be examined through a cross-sectional survey approach. Continuous pharmacy education can be given regarding the impacted performances of those enrolled in QA/QC clerkships during the COVID-19 endemic.

This study aims to analyze how students' perception of achievement of training objectives of QA/QC clerkship was impacted by their training experience during the COVID-19 pandemic. By comparing three clerkship platforms (online, on-site, and hybrid), the study examines the level of clerkship training, perceptions of clerkship-objective achievement, and student satisfaction.

Methods

Sample and site

The study population included students who participated in the QA/QC clerkship during the COVID-19 pandemic (2020–2021 academic years). Thus the survey was done from January 10, 2022, to March 30, 2022, after



the QA/QC clerkship period ended. In Thailand, 19 institutes have pharmacy programs. Students participated from five universities in Thailand, which were selected from northeastern, central, and southern regions. The population of students enrolling in QA/QC clerkships from the five institutes was 575, including online, on-site, and hybrid modes of study. Convenience sampling was employed, and data was collected by google forms.

Questionnaire design

Demographics, clerkship training platforms, level of clerkship training, perception of objective clerkship achievement, and student satisfaction were all covered in the survey. The investigators developed the survey items based on PECT's guidelines and objectives for clerkship training. The final survey's validity was not checked. Cronbach-alpha, as previously mentioned, was used to measure the questionnaire's internal consistency and reliability (Abu Farha *et al.*, 2021; Chisholm-Burns *et al.*, 2021). All of the questions had appropriate Cronbach's alpha values (≥ 0.964). Gender, institution, the academic year of clerkship, and GPAX were some of the participant characteristics. Online, on-site, and hybrid training platforms were initially surveyed. Training for the QA/QC clerkship was divided into three domains following PECT guidelines. The first domain includes four objectives focusing on knowledge and understanding of quality systems, good practices, standards and procedures, and international standards connected to quality assurance and quality control in producing pharmaceuticals and healthcare goods. The second domain, which has five training objectives, deals with knowledge about qualification guidelines, validation, and calibration. The last domain involves understanding quality control throughout the manufacturing process, analytical methods, pharmacopeia quality inspection, and equipment used to check for quality. This domain included seven training objectives.

The questionnaire was created based on these training objectives. Participants' levels of clerkship training and perceived levels of training objective achievement were surveyed. For each topic, there were five levels of clerkship

training: no training (0), lecture (1), observation (2), participation (3), hands-on (4), and independent hands-on (5). In addition, the perceived level of achievement of learning objectives was broken down into four categories: recall (1), understanding (2), apply (3), analyze (4), and evaluation (5). The achievement was measured using Bloom's Taxonomy of Learning Objectives (Gogus, 2012).

The questionnaire included 18, 14, and 8 topics from domains 1–3 (D1–3), respectively. Regarding PECT guidelines, the training schedule and topics can be designed by the training site and preceptor; however, the main training objectives must be covered. The last section dealt with questions on satisfaction (13 questions). The questions were aimed to assess students' satisfaction with clerkship training, using questions involving the training site, content, and preceptor. The satisfaction questions were based on PECT training guidelines. A satisfaction survey was conducted on the training facility and instructor. Dissatisfied (0), least content (1), less satisfied (2), moderately satisfied (3), very satisfied (4), and most satisfied (5) were the different levels of satisfaction.

Statistical analysis: IBM® SPSS version 24.0 statistical package Chi-Square and One-way ANOVA were utilized for data analysis, where $p < 0.05$ was considered statistically significant. The descriptive statistics were used to analyze sociodemographic information and the levels of clerkship training obtained. The Chi-squared analysis was conducted to compare the perceptive achievement of training objectives between clerkship platforms. The static significance of student satisfaction was analyzed by one-way ANOVA followed by Scheffe.

Study period: The study duration was from January 10, 2022, to March 30, 2022.

Ethics approval

The Ethics Committee in Human Research Walailak University (WUEC-21-336-01) approved this study on December 3, 2021 (Students' evaluation of the course, aims achievement, and satisfaction with industrial pharmacy training methodologies were compared online and onsite during the Covid-19 endemic).



Results

Sociodemographic information

Based on the population of students enrolling in QA/QC clerkship in the study period, the total response rate was 52.9%. According to Table 1, 68.8% of the participants were female. The sample of the three clerkship platforms

included online clerkship (31, 10.2%), on-site clerkship (118, 38.8%), and hybrid clerkship (155, 51.0%). Most respondents enrolled in the clerkship in the 2021 academic year (May 7, 2021 to March 4, 2022).

Table 1 Demographic data of respondents

Background Profile		Frequency	
		<i>n</i>	%
Gender	Male	95	31.2
	Female	209	68.8
Grade point average (GPAX)	2.00-2.50	7	2.3
	2.51-3.00	79	26.0
	3.01-3.50	152	50.0
	3.51-4.00	66	21.7
Institutions	University #1	57	18.8
	University #2	90	29.6
	University #3	52	17.1
	University #4	56	18.4
	University #5	49	16.1
Academic year	2020	65	21.4
	2021	239	78.6
Clerkship platforms	Online clerkship	31	10.2
	On-site clerkship	118	38.8
	Hybrid clerkship of online and on-site	155	51.0

Achieved level of clerkship training

The online clerkships covered fewer training topics, even though not all of them were required, according to PECT. The achieved level of clerkship training was compared between three different platforms of clerkship (Table 2). The respondents with no training for D1, D2, and D3 topics were 26.5%, 28.4%, and 30.9%, respectively, observed in online clerkship. Thus, students with online training lack experience in many aspects, which results from inconvenient material transfer and confidentiality. In addition, QC training usually deals with equipment. Training activities on the online platform were lecture-based clerkship

(51.3%, 58.0%, and 39.8% for D1 – D3, respectively), in which the preceptor provided assignments for self-directed learning and discussion. For on-site clerkships, the training levels observed by lecture, observation, participation, and hands-on learning were 15.8% – 32.6%, 4.0 – 5.1%, 15.6% – 20.5%, and 13.1% – 28.5% for all domains, respectively. For hybrid clerkships, the lecture, observation, participation, and hands-on training levels were 16.7% – 30.7%, 14.4 – 18.9%, 16.0% – 20.6%, and 17.6% – 29.1% for all domains, respectively. The on-site and hybrid clerkship can provide training by participation and hands-on, as compared to online clerkship.

Table 2 Levels of clerkship training obtained by respondents

Domain	Platforms	Clerkship training (% of respondents, mean ± SD)†					
		No training	Lecture	Observation	Participation	Hands-on	independent hands-on
D1	Online (n=31)	26.5% (8.2±3.6)	51.3% (15.9±3.3)	13.4% (4.2±1.6)	5.9% (1.8±1.3)	1.1% (0.3±0.6)	1.8% (0.6±1.8)
	On-site (n=118)	18.8% (20.0±0.0)	22.9% (24.4±6.9)	5.1% (5.4±2.8)	20.5% (21.8±4.8)	19.1% (20.3±5.6)	13.5% (14.4±4.6)
	Hybrid (n=155)	13.2% (20.5±10.0)	25.1% (38.9±9.5)	18.9% (29.2±5.9)	18.1% (28.1±6.3)	19.3% (29.8±7.6)	5.5% (8.4±4.7)
D2	Online (n=31)	28.4% (8.8±2.4)	58.0% (17.9±2.8)	9.0% (2.8±0.7)	2.3% (0.7±0.8)	2.1% (0.6±0.6)	0.2% (0.1±0.3)
	On-site (n=118)	19.8% (21.4±9.2)	32.6% (35.1±8.4)	4.0% (4.3±1.9)	15.6% (16.9±4.2)	13.1% (14.1±5.6)	14.9% (16.1±5.4)
	Hybrid (n=155)	15.0% (23.4±7.3)	30.7% (48.0±11.6)	16.5% (25.7±6.6)	16.0% (25.1±4.2)	17.6% (27.5±7.9)	4.2% (6.5±2.5)
D3	Online (n=31)	30.9% (9.5±2.3)	39.8% (12.3±1.4)	3.7% (1.1±1.1)	8.1% (2.5±0.9)	12.2% (3.8±0.5)	5.3% (1.6±0.7)
	On-site (n=118)	11.5% (12.6±3.6)	15.8% (17.3±5.8)	4.1% (4.5±1.7)	19.3% (21.1±2.9)	28.5% (31.1±7.2)	20.8% (22.8±5.0)
	Hybrid (n=155)	10.6% (16.6±4.6)	16.7% (26.1±3.8)	14.4% (22.5±5.0)	20.6% (32.3±2.5)	29.1% (45.5±7.1)	8.6% (13.5±6.9)

† The mean ± SD of respondents number (n) of each level of clerkship training was calculated based on questions of each domain.

The perceptive achievement of training objectives

Training objectives of each topic in all domains were to understand the topic at the least (designed by PECT). The achievement of each training aspect is shown in Tables 3 – 5 for D 1 – 3, respectively. Seventeen of eighteen topics in D1 were impacted by different training platforms (Table 3). The overall perceptive achievement of the training objective (from understanding to evaluating) was

0.0% – 66.7%, 0.0% – 39.8%, and 0.0% – 38.8% for online, on-site, and hybrid clerkship, respectively. For on-site and hybrid clerkship, apply and analyze, results showed higher perceptive achievement. The perception of achievement at apply was 6.5% - 23.3%, 13.8% - 39.8%, and 17.8% - 36.8% for those enrolled in online, on-site, and hybrid clerkships, while perceptive achievement of training objective at analyze was 0.0% - 16.7%, 12.9% - 35.0%, and 7.2% - 24.7%, respectively (Table 3).



Table 3 Student perception of domain 1 training objective achievement by clerkship platforms

Training topics	Achieved training objective [n, (%)] [†]					
	Online (n = 31), on-site (n = 118), hybrid (n = 155)					
	Platform	Recall	Understanding	Apply	Analyze	Evaluation
Total quality management (TQM)	Online	21 (67.7%)	6 (19.4%)	2 (6.5%)	2 (6.5%)	0 (0.0%)
	Onsite	45 (38.8%)	33 (28.4%)	23 (19.8%)	15 (12.9%)	0 (0.0%)
	Hybrid	65 (42.5%)	46 (30.1%)	31 (20.3%)	11 (7.2%)	0 (0.0%)
Corrective action/preventive action system (CAPA)*	Online	17 (54.8%)	5 (16.1%)	6 (19.4%)	3 (9.7%)	0 (0.0%)
	Onsite	25 (21.4%)	27 (23.1%)	39 (33.3%)	26 (22.2%)	0 (0.0%)
	Hybrid	31 (20.1%)	47 (30.5%)	54 (35.1%)	22 (14.3%)	0 (0.0%)
Change management system*	Online	21 (67.7%)	7 (22.6%)	2 (6.5%)	1 (3.2%)	0 (0.0%)
	Onsite	36 (30.8%)	27 (23.1%)	37 (31.6%)	17 (14.5%)	0 (0.0%)
	Hybrid	39 (25.3%)	45 (29.2%)	52 (33.8%)	18 (11.7%)	0 (0.0%)
Quality risk management*	Online	14 (45.2%)	8 (25.8%)	6 (19.4%)	3 (9.7%)	0 (0.0%)
	Onsite	31 (26.5%)	27 (23.1%)	31 (26.5%)	27 (23.1%)	1 (0.9%)
	Hybrid	28 (18.1%)	52 (33.5%)	55 (35.5%)	19 (12.3%)	1 (0.6%)
Good Manufacturing Practices (GMP)*	Online	12 (38.7%)	8 (25.8%)	7 (22.6%)	3 (9.7%)	1 (3.2%)
	Onsite	15 (12.7%)	27 (22.9%)	47 (39.8%)	29 (24.6%)	0 (0.0%)
	Hybrid	23 (14.9%)	44 (28.6%)	55 (35.7%)	31 (20.1%)	1 (0.6%)
Good Laboratory Practices (GLP)*	Online	1 (3.3%)	20 (66.7%)	3 (10.0%)	5 (16.7%)	1 (3.3%)
	Onsite	0 (0.0%)	31 (26.5%)	34 (29.1%)	31 (26.5%)	21 (17.9%)
	Hybrid	0 (0.0%)	51 (34.0%)	49 (32.7%)	37 (24.7%)	13 (8.7%)
Good Delivery Practices (GDP)*	Online	17 (56.7%)	5 (16.7%)	7 (23.3%)	1 (3.3%)	0 (0.0%)
	Onsite	28 (24.3%)	36 (31.3%)	27 (23.5%)	24 (20.9%)	0 (0.0%)
	Hybrid	49 (32.2%)	59 (38.8%)	29 (19.1%)	15 (9.9%)	0 (0.0%)
Good Storage Practices (GSP)*	Online	23 (76.7%)	1 (3.3%)	5 (16.7%)	1 (3.3%)	0 (0.0%)
	Onsite	40 (34.5%)	37 (31.9%)	24 (20.7%)	15 (12.9%)	0 (0.0%)
	Hybrid	65 (42.8%)	49 (32.2%)	27 (17.8%)	11 (7.2%)	0 (0.0%)
ISO Standards*	Online	24 (77.4%)	1 (3.2%)	5 (16.1%)	1 (3.2%)	0 (0.0%)
	Onsite	35 (30.2%)	37 (31.9%)	27 (23.3%)	17 (14.7%)	0 (0.0%)
	Hybrid	55 (35.9%)	50 (32.7%)	35 (22.9%)	13 (8.5%)	0 (0.0%)
Procurement of raw materials and packing materials*	Online	21 (70.0%)	7 (23.3%)	2 (6.7%)	0 (0.0%)	0 (0.0%)
	Onsite	47 (40.5%)	27 (23.3%)	16 (13.8%)	26 (22.4%)	0 (0.0%)
	Hybrid	58 (38.2%)	51 (33.6%)	29 (19.1%)	14 (9.2%)	0 (0.0%)
Key process techniques and parameters that are controlled in production*	Online	17 (54.8%)	9 (29.0%)	5 (16.1%)	0 (0.0%)	0 (0.0%)
	Onsite	31 (26.3%)	25 (21.2%)	21 (17.8%)	41 (34.7%)	0 (0.0%)
	Hybrid	32 (20.8%)	47 (30.5%)	50 (32.5%)	24 (15.6%)	1 (0.6%)

Table 3 Student perception of domain 1 training objective achievement by clerkship platforms (*Continued*)

Training topics	Achieved training objective [n, (%)] [†]					
		Online (n = 31), on-site (n = 118), hybrid (n = 155)				
	Platform	Recall	Understanding	Apply	Analyze	Evaluation
Factors affecting the consistency of the drug*	Online	19 (65.5%)	6 (20.7%)	4 (13.8%)	0 (0.0%)	0 (0.0%)
	Onsite	31 (26.3%)	20 (16.9%)	28 (23.7%)	39 (33.1%)	0 (0.0%)
	Hybrid	32 (20.8%)	43 (27.9%)	45 (29.2%)	33 (21.4%)	1 (0.6%)
Chemical, physical, and biological stability*	Online	20 (66.7%)	6 (20.0%)	4 (13.3%)	0 (0.0%)	0 (0.0%)
	Onsite	38 (32.2%)	20 (16.9%)	24 (20.3%)	36 (30.5%)	0 (0.0%)
	Hybrid	35 (22.7%)	47 (30.5%)	43 (27.9%)	29 (18.8%)	0 (0.0%)
Control and monitoring of the production environment*	Online	16 (55.2%)	9 (31.0%)	4 (13.8%)	0 (0.0%)	0 (0.0%)
	Onsite	34 (29.1%)	20 (17.1%)	22 (18.8%)	41 (35.0%)	0 (0.0%)
	Hybrid	27 (17.4%)	46 (29.7%)	57 (36.8%)	24 (15.5%)	1 (0.6%)
Principles of analytical technology in the production process*	Online	22 (75.9%)	4 (13.8%)	3 (10.3%)	0 (0.0%)	0 (0.0%)
	Onsite	38 (32.2%)	22 (18.6%)	27 (22.9%)	31 (26.3%)	0 (0.0%)
	Hybrid	42 (27.3%)	53 (34.4%)	38 (24.7%)	20 (13.0%)	1 (0.6%)
Batch release process*	Online	20 (64.5%)	8 (25.8%)	3 (9.7%)	0 (0.0%)	0 (0.0%)
	Onsite	36 (30.5%)	20 (16.9%)	27 (22.9%)	35 (29.7%)	0 (0.0%)
	Hybrid	38 (25.0%)	46 (30.3%)	43 (28.3%)	23 (15.1%)	2 (1.3%)
Product quality review*	Online	22 (73.3%)	4 (13.3%)	4 (13.3%)	0 (0.0%)	0 (0.0%)
	Onsite	27 (23.1%)	35 (29.9%)	19 (16.2%)	36 (30.8%)	0 (0.0%)
	Hybrid	43 (28.1%)	37 (24.2%)	44 (28.8%)	29 (19.0%)	0 (0.0%)
Self-inspection*	Online	20 (66.7%)	5 (16.7%)	5 (16.7%)	0 (0.0%)	0 (0.0%)
	Onsite	36 (30.5%)	36 (30.5%)	22 (18.6%)	24 (20.3%)	0 (0.0%)
	Hybrid	48 (31.4%)	41 (26.8%)	40 (26.1%)	24 (15.7%)	0 (0.0%)

† Chi-squared analysis was conducted using SPSS, where $p < 0.05$ was considered significant as indicated by *.

For D2, all topics training objectives were impacted significantly by training platforms (Table 4). The overall perceptive achievement of the training objective (understanding to evaluating) was 0.0% – 33.3%, 0.0% – 39.0%, and 0.0% – 38.8%, for those enrolled in online, on-site, and hybrid clerkships, respectively. The perception of

achievement at apply was 0.0% - 20.0%, 7.8% - 24.8%, and 16.8% - 34.2% for those enrolled in online, on-site, and hybrid clerkships, while achievement at analyze was 0.0% - 6.5%, 14.5% - 29.7% and 7.1% - 16.1%, respectively. On-site and hybrid clerkships training produced the perception of higher-level learning achievement.

Table 4 Perceptive achievement of training objectives (domain 2) comparing different clerkship platforms

Training topics	Achieved training objective [n, (%)] [†]					
		Online (n = 31), on-site (n = 118), hybrid (n = 155)				
	Platform	Recall	Understanding	Apply	Analyze	Evaluation
Design qualification*	Online	16 (51.6%)	8 (25.8%)	5 (16.1%)	2 (6.5%)	0 (0.0%)
	Onsite	27 (22.9%)	46 (39.0%)	22 (18.6%)	23 (19.5%)	0 (0.0%)
	Hybrid	46 (30.3%)	58 (38.2%)	35 (23.0%)	13 (8.6%)	0 (0.0%)

Table 4 Perceptive achievement of training objectives (domain 2) comparing different clerkship platforms (*Continued*)

Training topics	Achieved training objective [n, (%)] [†]					
	Online (n = 31), on-site (n = 118), hybrid (n =155)					
	Platform	Recall	Understanding	Apply	Analyze	Evaluation
Installation qualification*	Online	15 (48.4%)	9 (29.0%)	6 (19.4%)	1 (3.2%)	0 (0.0%)
	Onsite	22 (18.6%)	37 (31.4%)	25 (21.2%)	34 (28.8%)	0 (0.0%)
	Hybrid	39 (25.7%)	59 (38.8%)	37 (24.3%)	17 (11.2%)	0 (0.0%)
Operational qualification*	Online	14 (46.7%)	10 (33.3%)	5 (16.7%)	1 (3.3%)	0 (0.0%)
	Onsite	20 (17.1%)	36 (30.8%)	29 (24.8%)	32 (27.4%)	0 (0.0%)
	Hybrid	38 (25.2%)	56 (37.1%)	35 (23.2%)	22 (14.6%)	0 (0.0%)
Performance qualification*	Online	14 (46.7%)	10 (33.3%)	5 (16.7%)	1 (3.3%)	0 (0.0%)
	Onsite	20 (17.1%)	42 (35.9%)	29 (24.8%)	26 (22.2%)	0 (0.0%)
	Hybrid	36 (23.8%)	57 (37.7%)	35 (23.2%)	23 (15.2%)	0 (0.0%)
Validation and validation master plan*	Online	19 (63.3%)	4 (13.3%)	6 (20.0%)	1 (3.3%)	0 (0.0%)
	Onsite	31 (27.2%)	28 (24.6%)	24 (21.1%)	31 (27.2%)	0 (0.0%)
	Hybrid	47 (30.9%)	56 (36.8%)	33 (21.7%)	16 (10.5%)	0 (0.0%)
Prospective validation*	Online	26 (86.7%)	3 (10.0%)	0 (0.0%)	1 (3.3%)	0 (0.0%)
	Onsite	64 (54.7%)	19 (16.2%)	17 (14.5%)	17 (14.5%)	0 (0.0%)
	Hybrid	71 (45.8%)	38 (24.5%)	29 (18.7%)	17 (11.0%)	0 (0.0%)
Concurrent validation*	Online	26 (86.7%)	3 (10.0%)	0 (0.0%)	1 (3.3%)	0 (0.0%)
	Onsite	66 (56.4%)	21 (17.9%)	11 (9.4%)	19 (16.2%)	0 (0.0%)
	Hybrid	77 (49.7%)	31 (20.0%)	30 (19.4%)	17 (11.0%)	0 (0.0%)
Retrospective validation*	Online	28 (96.6%)	1 (3.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Onsite	68 (58.6%)	21 (18.1%)	9 (7.8%)	18 (15.5%)	0 (0.0%)
	Hybrid	83 (53.5%)	35 (22.6%)	26 (16.8%)	11 (7.1%)	0 (0.0%)
Re-validation*	Online	23 (76.7%)	6 (20.0%)	1 (3.3%)	0 (0.0%)	0 (0.0%)
	Onsite	45 (38.5%)	32 (27.4%)	19 (16.2%)	21 (17.9%)	0 (0.0%)
	Hybrid	48 (31.2%)	55 (35.7%)	40 (26.0%)	11 (7.1%)	0 (0.0%)
Change control*	Online	18 (60.0%)	12 (40.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Onsite	36 (30.5%)	39 (33.1%)	24 (20.3%)	19 (16.1%)	0 (0.0%)
	Hybrid	38 (24.5%)	47 (30.3%)	52 (33.5%)	18 (11.6%)	0 (0.0%)
Process validation*	Online	19 (63.3%)	8 (26.7%)	2 (6.7%)	1 (3.3%)	0 (0.0%)
	Onsite	34 (29.3%)	40 (34.5%)	15 (12.9%)	27 (23.3%)	0 (0.0%)
	Hybrid	35 (22.7%)	59 (38.3%)	43 (27.9%)	17 (11.0%)	0 (0.0%)
Analytical method validation*	Online	21 (70.0%)	6 (20.0%)	2 (6.7%)	1 (3.3%)	0 (0.0%)
	Onsite	31 (26.3%)	27 (22.9%)	25 (21.2%)	35 (29.7%)	0 (0.0%)
	Hybrid	27 (17.4%)	50 (32.3%)	53 (34.2%)	25 (16.1%)	0 (0.0%)
Cleaning validation*	Online	19 (63.3%)	9 (30.0%)	2 (6.7%)	0 (0.0%)	0 (0.0%)
	Onsite	35 (30.4%)	38 (33.0%)	22 (19.1%)	20 (17.4%)	0 (0.0%)
	Hybrid	35 (22.9%)	66 (43.1%)	34 (22.2%)	18 (11.8%)	0 (0.0%)
Calibration*	Online	18 (62.1%)	6 (20.7%)	5 (17.2%)	0 (0.0%)	0 (0.0%)
	Onsite	37 (32.2%)	28 (24.3%)	25 (21.7%)	25 (21.7%)	0 (0.0%)
	Hybrid	37 (24.3%)	61 (40.1%)	37 (24.3%)	17 (11.2%)	0 (0.0%)

[†] Chi-squared analysis was conducted using SPSS, where $p < 0.05$ was considered significant as indicated by *.

For D3, all topics training objectives were impacted significantly by training platforms. The overall perceptive achievement of the training objective (understanding to evaluating) was in the range of 0.0% – 20.7%, 0.0% – 36.8%, and 0.0% – 40.1%, respectively. The perception of achievement at apply was 10.0 – 20.0%, 23.7% - 35.0%,

and 29.9% - 40.1% for those enrolled in online, on-site, and hybrid clerkships, while achievement at analyze was 6.0% - 16.7%, 22.9% - 36.8% and 9.7% - 25.2%, respectively (Table 5). On-site and hybrid training produced the perception of higher-level learning achievement.

Table 5 Perceptive achievement of training objectives (domain 3) comparing different clerkship platforms

Training topics	Achieved training objective [n, (%)] [†]					
	Online (n = 31), on-site (n = 118), hybrid (n = 155)					
	Platform	Recall	Understanding	Apply	Analyze	Evaluation
Search procedures of United States	Online	17 (56.7%)	4 (13.3%)	4 (13.3%)	5 (16.7%)	0 (0.0%)
Pharmacopoeia (USP), British	Onsite	11 (9.4%)	21 (17.9%)	41 (35.0%)	43 (36.8%)	1 (0.8%)
Pharmacopoeia (BP), Thai	Hybrid	18 (11.6%)	36 (23.2%)	61 (39.4%)	39 (25.2%)	1 (0.6%)
Pharmacopoeia (TP), and International						
Pharmacopoeia (Ph. Int.)*						
Specifications for raw materials, packing	Online	16 (53.3%)	5 (16.7%)	6 (20.0%)	3 (10.0%)	0 (0.0%)
materials, and finished products*	Onsite	20 (16.9%)	28 (23.7%)	35 (29.7%)	35 (29.7%)	0 (0.0%)
	Hybrid	33 (21.3%)	40 (25.8%)	59 (38.1%)	21 (13.5%)	2 (1.3%)
Information on the raw material	Online	17 (56.7%)	6 (20.0%)	4 (13.3%)	3 (10.0%)	0 (0.0%)
specification, packing material, and	Onsite	23 (19.5%)	31 (26.3%)	28 (23.7%)	36 (30.5%)	0 (0.0%)
finished products*	Hybrid	33 (21.6%)	41 (26.8%)	50 (32.7%)	28 (18.3%)	1 (0.7%)
Document the requirements of raw	Online	19 (63.3%)	5 (16.7%)	3 (10.0%)	3 (10.0%)	0 (0.0%)
materials, packing materials, and finished	Onsite	29 (24.6%)	23 (19.5%)	33 (28.0%)	33 (28.0%)	0 (0.0%)
products*	Hybrid	39 (25.5%)	36 (23.5%)	55 (35.9%)	21 (13.7%)	2 (1.3%)
The statistical principles used in quality	Online	21 (70.0%)	3 (10.0%)	4 (13.3%)	2 (6.7%)	0 (0.0%)
control*	Onsite	34 (29.3%)	21 (18.1%)	33 (28.4%)	30 (25.4%)	0 (0.0%)
	Hybrid	48 (31.2%)	45 (29.2%)	46 (29.9%)	15 (9.7%)	0 (0.0%)
Analytical and testing tools*	Online	18 (60.0%)	4 (13.3%)	6 (20.0%)	2 (6.7%)	0 (0.0%)
	Onsite	28 (23.7%)	25 (21.2%)	35 (29.7%)	30 (25.4%)	0 (0.0%)
	Hybrid	35 (22.7%)	45 (29.2%)	58 (37.7%)	16 (10.4%)	0 (0.0%)
The important qualitative and quantitative	Online	16 (55.2%)	6 (20.7%)	5 (17.2%)	2 (6.0%)	0 (0.0%)
analyses specified in the textbook*	Onsite	24 (20.3%)	26 (22.0%)	38 (32.2%)	30 (25.4%)	0 (0.0%)
	Hybrid	33 (21.4%)	50 (32.5%)	53 (34.4%)	18 (11.7%)	0 (0.0%)
Analytical method development and	Online	18 (64.3%)	4 (14.3%)	4 (14.3%)	2 (7.1%)	0 (0.0%)
verifying the accuracy of the analytical	Onsite	26 (22.0%)	31 (26.3%)	34 (28.8%)	27 (22.9%)	0 (0.0%)
methods*	Hybrid	37 (24.3%)	38 (25.0%)	61 (40.1%)	16 (10.5%)	0 (0.0%)

[†] Chi-squared analysis was conducted using SPSS, where $p < 0.05$ was considered significant as indicated by *.



Online clerkship resulted in the perception of training objective achievement at 0.0% – 96.7% for all topics. The perception of achievement at apply was 0.0% - 23.3%, while achievement at analyze was 0.0% - 16.7%. Thus, in online clerkships, the achievement of learning objectives was lower than in on-site and hybrid clerkships. Therefore, it is clear that applying and analyzing the level of training outcomes required participation and hands-on activities associated with on-site and hybrid clerkships.

Students' satisfaction with clerkship training resources

Student satisfaction with the aspects of the training site, training content, and preceptor was evaluated. Except for Preceptors who have knowledge and experience in the profession, satisfaction with on-site and hybrid clerkships was not significantly different. However, students indicated significantly higher satisfaction with both clerkships than online clerkships. Scores for training sites varied from 0 to 5, and satisfaction was in the range of 1.93 – 2.13, 3.25 – 3.72, and 3.32 – 3.65 for online, on-site, and hybrid clerkships, respectively. In the case of training contents, satisfaction was in the range of 1.77 – 2.27, 3.36 – 3.57, and 3.19 – 3.57 for online, on-site, and hybrid clerkships, respectively. Satisfaction with the preceptor was 2.43 – 3.37, 3.76 – 4.08, and 3.76 – 3.82 for online, on-site, and hybrid clerkships, respectively. Student responses inform higher satisfaction scores for preceptors over training sites and content. Overall, online clerkship limited satisfaction in all aspects.

Discussion

All observations provided evidence that online clerkships limited the variety of training pedagogy. Only lectures, topic assignments, and discussions were feasible. Virtual clerkships are prone to engender a lack of confidence among students and obscure their perception of actual working circumstances (Bawadi *et al.*, 2023). The on-site and hybrid clerkships can provide training levels of observation, participation, hands-on, and independent hands-on. The interprofessional collaboration skills of

pharmacy students improve through observation and active participation in an interprofessional simulation program (Fusco and Foltz-Ramos, 2020). The hands-on learning program was a successful strategy for educating pharmacy students in the management of diabetes, increasing both their competence and confidence (Wongwiwatthanakit *et al.*, 2013). In addition, an on-site internship will provide a more thorough understanding of pharmaceutical manufacturing. Active participation and hands-on training are essential for students' skills and confidence, influencing their career performance. The continuous educations are recommended for pharmacist upskilling.

Based on D1, 17 out of 18 topics of the training objectives were impaired by different training platforms. The levels of training influence the perceptive achievement of training objectives. For domains 2 and 3, all learning objectives were perceptively achieved differently by students' self-assessments. Topics of QA/QC training were impacted by the transition from an on-site to an online approach. A person's perception of self-confidence is dynamic and evolves in response to cognitive processing of data that influence how they assess their capabilities, and hands-on instruction increases pharmacy students' self-confidence and attitudes about diabetes care (Wongwiwatthanakit, 2013). Hands-on activities appear to offer an embodied cognitive learning experience that aids in retaining knowledge through tactile and three-dimensional mental representations (Catena and Carbonneau, 2019). This cross-sectional survey confirmed that on-site and hybrid clerkships could provide hands-on training and result from students' perceived capabilities to apply and analyze knowledge.

The active participants' Interprofessional Collaborative Competency Attainment Survey scores were significantly higher than those of the observers (Fusco and Foltz-Ramos, 2020). In the Biomechanics course, the hands-on group of students did better than those who just received lectures and rated the course's overall activities as helpful to their learning (Catena and Carbonneau, 2019). The online clerkship training platforms that provided the

lecture, topic assignment, and discussion were less effective than on-site and hybrid clerkships. Access to training resources and direct experiences was limited for an online clerkship (Table 6, training site). Experiential learning programs within the community can potentially change the professional attitudes of pharmacy students because experiences can help students develop positive attitudes toward duty, responsibility, and compassion (Huang *et al.*, 2022). Non-direct experience of an online training group

limited the perceptive achievement of training objectives. Thus, online may not appropriate for pharmacy student clerkship. However, hybrid clerkship were the appropriate options for limited conditions. Those students with hybrid platform perceived achievement of training objective and satisfied with in the COVID-19 conditions. Previous study indicated that combining remote and onsite clerkship would be more successful (Sotoishi, 2021).

Table 6 Satisfaction with respect to clerkship training resources based on the clerkship platforms

Training resource	Clerkship platforms	Dissatisfied (0)	Satisfaction [n, (%)]					Mean±SD [†]
			least satisfied (1)	less satisfied (2)	Moderately satisfied (3)	Very satisfied (4)	Most satisfied (5)	
Training site								
Facilities.	Online	3 (9.7)	11 (35.5)	1 (3.2)	12 (38.7)	3 (9.7)	1 (3.2)	2.13±1.36 ^a
	On-site	4 (3.4)	7 (5.9)	1 (0.8)	31 (26.3)	38 (32.2)	37 (31.4)	3.72±1.27 ^b
	Hybrid	-	5(3.2)	12 (7.6)	50 (31.8)	53 (34.2)	35 (22.6)	3.65±1.02 ^b
Schedule of practice sessions in the QC/QA department	Online	7 (23.3)	4 (13.3)	6 (20.0)	11 (36.7)	1 (3.3)	1 (3.3)	1.93±1.39 ^a
	On-site	6 (5.1)	13 (11.0)	9 (7.6)	33 (28.0)	32 (27.1)	25 (21.2)	3.25±1.43 ^b
	Hybrid	4 (2.6)	14 (9.0)	19 (12.3)	36 (23.2)	56 (36.1)	26 (16.8)	3.32±1.29 ^b
Training content								
The quality control/quality assurance clerkships are in accordance with the plan.	Online	8 (26.7)	4 (13.3)	5 (16.7)	11 (36.7)	1 (3.3)	1 (3.3)	1.87±1.43 ^a
	On-site	7 (5.9)	8 (6.8)	9 (7.6)	31 (26.3)	37 (31.4)	26 (22.0)	3.36±1.40 ^b
	Hybrid	4 (2.6)	13 (8.3)	19 (12.3)	49 (31.6)	46 (29.7)	24 (15.5)	3.24±1.25 ^b
Quality control/quality assurance practice is consistent with the objectives.	Online	5 (16.7)	9 (30.0)	4 (13.3)	10 (33.3)	1 (3.3)	1 (3.3)	1.87±1.33 ^a
	On-site	4 (3.4)	7 (5.9)	12(10.2)	27(22.9)	39(33.1)	29(24.6)	3.50±1.31 ^b
	Hybrid	0 (0)	16 (10.3)	17 (11.0)	42 (27.1)	63 (40.6)	17 (11.0)	3.31±1.13 ^b
An overview of the quality assurance and quality control policies of the training site was included.	Online	5 (16.7)	11 (36.7)	4 (13.3)	7 (23.3)	2 (6.7)	1 (3.3)	1.77±1.36 ^a
	On-site	1 (0.9)	10 (8.5)	9 (7.7)	31 (26.5)	33 (28.2)	33 (28.2)	3.57±1.26 ^b
	Hybrid	0 (0)	8 (5.2)	21 (13.5)	51 (32.9)	54 (34.8)	21 (13.5)	3.38±1.05 ^b
The assignments or scope of work assigned are appropriate for the duration of the on-the-job training.	Online	5 (16.7)	7 (23.3)	7 (23.3)	6 (20.0)	4 (13.3)	1 (3.3)	2.00±1.41 ^a
	On-site	5 (4.2)	9 (7.6)	13 (11.0)	23 (19.5)	44 (37.3)	24 (20.3)	3.39±1.36 ^b
	Hybrid	1 (0.6)	11 (7.1)	16 (10.3)	50 (32.3)	53 (34.2)	24 (15.5)	3.40±1.12 ^b
Various meetings, seminars, and workshops were held at the training site as well as other academic conferences.	Online	4 (13.3)	6 (20.0)	4 (13.3)	11 (36.7)	4 (13.3)	1 (3.3)	2.27±1.39 ^a
	On-site	7 (5.9)	3 (2.5)	17 (14.4)	25 (21.2)	33 (28.0)	33 (28.0)	3.47±1.41 ^a
	Hybrid	7 (4.5)	9 (5.8)	23 (14.8)	47 (30.3)	46 (29.7)	23 (14.8)	3.19±1.28 ^b
Preceptor								
Preceptors have knowledge and experience in the profession	Online	1 (3.3)	3 (10.0)	2 (6.7)	7 (23.3)	12 (40.0)	5 (16.7)	3.37±1.33 ^a
	On-site	3 (2.5)	2 (1.7)	5 (4.2)	17 (14.4)	36 (30.5)	55 (46.6)	4.08±1.16 ^b
	Hybrid	1 (0.6)	4 (2.6)	13 (8.4)	33 (21.4)	55 (35.7)	48 (31.2)	3.82±1.09 ^{ab}

Table 6 Satisfaction with respect to clerkship training resources based on the clerkship platforms (*Continued*)

Training resource	Clerkship platforms	Dissatisfied (0)	Satisfaction [n, (%)]					Mean \pm SD [†]
			least satisfied	less satisfied	Moderately satisfied	Very satisfied	Most satisfied	
			(1)	(2)	(3)	(4)	(5)	
Preceptors are there to help and support the practice.	Online	3 (10.0)	3 (10.0)	6 (20.0)	4 (13.3)	11 (36.7)	3 (10.0)	2.87 \pm 1.53 ^a
	On-site	3 (2.5)	6 (5.1)	5 (4.2)	14 (11.9)	37 (31.4)	53 (44.9)	3.99 \pm 1.27 ^b
	Hybrid	0 (0)	10 (6.5)	12 (7.7)	32 (20.6)	50 (32.3)	51 (32.9)	3.77 \pm 1.18 ^b
Preceptor is a good example throughout the practice.	Online	1 (3.3)	5 (16.7)	7 (23.3)	2 (6.7)	11 (36.7)	4 (13.3)	2.97 \pm 1.47 ^a
	On-site	2 (1.7)	5 (4.2)	7 (5.9)	15 (12.7)	36 (30.5)	53 (44.9)	4.01 \pm 1.22 ^b
	Hybrid	1 (0.6)	8 (5.2)	12 (7.7)	31 (20.0)	46 (29.7)	57 (36.8)	3.83 \pm 1.19 ^b
Preceptor at the training site had time to advise students on their work.	Online	5 (16.7)	5 (16.7)	4 (13.3)	6 (20.0)	8 (26.7)	2 (6.7)	2.43 \pm 1.61 ^a
	On-site	5 (4.2)	5 (4.2)	11 (9.3)	20 (16.9)	28 (23.7)	49 (41.5)	3.76 \pm 1.41 ^b
	Hybrid	0 (0)	11 (7.1)	10 (6.5)	36 (23.2)	51 (32.9)	47 (30.3)	3.73 \pm 1.17 ^b
Preceptors pay attention to teaching and assignments.	Online	3 (9.7)	6 (19.4)	4 (12.9)	9 (29.0)	6 (19.4)	3 (9.7)	2.58 \pm 1.50 ^a
	On-site	3 (2.5)	3 (2.5)	13 (11.0)	14 (11.9)	34 (28.8)	51 (43.2)	3.92 \pm 1.28 ^b
	Hybrid	0 (0)	10 (6.5)	9 (5.8)	38 (24.5)	49 (31.6)	49 (31.6)	3.76 \pm 1.15 ^b

[†]The static significance was analyzed by one-way ANOVA followed by Scheffe. The same and different letters indicate nonsignificant and significant differences, respectively, when data were compared between clerkship platforms.

Regarding training platforms, students expressed low satisfaction with online clerkship training. Students mentioned getting more hands-on practice to understand the details better and be able to apply them. In addition, they reported that online clerkship looks like a lecture class and online training obscures working circumstances. The clerkship helps them decide their future careers, and on-site training allows them to see and practice their jobs. Regarding the free comments, QA/QC clerkships may influence students' deep learning and decisions about their careers after graduation. Regarding free comments on QA/QC training, they asked to separate QA and QC training because they mainly obtained QC training. In addition, QC training is usually provided by repeated routine jobs instead of overall QC tasks. Lack of time, insufficient training, and standard practice guidelines are among the variable described as barriers to the practice of health promotion in community pharmacy settings (Gelayee and Mekonnen, 2018). The barriers identified in the present study are consistent with these studies. Based on free comments, lack of preceptor time, low variety of training, and training

schedules were mentioned as training barriers. The lack of specific training guidelines and preceptorship training courses, also a possible source for which no training” of many training topics was stated by students in the QA/QC clerkships. Observations of practicing pharmacists who were less involved in health promotion counseling services might have a negative influence on students' practice (Gelayee and Mekonnen, 2018). The additional workload of the preceptor may result in less time and attention being given to the trainee. Preceptorship-related overtime was a significant positive covariate for stress, whereas preceptorship willingness was a negative covariate for pressure and a positive covariate for satisfaction (Seo *et al.*, 2018).

In addition to the change in pharmacy clerkship due to the COVID-19 pandemic, the impact on other kinds of clerkships should be assessed as well. The clerkship in pharmaceutical production and the compulsory clerkship are crucial for a career in pharmaceutical manufacturing. Based on survey data, continuing pharmacy education should be implemented.



Conclusion

The online clerkship involving QA/QC for pharmacy students was limited to lecture and assignment-based training. Thus, the online platform was less effective for facilitating student learning at the apply and analyze level. This leads to a lack of confidence in students. Student satisfaction was high for on-site and hybrid clerkships, which provided simulations of work environments. It is highly recommended to incorporate continuing pharmacy education modules that specifically address quality assurance and quality control (QA/QC) principles.

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