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Clinical placement before or after simulated learning environments? A naturalistic study of clinical skills acquisition amongst early-stage paramedicine students

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Abstract

Background

There is conflicting evidence surrounding the merit of clinical placements (CP) for early-stage health-profession students. Some contend early-stage CPs facilitate contextualisation of subsequently learned theory. Others argue attending CP before attaining skills competency is problematic and should only occur after training in simulated-learning environments (SLE). The evidentiary basis surrounding the extent to which either is true remains limited.

Methods

First-year paramedicine students (n=85) undertook three days of CP and SLEs as part of course requirements. Students undertook CP either before or after participation in SLEs creating two groups (Clin?Sim/Sim?Clin). Clinical skills acquisition was measured via objectively-structured clinical examinations (OSCE) conducted at four distinct time-points over the semester. Perceptions of difficulty of CP and the SLE were measured via the NASA-TLX.

Results

Students' OSCE scores in both groups improved significantly from beginning to end of semester (+35%, *p*p=.021). Both groups found SLEs more demanding than CP (47.6% vs. 31.4%, *p*p=.003).

Conclusions

Differences in temporal demand suggest Clin?Sim students had fewer opportunities to practice clinical skills during CP than Sim?Clin students due to a more limited scope of practice. Sim?Clin students contextualised SLE within subsequent CP resulting in greater improvement in clinical competency by semester's end in comparison to Clin?Sim students that were forced to contextualise skills retrospectively.

KEYWORDS: Simulated-learning environments; Clinical placements; early-stage students; paramedicine

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Experiential learning is an essential component of health services education allowing students to integrate theory with practice [1]. Simulated learning environments (SLE) are often used for early-stage students to initiate experiential learning, as a forerunner to subsequent clinical placements (CP) [2]. There is a high level of consensus (at least in 18 Australian medical schools) that SLEs are best suited to early-stage students to optimise the benefit of later CPs [3]. SLEs are favoured for this group as they can provide experiential learning in a controlled and safe environment, devoid of patient risk, and allow creation of a wide variety of clinical encounters on demand [4-5]. In contrast, CPs are subject to random clinical presentations limiting the spectrum of clinical skills students might have the opportunity to practice [6-7]. Opportunities to practice skills in CPs are also restricted by early-stage students' limited level of competency [8-10]. Despite these drawbacks, a systematic review of 38 studies investigating the effects of early CPs on learning outcomes concludes that early clinical experience can "strengthen and deepen cognitively, broaden affectively, contextualise, and integrate medical education" (p.389) [11]. However, the authors of this review were highly critical of the generally poor designs of most studies due to an overreliance on student self-reported performance data and lack of relevant comparison groups and cautioned that, although largely consistent, the evidence supporting early-stage CPs remained 'weak'. Thus, the literature to date would suggest there is evidence, albeit 'weak', that early-stage students benefit from CPs but SLEs should probably come first. However, there remains a lack of robust evidence to substantiate this assumption.

We used the Challenge Point Framework (CPF) as a theoretical paradigm to help conceptualise the relative merits of CP and SLEs for early-stage students. The CPF is based upon the premise that optimal learning is achieved when students are provided opportunities to practice skills within the upper limit of their current theoretical knowledge but extending them beyond this limit will result in cognitive overload and result in poorer learning outcomes [12]. Thus, the CPF would predict learning outcomes for early-stage students will be better within the more structured confines of SLEs compared to the more complicated and largely random clinical presentations of CPs. We used the CPF to form the following hypotheses:

H_1: Early-stage students will perceive early CP as more challenging than SLE.

H_2: Early-stage students completing SLE before CP will evidence better clinical skills learning outcomes than students undertaking CP before SLEs.

METHODS

Unit Description

We used a naturalistic, quasi-experimental study design with paramedicine undergraduates enrolled in a first-year clinical skills unit at Edith Cowan University, Western Australia in 2013. The four learning objectives of the unit were: (1) to relate physical assessment and the application of clinical skills to basic anatomy and physiology; (2) to apply basic problem-solving skills in clinical assessment and differential diagnosis in health care settings; (3) to demonstrate the practical use of the clinical skills, medical documentation, medication dosage calculations and therapeutic communication in approach to patients that provide the foundations of emergency health care and provision; and (4) to demonstrate the ability to work as part of a therapeutic team. The theoretical component of the unit was based online with weekly theory modules to be completed by students over fourteen weeks. Students were also expected to undertake three days of external CP during semester plus three days of internal SLEs during the mid-semester teaching break. While all students completed the SLE workshop at the same time over the mid-semester break, students were responsible for booking and attending their own CPs, but were informed all three days were to be completed in a block either before *or* after the mid-semester SLE workshop. Thus two naturally occurring groups of students were formed: 1) those completing three days of early-stage CP before the three-day SLE workshop (Clin→Sim); and 2) those completing the three-day SLE workshop before three days of early-stage CP (Sim→Clin).

SLE workshop

The compulsory three-day SLE workshop, held at the university during the mid-semester teaching break, was designed to simulate clinical learning environments and healthcare scenarios and provided students the opportunity to practice clinical skills for a wide variety of clinical conditions with a focus on the correct application of primary and secondary surveys.

Clinical placement

Students undertook three days' external CP at general practice surgeries around metropolitan Perth. Clinical supervisors at each of the placement sites were asked to provide experiences as closely related to the unit learning objectives as possible. As per the nature of CPs, student experiences were dependent upon random presentations and could not be standardised. However, the 'typical' student experience involved the opportunity to observe and/or aid registered nurses undertaking health assessments, assist with medical documentation, arrange follow-up appointments with patients, and sort medical supplies.

Participants

The participant pool included all students (n=86) who completed the unit. Participation in the study was voluntary and after providing students with informed consent only one declined to participate, reducing the final sample to n=85. Approval for the study was granted by the Edith Cowan University Human Ethics Committee (#8725). The final sample was 52% male and 48% female with an average age of 23.7 years (range 18–48, SD=6.47). Thirty-seven students (44%) formed the Clin→Sim group and n=48 students (56%) formed the Sim→Clin group.

Measures

Clinical Skills Competency

As per the recommendations of Cant and Cooper [13] to avoid student self-reported data, we assessed students' clinical skills competency via objectively structured clinical examinations (OSCE), designed by following the recommendations of Harden and Gleeson [14] and Smee [15]. In order to establish content validity the eleven capacity development areas outlined by the Council of Ambulance Authorities Paramedic Professional Competency Standards (v.2) [16] were used to formulate a generic marking guide for the four clinical scenarios, each reviewed by a panel of content experts (senior paramedicine clinical staff) for confirmation as an appropriate generic indicator of paramedicine clinical skill. Students received scores of 2 (competent), 1 (requires supervision) or 0 (requires development) for each of the 24 items of the OSCE. During each OSCE students were randomly allocated to treat a standardised actor patient with one of four clinical conditions associated with trauma, endocrine, immunological, or respiratory problems. Each student's clinical skills were tested four times over semester: in Week 3 prior to any students undertaking CP (T_1); in Week 8 prior to undertaking the mid-semester SLE workshop (T_2); in Week 9 after undertaking the SLE workshop (T_3); and in Week 14 at the end of semester (T_4).

[Insert Figure 1 hereabouts]

Perceived Difficulty

Students' subjective ratings of the relative difficulty of the CP and SLE activities were assessed using the National Aeronautics and Space Administration Task Load Index (NASA-TLX). This self-completed instrument evaluates perceived difficulty of a set task across six dimensions rated on 21-point scales. Although a subjective measure, its standardisation and extensive testing make it widely regarded as the strongest tool available for reporting perceptions of workload [17]. The NASA-TLX was rigorously tested throughout a three-year development period [18] and has since appeared in over 2,850 studies [19]. It has previously been used in several studies assessing perceived workloads in the health industry [e.g. 20-22]. Xiao et al. evaluated the NASA-TLX on n=1,268 mental health workers in China and found it to have good test/re-test reliability, good internal consistency and good structure validity [23]. Students completed the NASA-TLX twice, once in regard to the SLE workshop and once in regard to their CP.

Statistical Analysis

All analyses were undertaken with SPSS (v.22.0). OSCE scores were compared using the GLM Repeated Measures procedure to examine within-subject differences over the four time points.[1] Independent samples t-tests were used to investigate between-subject contrasts at each time point. Paired samples t-tests were used to compare students' NASA-TLX scores for CP and SLEs. Non-significant differences for both OSCE and NASA-TLX measures were tested for equivalence using the confidence interval (CI) equivalency testing procedure, assuming an equivalency interval criterion of ±10%, following the recommendations of Rogers *et al.* [24].

RESULTS

Perceived Difficulty

Mean NASA-TLX scores met the assumption of normal distribution (skewness =.451 and kurtosis=-.505) making them suitable for parametric analysis. The average student rated the SLE significantly more challenging (47.6%) compared to CP (31.4%) ($t(80)=9.463$ $p<.001$). No statistical differences were evident between the Clin→Sim and Sim→Clin groups. Indeed, group equivalence was indicated for both CP (90% CIs -7.4–2.6%) and SLEs (90% CIs -2.8–6.6%) suggesting both groups rated their SLEs and CP experiences similarly. However, on the *temporal demand* subscale of the NASA-TLX (i.e. "How hurried or rushed was the pace of the task?") the mean CP vs. SLE difference for the Clin→Sim group (-26.3%) was significantly larger than the mean difference for the Sim→Clin group (-11.0%) ($t(80)=3.100$, $p=.003$) essentially suggesting Clin→Sim students found their CP relatively less rushed than SLE, in comparison to the Sim→Clin students.

Clinical Skills Competency

An examination of pooled OSCE scores over the semester suggested the data met the assumption of normality (skewness=.171 and kurtosis=-.109). A reliability analysis of the 24 items of the OSCE instrument at T_1 suggested high internal consistency with a Cronbach's α=.935. The mean OSCE scores for each group at each time-point are displayed in Figure 2.

[insert Figure 2 hereabouts]

[1] As there were uneven group sizes, the Type III method was used to calculate the sum of squares.

Mauchly's W was statistically significant (W=.845, $\chi^2(5)$=13.773 p=.017) suggesting our data failed the assumption of sphericity. Therefore, the Huynh-Feldt procedure was used to adjust downwards the degrees of freedom in order to reduce risk of Type 1 error [25] (α=.05).

[insert Table 1 hereabouts]

No significant difference was detected between group means aggregated over the four time points (p=.920) but statistically significant and large differences were detected over consecutive time-points (p<.001). No difference was detected between T_1–T_2 (p=.588) but differences were evident between T_2–T_3 (p<.001) and T_3–T_4 (p<.001). Significant interactions were also detected between group and time-point, not between T_1–T_2 (p=.872) but between T_2–T_3 (p=.015) and T_3–T_4 (p<.001). This was confirmed by between-group comparisons suggesting group means did not statistically differ at T_1 (p=.921) or T_2 (p=.699) but medium size effects were evident at both T_3 (p=.017) and T_4 (p=.021). The non-significant differences in groups' scores were within ±10% at T_1 (90% CIs -8.5–7.6%) and T_2 (90% CIs -7.0–4.4%) suggesting at both times the groups' means met the criterion for equivalency.

DISCUSSION

The equivalency of the two groups' OSCE scores at T_1 suggests minimal group allocation bias at the beginning of semester. The statistically significant improvement in clinical skills by semester's end for both groups also provides face validity for our OSCE measure as a plausible indicator of changes in clinical skill. The two statistically significant interactions between OSCE scores and groups from T_2–T_3 and T_3–T_4 also demonstrate that our measure was sufficiently sensitive to detect changes corresponding to students' staggered exposures to CP before and after the SLE workshop. A significant group interaction detected between the SLE and CP on the NASA-TLX suggests this measure was also sufficiently sensitive. We deem these results a successful manipulation check to confirm the suitability of our research paradigm to test our research hypotheses.

Our first hypothesis, in line with the CPF, predicted that early-stage students would perceive CPs to be more challenging than the SLE due to the multiple, uncontrollable factors in real clinical settings potentially resulting in increased cognitive overburden. However, this hypothesis was not supported and a large and statistically significant difference was detected in the opposite direction to our prediction; students in both groups consistently found the SLE more challenging than CP for this unit. The lower relative *temporal demand* reported by the Clin→Sim group in comparison to the Sim→Clin group during their CP may be explained by the fact the former group undertook CP early in the semester. Our interpretation of these data is that the Clin→Sim students may have experienced less task load given their more limited skills repertoire earlier in semester with fewer associated opportunities to practice within the scope of their abilities. This is similar to previous studies that report clinical supervisors experiencing frustration with early-stage students on CP being unable to participate in activities due to a limited scope of practice [10,26-27].

This is consistent with our data testing the second hypothesis that predicted the Sim→Clin group would hold the advantage over the Clin→Sim group by the end of semester. The statistically significant 7.2% average superiority of the Sim→Clin group's scores over the Clin→Sim group by semester's end certainly appears to support H_2. Despite the Clin→Sim group's three days of CP between T_1 and T_2, compared to no experiential learning for the Sim→Clin group, the mean OSCE scores of both groups remained equivalent at T_2. *Prima facie* this result suggests that the three days of CP were of no additive value to the Clin→Sim students in terms of clinical skill acquisition. This reflects previous literature that warns against early-stage CP where students are 'thrown in the deep end' prior to receiving adequate training or close supervision [8-10,28]. Alternatively, it could suggest the measure was simply more sensitive to learning acquired during SLEs compared to CP. However, we do not believe this to be the case; statistically different OSCE scores between groups at T_3 and T_4 strongly suggest students learnt *something* during the CPs that interacted with the SLEs and was, at least indirectly, detectable by the OSCEs. It is likely the Clin→Sim group gained contextualisation knowledge as a result of their CP that was not directly measured by the OSCE at T_2. The significant interaction between T_2 and T_3 and superior clinical skills of the Clin→Sim over Sim→Clin group by T_3 goes some way to support this interpretation.

By T_3 the Clin→Sim group also enjoyed a dosage-effect advantage over the Sim→Clin group—having received twice the amount of experiential learning (three days of CP plus three of SLEs) compared to only three days of SLE for the Sim→Clin group. However, this still does not explain the groups' equivalency at T_2. Our interpretation is that the Clin→Sim group was able to retrospectively synthesize the SLE activities with their experiences gained from CP—such as greater familiarity with medical documentation and supplies, and the practicalities of communicating and conducting clinical assessments with actual patients—thereby explaining both the non-linear improvement in Clin→Sim scores from T_1 to T_2 and T_3 and the superiority of this group's mean score over the Sim→Clin group's at T_3. In effect, these data provide objective evidence of a benefit of early-stage CP to students' subsequent acquisition of clinical skills. This result seems consistent with the conclusion of Littlewood *et al.'s* systematic review; that early-stage CP can "strengthen and deepen cognitively, broaden affectively, contextualise, and integrate medical education" [11] (p. 389).

The significant, reversed interaction between T_3 and T_4 and resultant superiority of the Sim→Clin over Clin→Sim at T_4 are possibly of most interest as it suggests this group was able to proactively contextualise SLE with real-world experiences gained during CP. Sim→Clin students also had opportunity to practice SLE-gained clinical skills while on CP whereas Clin→Sim students did not. This is consistent with our data suggesting Sim→Clin students experienced greater temporal demand during their CPs than the Clin→Sim group.

It should be stressed that over the course of the semester students also received online coursework in addition to their experiential learning, resulting in the theoretical knowledge of students in both groups increasing presumably at the same rate over semester. As such, compared to the Sim→Clin group, the Clin→Sim group would have undertaken their CP in the first half of semester with less theoretical knowledge. It is beyond the scope of the present study to suggest the extent to which differing stages of theoretical knowledge affected our OSCE measures in comparison to retrospective versus proactive contextualisation. Ours was a naturalistic study but future research could remove this uncertainty by providing a single cohort of early-stage students randomly allocated to simultaneous, equal doses of either SLE or CP. Also, this type of research needs to be replicated across other health disciplines to increase generalizability of findings.

With these limitations in mind, our data suggest both groups benefited from early-stage CP, but those in the Sim→Clin group benefited more. It appears the Sim→Clin group was significantly more challenged during their CP than the Clin→Sim group, most likely due to greater opportunities to practice clinical skills already learnt in SLE. While beyond the scope of the present study, this hypothesis could be testable by quantifying the clinical skills practiced by both Sim→Clin and Clin→Sim groups during CP.

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Table 1: Differences between OSCE means by group (Clin→Sim vs. Sim→Clin), time-point (T_1, T_2, T_3 T_4) and their interaction

GLM Repeated Measures		F	*df*	p-value	partial η^2	
Group		.010	1	.920	<.001	
Time-point		83.728	2.815	<.001	.502	*
Within-subject Contrasts	T_1–T_2	.296	1	.588	.004	
	T_2–T_3	61.081	1	<.001	.424	*
	T_3–T_4	41.556	1	<.001	.334	*
Group X Time-point		4.294	1	.007	.049	*
Within-subject Contrasts	T_1–T_2	.026	1	.872	<.001	
	T_2–T_3	6.157	1	.015	.069	*
	T_3–T_4	-15.387	1	<.001	.156	*
Independent Samples *t*-test		*t*	*df*	p-value	Cohen's *d*	
Time-point	T_1	.099	83	.921	.022	
	T_2	-.388	83	.699	.085	
	T_3	2.442	83	.017	.519	*
	T_4	-2.351	83	.021	.501	*

* denotes a statistically significant difference at α=.05

Figure 1: Participant allocation and intervention procedure

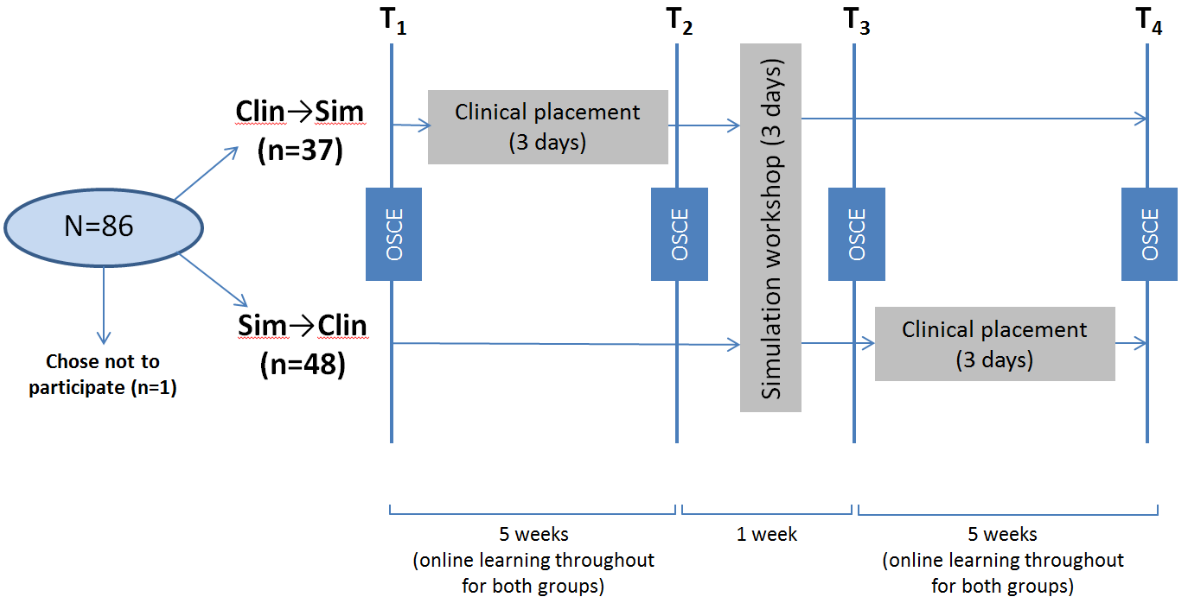
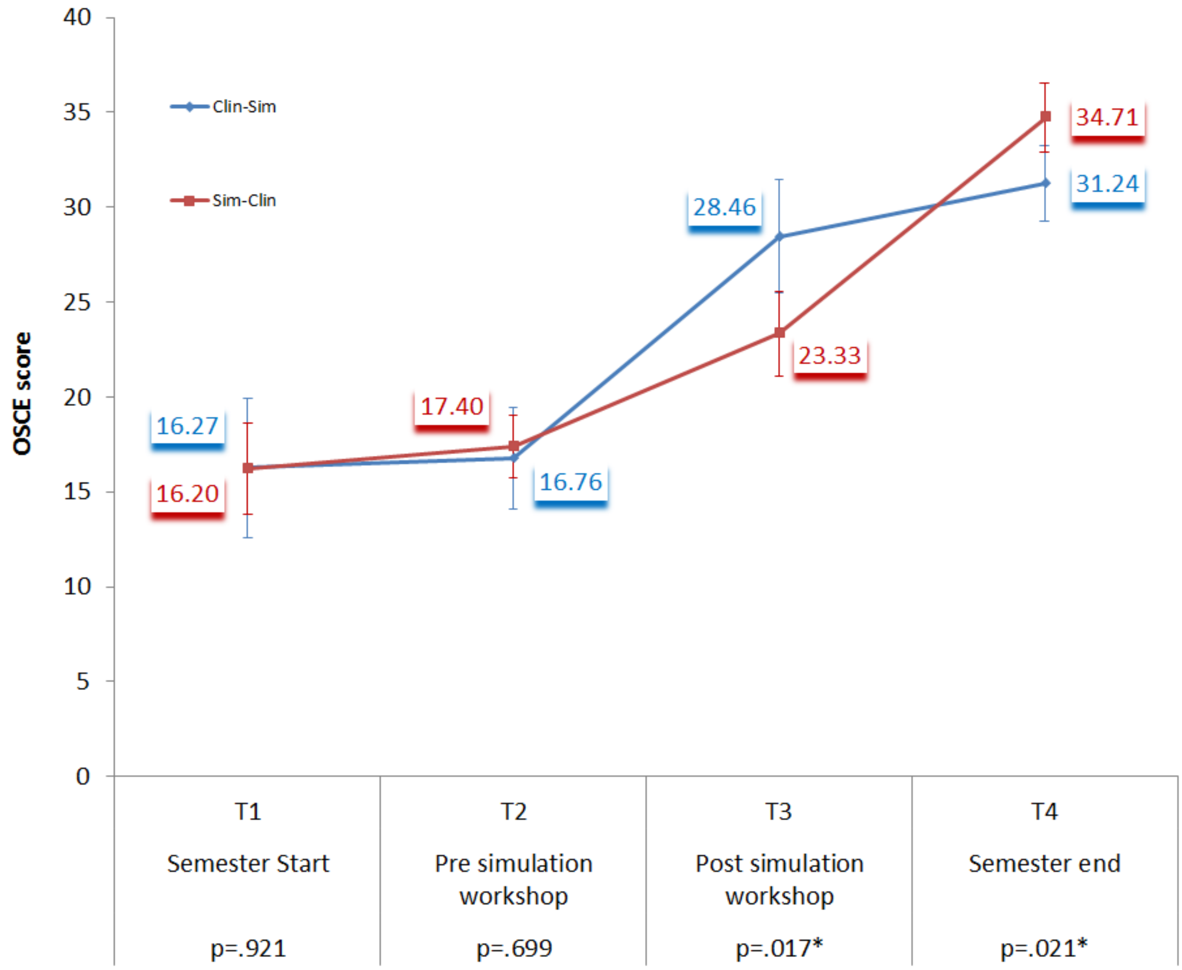


Figure 2: Mean OSCE scores of comparison groups (with 90% Confidence Intervals) and differences in group means at each time point



* denotes statistically significant differences at α=.05