Acceptability of a blended learning model that improves student readiness for practical skill learning: A mixed-methods study

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Abstract

Background: The most effective method for teaching practical skills to healthcare professional students is unclear. Traditional teaching models perpetuate a passive learning pedagogy, whilst variation between tutors reduces target clarity. The flipped classroom model provides opportunities for enhancing student engagement. In a flipped classroom, skill explanation and demonstration is delivered online prior to a face-to-face session. The ideal model should generate an incentive for engagement while avoiding content overload. The aim of this study was to evaluate a flipped classroom teaching method that created an imperative for learner engagement among third-year physiotherapy students.

Methods: The new teaching method required students to view high production-quality preparatory material and complete unsupervised peer practice as prerequisites for receiving tutor feedback. Two skills classes were taught with the new method. Evaluation data was collected using an anonymous online survey, and responses were analysed to identify key themes. Year-on-year delivery costs were modelled by manipulating key variables, such as class size and video update schedule.

Results: The survey was delivered to 72 students: 75% responded after the first class, 32% after the second class. Respondents identified improved readiness for and receptiveness to feedback, and increased control over their learning. Emergent themes included a power shift towards the student, enhanced skill development and improved efficiency. Using parameters relevant for our department, video production costs were recouped after 3 years.

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ISSN 1442-1100

Discussion: This teaching approach engaged students and encouraged them to prepare before attending a skills class. The flow-on effect was improved efficiency in class, which created more opportunities for practice and expert feedback.

Keywords: eLearning; physical therapy; adult learning; practical class; flipped classroom.

Introduction

Practical skills are essential for healthcare professionals (Cosman, 2013; Wulf, Shea, & Lewthwaite, 2010). While many skills are specific to individual professions (e.g., nurse, doctor, physiotherapist), the underlying principles of the teaching and learning of clinical skills apply across all healthcare professions (Wulf et al., 2010).

Teaching practical skills typically occurs through four discrete steps: explanation, demonstration, practice and feedback (Figure 1) (Cosman, 2013; Weeks & Anderson, 2000). This process may be formalised within the undergraduate education setting or occur more spontaneously within a workplace learning model. This four-step framework for practical skill teaching, or modifications of this framework, is a long-standing tradition in medical and allied health education (Cosman, 2013).

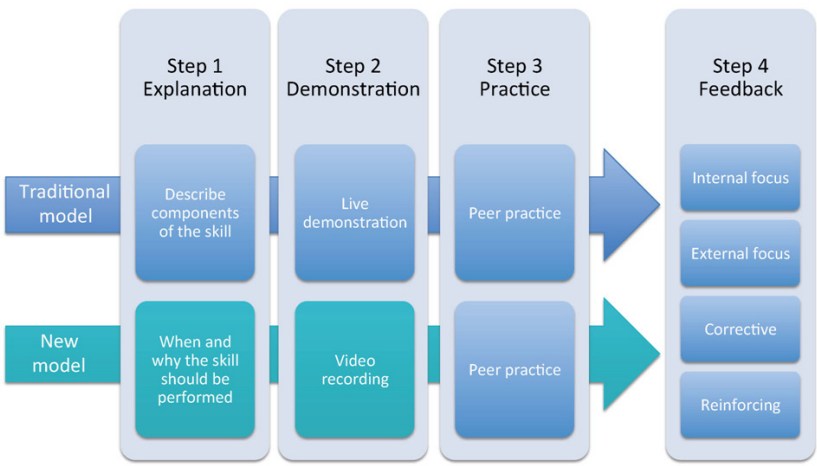

Figure 1. Contrasts between traditional skill teaching model and the new model implemented in this study.

The traditional teaching model has been criticised for perpetuating a passive learning pedagogy, which may result in suboptimal outcomes for knowledge recall, depth of learning and development of critical thinking (Michael, 2006; Rosen et al., 2010). A further limitation of the traditional model is the potential for variability in demonstration (Cannon, Kelly, Lyng, & McGrath, 2009; Cosman, 2013), which may reduce target clarity and inhibit skill development and knowledge acquisition (Faraone, Garrett, &

ISSN 1442-1100

Romberg, 2013; Feil & Reed, 1988). Furthermore, live skill demonstration requires a high staffing commitment to maintain small class sizes. Innovations in practical skill teaching should aim to address these limitations and maximise student feedback opportunities (Nicol & Macfarlane-Dick, 2006).

Thoughtful implementation of technology may allow innovation in practical skill teaching (Rowe, Frantz, & Bozalek, 2013). The *flipped classroom model* (Prober & Heath, 2012) shifts the explanation and demonstration steps to an online format and addresses some of the limitations noted above. Providing students the opportunity to engage with the learning materials at their convenience may increase student engagement (Kay, 2012). Gains will be diminished if online material is supplementary, rather than an alternative, to live delivery (Veneri, 2011).

Research on practical skill teaching design is modest (Rosen et al., 2010; Wulf, 2007), particularly when focused on technology-enabled learning methods that replace rather than supplement traditional approaches. There are potential risks associated with implementing a technology-enabled approach to practical skill acquisition, particularly one that reduces the availability of live tutor time and that is designed to reward the prepared learner while reducing the benefit to the unprepared student. Academic staff are open to developing efficiency but are concerned about the risk to the quality of learning outcomes and the satisfaction of students with their learning experience (Fox & MacKeogh, 2003).

Our primary research question was: *How do physiotherapy students perceive a new practical skills teaching method in which viewing an online demonstration and peer practice are essential requirements for accessing expert feedback?* A secondary focus was financial modelling of the new implementation.

Method

Curriculum in context

The physiotherapy program at Monash University is built around an integrated curriculum. The lectures, case-based learning sessions and practical classes for each week build knowledge on one topic. For example, anatomy of the knee, mechanisms of common knee injuries, special tests for the knee, rehabilitation of knee injuries and strength tests for muscles that cross the knee will be taught together. Each week, students typically have two, 2-hour practical classes, which introduce skills related to the week's topic. The new method was trialled for two practical sessions with third-year students, targeting lumbar spine assessment and management, and vestibular dysfunction assessment and management.

Video content and delivery

Videos demonstrating the skills were developed and provided to students via the virtual learning environment *Moodle*. The videos typically showed what the skill looked like when mastered, as well as its individual components. Commentary and multiple camera angles were used when required. Supporting text and activities were provided

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to give context to when and how the skill should be applied, and how it can be tailored to different client types. For example, the video for lumbar spine assessment and management covered physical examination with a focus on biomechanics and manual handling. The video emphasised professional communication practices and the process of using clinical reasoning to generate a management plan. Similarly, the video for vestibular dysfunction covered physical examination procedures, clinical treatment techniques and the process of using clinical reasoning to tailor these techniques according to patient characteristics.

Activity design

The teaching model implemented is an extension of previous work exploring video demonstration for teaching clinical skills (Coffee & Hillier, 2008; Smith, Jones, Cavanaugh, Venn, & Wilson, 2006). There are parallel applications of the *flipped classroom model* for skills education in related fields (Cannon et al., 2009; Faraone et al., 2013; Goorah & Bahadur, 2012; Kelly, Lyng, McGrath, & Cannon, 2009). Three innovations distinguish this work from previous iterations (Ford, Mazzone, & Taylor, 2005; Mir, Marshall, Evans, Hall, & Duthie, 1984; Moore & Smith, 2012; Osborn & Tentinger, 2003; Simpson, 2003; Sole, Schneiders, Hébert-Losier, & Perry, 2013). First, total student workload remained unchanged; video viewing and unsupervised peer practice was scheduled during the first hour of the 2-hour practical class, with unrestricted video access. Second, the second hour of the class was solely dedicated to expert feedback and ongoing peer practice. Third, tutors were only present for the second hour. Students who had not viewed and practised the skill were not provided with expert demonstration or teaching of the skill during this time. In short, ready learners were able to obtain further advancement of their skills, and live tutor time was reduced by 50%.

Study sample

The study sample was the third-year physiotherapy cohort at Monash University. This four-year bachelor program accepts students directly from high school in addition to students who enter via alternative routes (e.g., course transfers, graduates from other degrees), with approximately 60% coming directly from high school. The average age of the third-year cohort is 23 years, and 60% of the students are female.

Questionnaire

Students' perceptions of the new teaching method were evaluated via two online questionnaires, delivered after each skills class. The questionnaire was opened immediately after the practical class and closed 72 hours later. Students were asked to indicate when they accessed the online video (i.e., before class, during the first hour of class, during the second hour of class, after the class or not at all). Students were also asked to provide their rating of agreement for seven statements—S1: I was more prepared for receiving feedback when tutor feedback opportunities became available; S2: I began preparing for the practical earlier than I would for a regular practical session; S3: Due to being prepared earlier, I was able to receive more practice time than I would have in a regular practical session; S4: Due to being prepared earlier, I was

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able to receive more feedback (including peer and/or tutor feedback) during the class than I would have otherwise; S5: I felt more in control of my learning; S6: I was happy with the new practical format for learning clinical skills; S7: I felt that my rapport/relationship with the tutor was unchanged, despite them being there for less of the practical time. Free text responses were collected in response to the prompt "What did you think of the new practical format?"

Analysis

Questionnaire responses were summarised with diverging stacked bar charts as recommended by Robbins and Heiberger (2011). In this method, positive responses are given as a positive percentage (of all responses) while negative responses are given as a negative percentage (of all responses). Neutral responses are shown separately (right panel).

Free-text responses were coded and examined using thematic analysis (Liamputtong, 2013). Two members of the team independently coded the free-text responses. Whenever possible, the codes were named using the actual words or terms used by respondents. Once this was complete, we looked for emergent patterns within and between the codes. This process, axial coding, was used to identify themes within the data. We then returned to the data to see whether these themes were an accurate summary of the actual responses or needed to be adjusted. Once we were confident that the themes accurately represented the participants' responses, we then looked for similarity within the themes. In the final model, the highest-level groupings are called themes and the lower-level groupings are called subthemes. We returned to the data one more time to select direct quotes to accurately illustrate each theme. We took special effort to select both positive and negative responses for each theme to reflect the range of experiences with the new teaching method. It is important to note that this approach can make a positively-skewed distribution of responses (i.e., 8 positive and 2 negative) look more like a 50:50 distribution (i.e., 1 positive and 1 negative). To address this limitation, the thematic analysis was triangulated using the questionnaire responses.

Financial modelling

The cost of developing, implementing and maintaining the teaching model were modelled across a range of scenarios. Key variables were manipulated to explore the effect this would have on the financial sustainability in various contexts. A ready reckoner table was developed to allow academics working under a variety of operational conditions to quickly estimate the initial set-up costs, break-even time and long-term costs or savings. For example, the implementation cost was examined where tutor costs were 25% lower and higher than costs at our institution to accommodate academics working in high-cost and low-cost environments. The time periods were selected to minimise data-overload while still covering relevant timespans (i.e., 1, 3, 5, 10 years). Universities with large cohorts must repeat tutorials if they wish to constrain class sizes; as this teaching model saves 1-hour of tutor time for each repetition, the cost savings are a function of cohort size. This factor was explored in the ready reckoner table by quantifying costs where the tutorial is repeated two, four or eight times per year. Another factor that is explored in the ready reckoner is the use, or not, of professional video services. From our experience, we estimated that 2 hours of professional filming is

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required, followed by 5 hours of editing and voice-over by the unit coordinator. Finally, the videos need to be replaced in order to keep pace with changes in clinical practice; the cost of updating the video at 1, 5 or 10 years is shown in the ready reckoner. Cost differentials were calculated by subtracting the delivery costs of the new method from the delivery costs of the traditional method.

Financial modelling was based on 2013 market costs. Unit coordinator input was costed at $42 per hour. Routine work associated with maintaining the virtual learning environment (VLE) platform was costed under "other academic activity" at $39 per hour. Video production costs ($320/hour) included multimedia services ($112.50/hour), tutor ($117/hour) and room hire ($90/hour). The list of costs considered is not exhaustive but is intended to illustrate the financial sustainability of the new model under a range of realistic conditions.

Ethics approval was obtained from the Monash University Human Research Ethics Committee [CF12/2137 – 2012001160].

Results

Survey responses were collected from 75% (54/72) of students after the lumbar spine skills class and 32% (23/72) of students after the vestibular skills class. As the same group of 72 students were asked to give feedback twice, using the same questionnaire format, between 75% and 100% of the 72 students responded to at least one questionnaire. It was not possible to identify when a student answered the questionnaire twice. Responses were pooled for analysis (n = 77). Respondents accessed the video before the practical class (n = 71), during the first hour of the class (n = 35), during the second hour of the class (n = 13) and after the class had finished (n = 13). Many respondents watched the videos at multiple time points (Table 1). The most common time combinations were i) only before the class (n = 35) and ii) before the class and during the allocated preparation time during the first hour of the class (n = 17).

Table 1
Number of Times That Students Watched Video

Times watched	Viewing pattern (see key in note)					
None (n = 1)						
Once (n = 39)	A = 35	B = 3	C = 0	D = 1		
Twice (n = 21)	AB = 17	AC = 2	AD = 2	BC = 0	BD = 0	CD = 0
Three times (n = 13)	ABC = 6	ABD = 5	ACD = 1	BCD = 1		
Four times (n = 3)	ABCD = 3					

Notes: A = before the class (n = 71); B = first hour of class (n = 35); C = second hour of class (n = 13); D = after class (n = 13)

More than 85% of respondents agreed or strongly agreed to statements S1–S6 (Figure 2). Although there was an increased number of neutral responses to statement S7, >75% of respondents agreed or strongly agreed with this statement. For all questions <5% of respondents disagreed or strongly disagreed.

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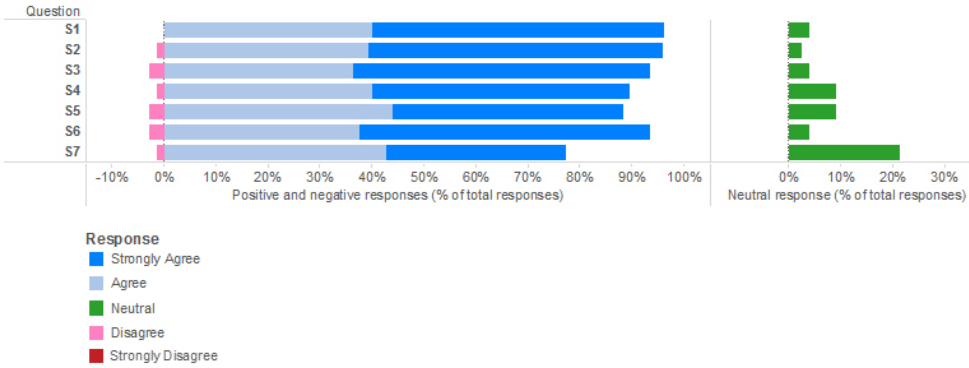

Figure 2. Respondents' feedback on the new teaching model (diverging stacked bar chart).

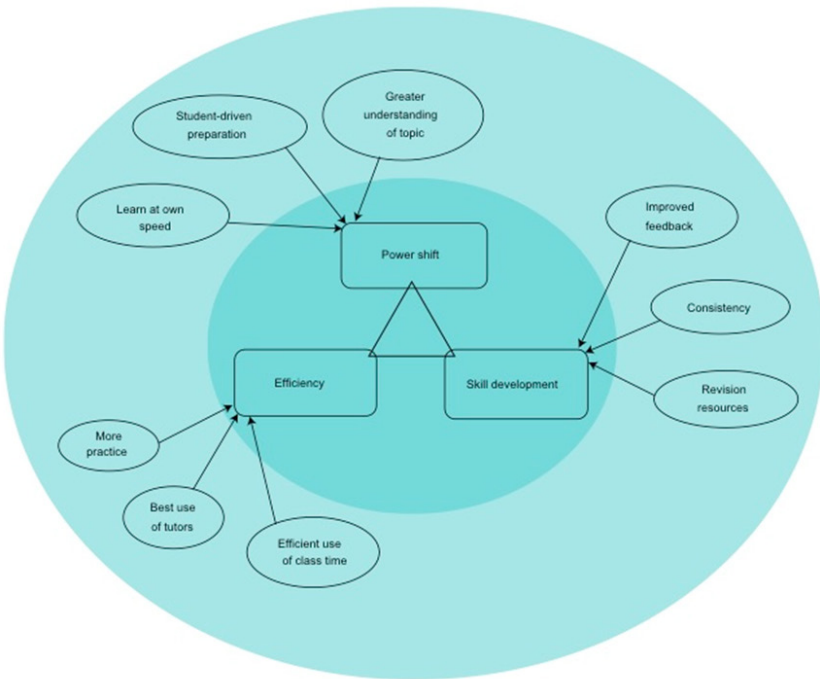

Figure 3. Key themes (inner circle) and subthemes (outer circles) identified in free-text responses from students in response to the new teaching method.

Thematic analysis revealed that respondents felt greater control over their learning (*power shift*), achieved a greater depth of understanding (*skill development*) and perceived greater efficiency in the teaching method (*efficiency*). These themes are shown visually in the centre of Figure 3, along with the contributing subthemes in the outer ring.

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Theme 1: Power shift

A shift in the power dynamic towards student responsibility emerged from the data. Respondents used a range of words and phrases to describe a sense of ownership and responsibility for their own learning outcomes. This included terms such as adult learning, ownership, control, independent learning, motivation and preparation. Key subthemes under *power shift* were the ability to *learn at own speed*, *student-driven preparation* and *greater understanding.*

Theme 1.1: Learn at own speed

The ability to pause and rewind the video was particularly helpful. Respondents reported that they paused the video to take notes or watched a particular aspect of the demonstration several times until they fully understood the requirements of the task.

> *"It allows me time to understand and re-watch if needed."*
>
> *"I can watch the videos at my own pace and write notes."*
>
> *"The flexibility of the new practical session allows you to work through things at a pace that suits rather than rushing to complete content in a set time."*

Theme 1.2: Student-driven preparation

Increased motivation to study before the scheduled practical class was a strong theme. Respondents who engaged with the learning material prior to class reported having better focus on the task at hand during class. Previously, they reported dividing their attention between watching the demonstration and taking notes. The contributing themes under *student-driven preparation* included *more prepared, greater understanding, better in-class focus* and *learning independence.*

> *"It made me able to prepare earlier for prac than I normally would."*
>
> *"I felt more prepared for this prac than any other, and I felt that because I knew what I was doing, the time with the tutors was much more effective."*
>
> *"I think it works well as long as you prepare. Some of the students in our prac class didn't and mentioned that they wished they had upon reflection."*

Theme 1.3: Greater understanding

The participants reported greater understanding and increased confidence in performing the practical skills taught during the class. Many students identified the ability to learn at their own speed (Theme 1.1), student-driven preparation (Theme 1.2) and more practice (Theme 3.2) as factors that contributed to their increased understanding.

> *"Going over the material by myself I think also helped me better learn the techniques."*
>
> *"I really enjoyed it, felt like I learnt much more than a usual prac session."*
>
> *"I learned so much more and got so much more hands-on time."*

Theme 2: Skill development

Skill development was a key theme that emerged from the survey responses. The more effective development of practical skills was linked to subthemes of *improved feedback, target clarity, consistency* and *revision resources.*

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Theme 2.1 Improved feedback

Respondents consistently reported receiving more feedback with the new teaching method despite tutor time being reduced. Having a flipped classroom teaching method prevented tutor time being consumed with explaining and demonstrating skills. In fact, reserving tutor time solely for feedback was a key feature of the new teaching method.

"I think that it gives you the opportunity to receive more targeted feedback."

"This format allowed every student to get personal feedback for their performance."

"It also allowed greater time for feedback and assistance to be received from the tutors."

Theme 2.2: Consistency (Target Clarity)

Target clarity means that students have a clear understanding of the desired outcome they are working towards. Target clarity is reduced when different tutors demonstrate a skill slightly differently. Even though students understand this is normal clinical practice, they prefer working towards a single clear target.

"I like that everyone learns the same thing. We've had a few problems in other years where two prac groups get taught different things due to different tutors."

"Also, it standardises the content, as previously we had found that different prac groups were taught different things due to the variety of prac tutors. Now we know exactly what is expected of us."

"I understand that it is good to have variation in techniques being taught, but it is also extremely reassuring to master a given technique, and to not be shown a different one by another student later-on in the course which can sometimes lead to doubt over who is correct (even though both are probably right)."

Theme 2.3: Revision resources

As students have on-going access to online resources, they are able to use these during independent skills revision in the lead up to practical exams and clinical placements. The respondents indicated that they plan to use the videos for this purpose.

"The videos will be handy to look at again."

"It is a great resource come exam time."

"The videos were really descriptive and will be a great resource for OSCE prep."

Theme 3: Efficiency

Efficiency was a strong theme that emerged from the survey responses. As well as explicitly identifying efficiency, students also made note of having time for *more practice* (Theme 3.2), and they felt that the format provided for *better use of tutors* (Theme 3.3). The respondents clearly identified the previous inefficiency of having the tutor deliver background content and felt the new method was a better use of the tutor resource, although concern was raised regarding lack of guidance in the unsupervised component of the practical class.

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Theme 3.1: Efficient use of class time

The respondents generally indicated that the new teaching approach was a more efficient use of tutorial time. A minority of students felt the first hour was wasted.

> *"I think it was useful to spend the time actually practising, and not be introduced to things which we could read in our own time."*
>
> *"I think the new practical format was great as it cut out all the time wasted on watching the tutor performing a task."*
>
> *"It felt like we almost wasted an hour being unsure as to what to do and had no other guidance than from the videos."*

Theme 3.2: More practice

A consistent message from the respondents was that moving the explanation and demonstration online allowed more class time to be used for explicit practice of the skill being taught.

> *"It allowed us to practise our skills for a longer period of time allowing us to master the skills."*
>
> *"Also, we have more time to practise on different students, gain peers' perspectives and learn more from what our peers are doing."*
>
> *"Everyone I worked with had already watched the videos so we spent 2 hours practising the content."*

Theme 3.3: Better use of tutors

The respondents generally indicated that they preferred the tutors' time be used for providing hands-on feedback rather than explaining and demonstrating a skill. This theme was closely linked with efficiency, as it allowed well-prepared students to progress rapidly through tasks rather than having to wait for the explanation and demonstration to be finished before starting hands-on practice.

> *"I have always found the practical format frustrating and an impractical use of our and our tutor's time. This resolved all the issues; I learned so much more and got so much more hands-on time. Greatly prefer this way."*
>
> *"Having the time to carefully and thoroughly go through the pre-reading materials and videos was really good to revise all aspects of the practical which then made the tutor-supervised practical session far more productive."*
>
> *"I think you can miss valuable demonstration time with the tutor."*

Economic analysis

The new teaching method as implemented in our setting—one skills class delivered to four groups each year, with a new video created and then updated every 3 years (requiring 2 hours of professional filming and 5 hours of editing and voice over), was more expensive after 1 year but generated cost savings after that time (Model A in Table 2). In contrast, if the class is taught to eight groups of students each year, there is a saving at all time points, reaching $6,000 at Year 10. Extending the time between video updates increases cost savings over time. Similarly, if learning resources are constructed by the unit coordinator, costs savings are seen at all time points.

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Table 2
Ready Reckoner: Sensitivity Analysis of Incremental Cost Differential Between New Teaching Method and Traditional Teaching Method

Model	Repetitions of class per year	Sessional tutor ($/hr)	Filming costs ($/hr)	VLE ($/hr)	Video update schedule*	1 year cost differential	3 year cost differential	5 year cost differential	10 year cost differential
A: new model with professional video services	4	117	320	39	3	-366	570	672	1,344
B: new model with existing video (i.e., update costs but no creation costs)	4	117	320	39	3‡	468	1,404	1,506	2,178
C: unit coordinator as video creator with department owned camera, no room hire, volunteer demonstrator and patient	4	117	42	39	3	189	1,125	1,782	3,564
D: halve number of class repetitions	2	117	320	39	3	-600	-132	-498	-996
E: double number of class repetitions	8	117	320	39	3	102	1,974	3,012	6,024
F: decrease tutor costs 25%	4	88	320	39	3	-483	219	87	174
G: increase tutor costs 25%	4	146	320	39	3	-249	921	1,257	2,514
H: decrease filming costs 25%	4	117	240	39	3	-206	730	992	1,983
I: increase filming costs 25%	4	117	399	39	3	-526	410	353	705
J: decrease VLE costs 25%	4	117	320	29	3	-317	619	770	1,539
K: increase VLE costs 25%	4	117	320	49	3	-415	521	575	1,149
L: decrease update schedule to 1 year	4	117	320	39	1	-366	-1,098	-1,830	-3,660
M: update schedule increase to 5 years	4	117	320	39	5	-366	570	1,506	3,012
N: update schedule increase to 10 years	4	117	320	39	10	-366	570	1,506	3,846
O: all tasks by unit coordinator	4	NA	245	42	3	69	1,605	2,442	4,884

*number of years between updates
Notes: Shaded highlight indicates the variable/s that differ from Model A. Model A outlines the estimated costs for a department that wishes to create a new video using professional video services, delivers the same tutorial to four separate classes each year and plans to replace the video every 3 years to keep pace with current practice. Model A assumes sessional tutor costs of A$117 per hour and unit coordinator costs of A$39 per hour. All costs in Australian dollars.
All scenarios include 2 hours allocated for filming and 5 hours allocated for editing and uploading to virtual learning environment (VLE) platform.

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Discussion

For this study, we designed, implemented and evaluated a novel approach to teaching complex clinical skills to physiotherapy students. The majority of respondents reported a positive perception of the newly implemented teaching method. Thematic analysis explored contributing factors, with responses clustered around three key themes—*power shift*, *skill development* and *efficiency*.

The *power shift* theme centred on students taking responsibility for pre-class preparation (i.e., adult learning). Adult learners are active and collaborative constructors of their own knowledge base. The effectiveness of adult learning is well supported (Michael, 2006), although some question the underlying assumptions of the theory (Misch, 2002; Norman, 1999).

A key implementation step was informing students that video content would not be repeated in class. This generated an imperative to engage with the material before class and rewarded the prepared learner. This imperative would be diluted if the teacher acquiesced to requests from unprepared students to explain the material. Nearly all (92%) respondents chose to access the video before attending class, which supports the idea that students took ownership of their learning.

The *skill development* theme indicated that respondents were satisfied with learning outcomes and felt confident in their ability to perform a skill. This increased satisfaction level was achieved despite the tutor being present only for the second hour. In fact, >85% of respondents agreed or strongly agreed that feedback opportunities increased rather than decreased (Figure 2). This is an interesting finding considering tutor time was halved. Other key contributors to this theme included the two related subthemes of *consistency* and *target clarity*. The reference video provided a benchmark of skill mastery, which has been shown to improve performance in other areas of practice (Faraone et al., 2013; Feil & Reed, 1988).

The *efficiency* theme emerged strongly with respondents valuing the new model where all allocated time was used for skill practice and feedback. This was achieved by delivering basic concepts and learning foundations through the demonstration video. The tutor did not demonstrate how to perform the skill but instead provided advice on what students needed to change in order to match the criterion standard shown on the video.

The cost analysis allows estimation of the cost of implementing this teaching method in other settings. The scenario implemented in this study is estimated to generate a savings of $1,300 over 10 years compared with the traditional model (1 skills class to 4 groups of students each year). Modelling indicates that substantial cost savings can be generated ($3,500 over 10 years, per practical class) if academic staff film/produce the multimedia themselves. Similarly, substantial savings can be generated with professional video production if videos are refreshed at 5- or 10-year intervals. The key message distilled from this sensitivity analysis is that individual circumstances will determine whether this new method will be more or less expensive than a traditional model. Key factors include the number of times the same class is taught each year and frequency of video resource updating.

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A limitation of this study is the absence of objective data comparing student performance with the new versus traditional method. As we did not compare student performance under the new teaching model against performance with the old model, it is possible that results deteriorated; however, previous research in combination with student evaluations suggests that this is unlikely (Faraone et al., 2013; Ford et al., 2005). Nevertheless, it has been argued that e-learning research should not ask "if" we should use e-learning, but rather ask "when" and "how" it should be used most effectively (Cook, 2009). This is based on the observation that e-learning is better than no intervention (Cook et al., 2008) and that e-learning is little or no different from traditional teaching methods (Clark, 2002; Cook, 2009; Cook et al., 2008; Roh & Park, 2010). Therefore, the focus of this work was not whether students performed better under examination but instead focused on the students' experiences.

The survey response rate was another limitation, as we do not know whether there were systematic differences between those who did and did not submit survey responses. However, as noted in the results section, between 75% and 100% of students responded to at least one survey. A factor that may impact implementation is staff and student familiarity with online learning environments. In fact, difficulty with technology has been noted as a key barrier to learning for some students (Cannon et al., 2009; Coffee & Hillier, 2008).

An additional limitation of the study is the wording of statements S3 and S4, where we ask the students to evaluate both the change in feedback opportunities and the cause of that change (i.e., due to being prepared earlier). This creates an issue for students who have not prepared earlier, as there is no valid response. We can speculate that an unprepared student might strongly disagree or disagree with this statement. However, the situation becomes decidedly unclear if we try to predict how an unprepared student who felt they gained more feedback might respond. We decided to group these factors into one statement focusing the students' attention on the cause of the change, but acknowledge the leading sentence construction has created ambiguity in the response data for these statements.

A limitation of the economic analysis is that it does not consider student costs in purchasing computer hardware and software. We also did not account for university costs of providing Wi-Fi access for on-campus students. These assumptions may be inappropriate at other institutions and would influence cost analysis.

An implementation consideration is student safety during unsupervised practice time. This trial included a cohort of senior students who are familiar with the safe use of practical room equipment and appropriate behaviour. If implemented with more junior students, greater staff supervision may be appropriate.

In summary, a practical skill teaching approach that utilises online skill demonstration and peer practice as essential requirements to access expert feedback can be implemented whilst preserving the student learning experience within an undergraduate health professional program. Our modelling indicates that the new learning approach as implemented in our setting ran at a deficit in Year 1 (-A$366) but delivered a surplus at Year 3 (A$570) and beyond. Student control over their learning was increased with this teaching model, and students reported feeling that there were increased opportunities for feedback.

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