The value of an e-learning bundle in the acquisition of a clinical skill: Exploring the perceptions of third-year medical students at Stellenbosch University, South Africa

by

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ABSTRACT

Introduction: The influence of e-learning and blended learning approaches (such as flipped classrooms) on the assimilation of theoretical knowledge has been studied extensively. However, health professions education requires not only the acquisition of theoretical knowledge but also the ability to integrate theoretical knowledge with clinical psychomotor skills to graduate as a clinically competent healthcare practitioner. While it is challenging to teach clinical psychomotor skills online, the cognitive component as well as practical demonstrations can be addressed in a flipped classroom scenario. This study aimed to determine how valuable students found an e-learning bundle on the administration of injections in preparation for a face-to-face contact session on the same topic.

Materials and methods: Forty-one of 133 third-year medical students undergoing the Internal Medicine rotation participated in the study. They had to have completed the e-learning bundle on injections, attended the face-to-face contact session and completed an online medical e-learning evaluation questionnaire within 72 hours thereafter.

Results: The students indicated that they had found the e-learning bundle to be extremely valuable in their preparation for the contact session, with a mean score of 9 out of a possible 10. The students also reported positively on the content, the relevance for their level of training and their overall enjoyment of the bundle. The students identified some barriers, namely not having enough time for preparation within a very full curriculum and experiencing technical difficulties such as slow loading and incompatible video formats.

Discussion: Using an e-learning bundle in preparation for a contact session seems to be beneficial before actually practising the skills. By creating protected time for the students to complete the online learning related to clinical skills, the face-to-face contact sessions can be more focused on the actual psychomotor component, resulting in more time for deliberate practice in the Simulation and Clinical Skills Unit (SCSU). The latter has been proven to improve performance in clinical skills in real-life scenarios.

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OPSOMMING

Inleiding: Die invloed van e-leer en gemengde leerbenaderings (soos omgekeerde klaskamers) op die assimilasie van teoretiese kennis is breedvoerig bestudeer. Onderwys in gesondheidsberoepe vereis egter nie net die inwin van teoretiese kennis nie maar ook die vermoë om teoretiese kennis met kliniese psigomotoriese vaardighede te integreer om as ‘n klinies bevoegde gesondheidswerker te kwalifiseer. Alhoewel dit uitdagend is om kliniese psigomotoriese vaardighede aanlyn aan te leer kan die kognitiewe komponent sowel as praktiese demonstrasies in ‘n omgekeerde klaskamer-scenario aangespreek word. Hierdie studie was daarop gemik om vas te stel hoe waardevol studente ‘n e-leer bundel oor die toediening van inspuitings gevind het ter voorbereiding van 'n aangesig-tot-aangesig kontakgeleentheid oor dieselfde onderwerp.

Materiaal en metodes: Een-en-veertig van 133 derdejaar mediese studente wie die rotasie van Interne Geneeskunde ondergaan het aan die studie deelgeneem. Hulle moes die e-leer bundel oor inspuitings voltooi het, die aangesig-tot-aangesig kontakgeleentheid bywoon en binne 72 uur daarna ‘n aanlyn mediese e-leer evalueringsvraelys voltooi.

Resultate: Die studente het aangedui dat hulle die e-leer bundel uiters waardevol gevind het in hul voorbereiding vir die kontaksessie, met ‘n gemiddelde telling van 9 uit 'n moontlike 10. Die studente het ook positief gerapporteer oor die inhoud, die relevansie vir hul vlak van opleiding en hulle algehele genieting van die bundel. Die studente het ‘n paar hindernisse geïdentifiseer, naamlik dat hulle nie genoeg tyd gehad het vir voorbereiding binne ‘n baie vol kurrikulum nie en tegniese probleme ondervind het, soos stadige laaityd en onversoenbare videoformate.

Bespreking: Die gebruik van ‘n e-leer bundel as voorbereiding vir ‘n kontaksessie blyk voordelig te wees voordat die vaardighede geoefen word. Deur die beskerming van tyd vir studente om die aanlynleer wat met kliniese vaardighede gepaard gaan te voltooi, kan die aangesig-tot-aangesig kontakgeleenthede meer gefokus word op die werklike psigomotoriese komponent, wat meer tyd vir doelbewuste oefening in die Simulasie- en Kliniese Vaardighede-eenheid (SKVE) tot gevolg het. Laasgenoemde het bewys dat dit die prestasie in kliniese vaardighede in werklike scenario’s verbeter.

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questions.

- My supportive husband who made countless cups of coffee and took care of our children while I was glued to my computer.
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- My Father God, for giving me strength, motivation, and calmness when the world around us were falling apart.

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1. Introduction

Advances in technology have characterised the last few decades in all educational spheres, and e-learning, in various formats, has proven to be very valuable as an educational strategy to facilitate flexible, active engagement and self-directed learning in students [1–6]. This global shift towards e-learning has been escalated during the COVID-19 pandemic because in many cases that was the only way in which educators could present lectures and content [7,8]. This is true not only for education globally but also for health professions education, and has proved especially challenging for students are required to also learn clinical skills. The literature has proved that e-learning can be effective in conveying cognitive and affective content [9,10], but the psychomotor learnt online, for example handwashing and biomedical waste disposal [11], or that skills such as injections or intraosseous access can be learnt remotely, given that the skills practice sets are available to the student [12]. In low- to middle-income countries such as South Africa, the resources may not be available to teach psychomotor skills online only. A possible solution to this problem is to incorporate e-learning as preparation for a face-to-face contact session. The added benefit of this flipped classroom setup is that face-to-face contact sessions can be utilised to facilitate deliberate practice with feedback, which can lead to deeper understanding and clinical competence in real-life situations.

At Stellenbosch University, third-year undergraduate medical students attend five clinical rotations, one of which is Internal Medicine. During this rotation, students are expected to attend face-to-face contact sessions in the SCSU and will learn certain clinical skills related to the rotation. One such skill is the administration of intramuscular and subcutaneous injections. Students are expected to use the online learning management system (SUNLearn) to prepare for these contact sessions, although anecdotal evidence suggests that students lack time and motivation to prepare for contact sessions. During the face-to-face contact session they are given another demonstration, chances to ask questions for clarification, and practice the skill under supervision of a staff member. Groups consist of approximately 15 students with one facilitator, and one 45-minute session per group is facilitated on learning to perform intramuscular and subcutaneous injections. This short timeframe does not allow for much deliberate practice to occur, considering the amount of cognitive knowledge that has to be processed in conjunction with the psychomotor component. One could argue that if a fun, interactive e-learning bundle was available, students may be more motivated to utilise it in preparation for the face-to-face contact session.

This study aimed to explore the perceptions of third-year medical students at Stellenbosch University, South Africa, of the value of an e-learning bundle on injection administration in preparation for a face-to-face contact session.

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2. Extended literature review

2.1 E-learning and blended learning

Many researchers have attempted to define the term ‘e-learning’, but there appears to be a lack of consensus on an official definition [5,6,13]. E-learning can conceptually be described as any learning that is enabled by technology and electronic and/or mobile media [14–17] and is used to facilitate the adoption of knowledge, skills and attitudes [6]. E-learning may include a variety of learning methods, devices, applications and processes aiding and supporting learning [15,18] while simultaneously doubling as a pedagogical approach to facilitate student-centeredness and flexibility [19]. Multiple factors may influence the attitude towards and utilisation of e-learning. These may include the motivation of students to engage in the preparation [16] while taking cognisance of their time constraints [20–24]. The usability of the e-learning material can influence the utilisation of e-learning positively or negatively [3,25]. Digital literacy of students [26–28], internet accessibility [29] and instructional design [30–33] are also factors that warrant consideration as possible influencers of e-learning utilisation.

E-learning can be utilised as an individual strategy but can also be combined with face-to-face contact sessions; this is labelled as blended or hybrid learning [34–39]. The ratio of face-to-face sessions and e-learning is flexible and can be adapted as required or deemed fit by the facilitator, or in some cases are governed by the Council for Higher Education, as well as undergraduate, postgraduate, residential or online programmes. The flipped classroom is one form of blended learning found ubiquitously in the literature. Students are expected to engage with content in preparation for the session followed by a face-to-face contact session during which understanding is deepened, questions and concerns can be addressed and feedback can be given [40–44]. Amongst the benefits of a flipped classroom is that students determine their own pace of learning, the material is available for revision as many times as is required and it allows flexibility and developing problem-solving skills and self-directed learning [45–47]. Knowledge can be shared among students and active learning is encouraged [45,48,49]. Flipped classrooms also pose some challenges for students, facilitators and instructional designers involved in content creation. Students have to adapt their way of thinking while moving from a consumer position to a co-constructor of knowledge in a self-directed environment [43], and the considerations are the same as when considering how students perceive and utilise e-learning. For the facilitators, classroom activities should be carefully planned and focused on problem solving, discussions and group work. Collaboration between a content expert and an instructional designer is imperative to create content and manage the accessibility and usability of resources [43,45,48]. The combination of face-to-face learning with e-learning learning holds the advantages of both methods [16,43,48]. Students still attend class, experience human interaction and have the opportunity to ask questions but to some extent have the flexibility to gather information at their own pace and at convenient times [36,38,50].

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2.2 Application of e-learning in health professions education

Medical education is not insulated against the influences of the global movement towards e-learning, which has been used internationally in the education of health professions students for the past two decades [50]. However, the landscape has changed considerably within the past 20 years – new technology, software and formats, and advanced internet capabilities have become available [9]. In the current state of affairs with the COVID-19 pandemic, e-learning is considered an essential teaching strategy in medical education for the transfer of cognitive knowledge onto the clinical platform [10,51–53]. Medical education involves not only theoretical knowledge but also a clinical skills component – the combination of these two components is required of the doctors of the future to render preventative, diagnostic and curative care. To gain clinical competence, students need to be able to practise skills without endangering themselves or their patients, hence the establishment of simulation units globally [54–56].

Simulation is widely regarded as an acceptable alternative to practising skills on actual patients; a low-risk and low-pressure environment is created where students have 'permission to fail' and no patient lives are placed at risk [57,58]. Students can practise repeatedly until confident and able to perform the procedure safely on a patient [3,59]. Miles [90] postulated that in nursing education, adequate and effective simulation could replace up to 50% of clinical time and still lead to increased readiness for practice and reaching educational outcomes. Partial task training falls under procedural simulation and is considered to be appropriate and effective when practising psychomotor skills, procedures and techniques [56]. Partial task training occurs when students use a simulator to practice the psychomotor part of a task, as opposed to full task training where all aspects of the skill is practiced. Movement from novice to expert depends directly on the time that is spent on the practice of the skill, whether in simulation or real life [60].

2.3 Models of procedural skills learning

Diverse theoretical models have been described in the literature on effective methods to learn procedural skills, and many of these overlap somewhat. Dreyfus describes the five stages of adult skills acquisition (figure 1) as the progression from novice to expert [61–63]. These steps toward expertise include various levels of responsibility and 'following the rules'.

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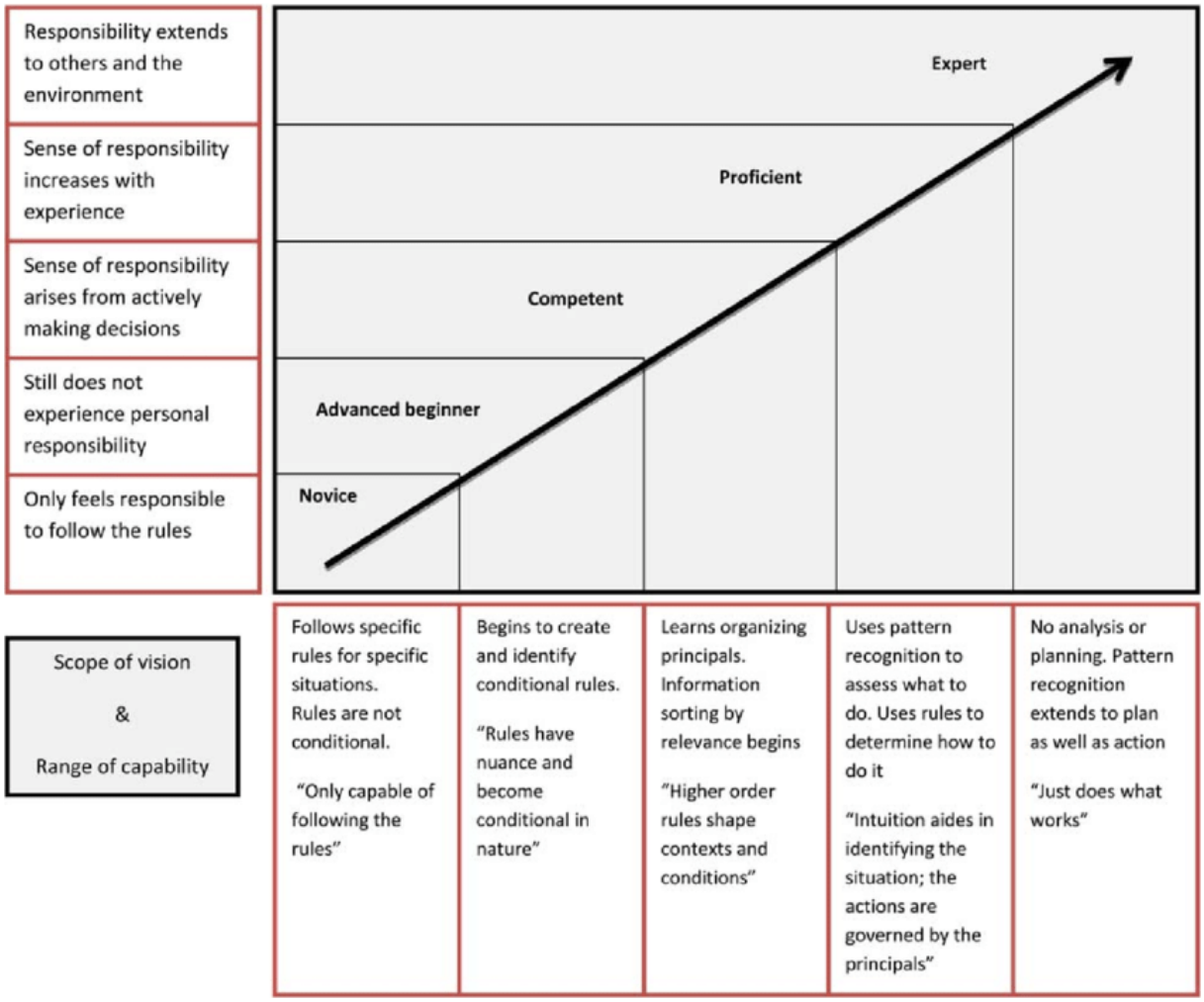

Fig 1 The Dreyfus model of skills acquisition [63,64]

'Novices', or beginners, typically learn by using theoretical knowledge but are unable to link it to clinical practice due to the lack of experience and if in clinical practice should be closely supervised. They have minimal concepts of complexity and tend to see events in isolation with a very narrow view of the task at hand. The 'advanced beginner' has some clinical exposure and can therefore start to link theoretic knowledge to clinical practice and start to understand the context of knowledge within clinical practice. Decisions are still made following a step-by-step approach. 'Competence' implies that students will have good working and background knowledge. Their judgement can be used in most clinical situations, but complex situations are still managed by analysis and planning. They view their actions as part of long-term planning. 'Proficient' individuals can see the bigger picture and view actions within a specific context. They perform independently, take responsibility for their actions and can confidently analyse and navigate through complex situations. Finally, an 'expert' is an individual who is confident in her/his knowledge, has an excellent skill set, can intuitively navigate through the most complex of situations and can see the greater picture and how her/his decisions and actions influence her/his care.

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Another model that describes the progression from knowledge to skilled performance is Miller's Pyramid of Clinical Competence. This model was proposed by George E Miller in 1990 [65] and was developed initially to assess clinical competence. However, it can also serve as a guide for the process through which students need to move to reach competence. There are four tiers on which assessment of clinical competence could be done: The first tier concerns testing knowledge only, and therefore the first step to learning the skill is to understand the theoretical aspects or cognitive knowledge on the subject. The second tier is where application or interpretation of knowledge is tested; does the student know how to perform the skill? These two tiers constitute the cognitive levels of the pyramid. The behavioural tiers are 'shows' and 'does'. At the 'shows' level, which is the third tier, students can demonstrate their skills in simulation and can be assessed by utilising methods such as objective structured clinical examination. The last tier, 'does', implies that students can perform the skills safely and can be evaluated as such when task complexity is added. Miller's Pyramid was adapted in 2009 by Mehay and Burns (see Figure 2). They added the dimensions of knowledge, skills and attitudes to each level, implying that there is no progression from knowledge to skills to attitudes but that all three dimensions are present for each level. However, Miller's Pyramid does not allow for the development past the 'does' tier, whereas Dreyfus [63] caters for progression to an expert skills level whereby a student can adapt in response to situational changes.

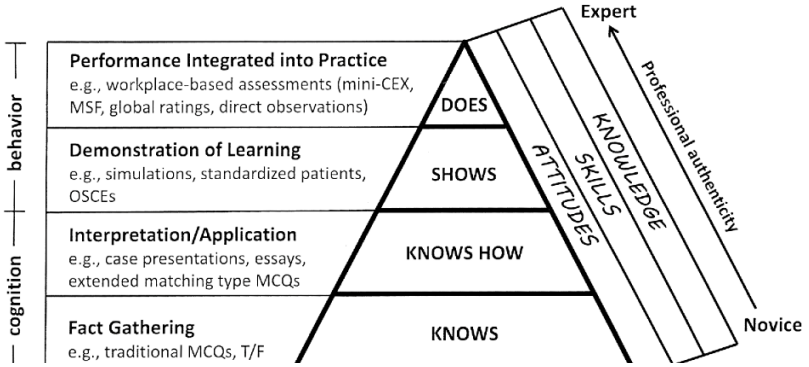

Fig 2 Miller's Prism of Clinical Competence [68]. Adapted Mehay & Burns, 2009

Peyton [66] and George and Doto [67] describe similar models for learning clinical skills. George and Doto initiate the process of learning a skill by ensuring that the students understand the relevance and importance of the skill within the clinical area. If students believe that they will never need or use certain skills, they may not invest in learning and practising these skills optimally. Both Peyton, and George and Doto concur that there should be a master (silent) 'demonstration', followed by a demonstration with a narrative explanation of the procedure (or 'deconstruction'). The student should verbally take the facilitator through the procedure ('comprehension') although this step might prove problematic with larger groups. The last step is 'execution', during which students perform and practise the skill themselves [66,67].

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Peyton [66]	**George and Doto** [67]
	Relevance
Demonstration	Silent demonstration
Deconstruction	Narrated demonstration
Comprehension	Student narrates the skill
Execution	Student does the skill

Table 1: Comparison of the steps of learning a clinical skill, as described by Peyton [66] and George and Doto [67]

To address the issue of larger groups, Nikendei et al. [68] proposed an adaptation to be used in larger groups of five to eight students. The facilitator conducts the demonstration and deconstruction, followed by the first student's talking the facilitator through the procedure while the other students observe. The next student then performs the procedure while the first student talks him/her through it and another student offers feedback. This is continued until everyone has had a chance to perform the procedure and to talk someone else through it and feedback has been received on everybody's performance. The facilitator then gives feedback to the last student and concludes the session. This may prove to be effective for groups of less than eight students, but often in skills units, student-to-facilitator ratios are much bigger and learning skills in this manner may not be feasible due to time constraints unless the demonstrations and discussions are done online. This will allow more time for consolidation of skills and deliberate practice in the skills unit.

Deliberate practice was initially described to explain why and how some people become masters in sports, art and science. The short answer is repetitive practice with feedback, over a prolonged period [69]. Ericsson et al. [69] postulate that these individuals focus on a specific skill, acquire knowledge on the topic, set objectives and then engage in focused practice to improve on that specific skill. They should then reflect on their practice and make adjustments accordingly to improve on their performance. Feedback plays an integral role in developing clinical skills as it may guide reflection and assist the individual to identify areas for improvement in her/his practice (Figure 3). Two instances with regard to skills development have been described by Ericsson [69]. First, an individual moves from novice to expert with regular feedback and subsequent change in technique, which allows for an improvement in skills performance up to a certain point. Second, students may have reached a certain level of competence but if the skill is not utilised regularly, skills decay will occur. Deliberate practice is valuable in both instances as a way to improve skills and also as a way to retain those skills. While clinical skills are merely part of becoming a competent medical practitioner, we are focusing only on partial-task psychomotor skills for this study.

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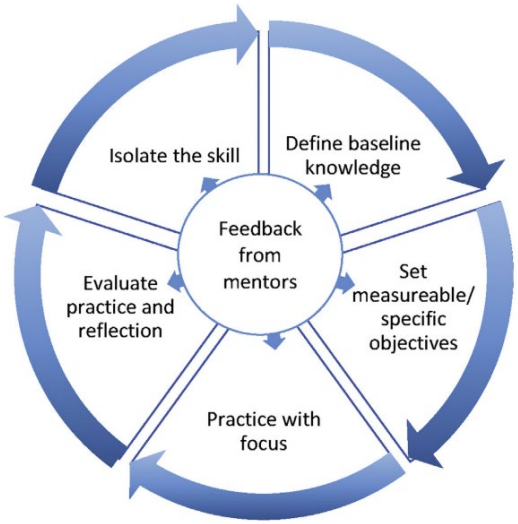

Fig 3 Phases of deliberate practice with feedback [74]

2.4 E-learning and clinical skills: Are they compatible?

E-learning has proven to be effective in improving cognitive knowledge [20,53,70,71,54,55,64–69] and since knowledge is the foundation of learning any clinical skill [65], theoretically, e-learning could be incorporated into clinical skills training. Students have reported a positive experience when combining e-learning with face-to-face contact sessions [15,38,51,54,74]. They found e-learning enjoyable and beneficial when learning consultation skills [39], physical examination skills [79,80] and handwashing skills [81]. E-learning may be beneficial in procedural skills training when it encourages student engagement in preparation for sessions in a flipped classroom scenario [45,49,82]. E-learning is considered helpful as a resource for revision whereby students can work through the material at hand at leisure; they can watch and re-watch demonstration videos to assist them in processing information and preparing for procedural skills practice [83–85]. Proper preparation utilising e-learning may shorten the discussion, demonstration and explanation times during the skills sessions; therefore, students will have more time to practise with feedback from the facilitator [16,86,87] and engage in deliberate practice. Lack of practice under controlled circumstances may lead to anxiety and poor performance in clinical placements [88]; therefore, the limited time in the skills unit should be optimised.

The literature suggests that due to the nature of psychomotor skills, they cannot be learnt to the full extent in an online format [82]. However, Seymour-Walsh et al. suggested that if students had internet connectivity and equipment available at remote sites, limited skills could be learnt online. The students would require a stable internet connection to view the e-learning demonstrations and for the facilitator to be able to give feedback during the practice, as well as equipment, for example needles, syringes and an orange for practising injections, or a sponge with a suture kit for practising suturing techniques [12]. This may be feasible in a well-resourced environment, to a certain extent,

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but would not be a viable option for skills such as catheterisation or venepuncture as anatomical models are required to practice the skill. In studies done by Bloomfield et al. [16,81,89], the possibility of integrating e-learning into clinical skills training has been explored. These studies showed promise regarding future integration but reiterated that the face-to-face contact session was found extremely valuable to the students. These contact sessions assisted in deepening the students' learning and assisting them to consolidate the skill.

Many different theories of learning of clinical skills have been described over the last decades, but they all follow similar structures – students start at novice level, and as their experience and cognitive knowledge expands, they are able to perform more complex tasks in a variety of scenarios. The way in which they learn clinical skills typically involves watching the procedure, verbalising the procedure and then engaging in deliberate practice with feedback.

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3. The manuscript prepared for submission to the medical science educator

Title: The value of an e-learning bundle in the acquisition of a clinical skill: Exploring the perceptions of third-year medical students at Stellenbosch University, South Africa

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Abstract

Introduction: The influence of e-learning and flipped classrooms on the assimilation of theoretical knowledge has been studied extensively. However, medical education requires not only the acquisition of theoretical knowledge but also the ability to integrate theoretical knowledge with clinical psychomotor skills to graduate as a clinically competent healthcare practitioner. While it is challenging to teach clinical psychomotor skills online, the cognitive component can be addressed in a flipped classroom scenario. This study aimed to determine how valuable students found an e-learning bundle on the administration of injections in preparation for a face-to-face contact session on the same topic.

Materials and methods: Forty-one of 133 third-year medical students undergoing the Internal Medicine rotation participated in the study. They had to have completed the e-learning bundle, attended the face-to-face contact session and completed the online Medical E-learning Evaluation (MEES) within 72 hours.

Results: The students indicated that they had found the e-learning bundle to be extremely valuable in their preparation for the contact session as well as relevant to their level of training. The students identified some barriers, namely not having enough time for preparation and experiencing technical difficulties such as slow loading and incompatible video formats.

Discussion: Using an e-learning bundle in preparation for a contact session seems to be beneficial before actually practising the skills. By creating protected time for the students to complete the clinical skills related to online learning, the face-to-face contact sessions can be more focused on the actual psychomotor component, resulting in more time for deliberate practice in the Simulation and Clinical Skills Unit (SCSU). The latter has been proven to improve performance in clinical skills in real-life scenarios.

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3.1 Introduction

Many medical curricula have traditionally been overloaded in terms of content [90,91]. At Stellenbosch University, clinical skills training through simulation constitutes a small percentage of the total curricular activities, and therefore minimal time is allotted (and available) for attending the SCSU and practising a clinical skill there. With the arrival of COVID-19, almost all teaching had to move to online platforms, which necessitated creative approaches to online learning, especially of clinical skills. Literature on the integration of e-learning into clinical skills training appears to be lacking, which demanded urgent innovation to restructure clinical skills training utilising blended (or hybrid) approaches.

Technology in medical education has advanced immensely over the past decades, especially within the e-learning space [12,52,78,81]. This shift has escalated during the COVID-19 pandemic because learners and lecturers alike had to adapt quickly and forcefully to e-learning (or online learning) [7,8]. The influence of e-learning and blended learning approaches on the assimilation of theoretical knowledge and assessment thereof is well studied [7,93].

However, medical education requires not only gaining theoretical knowledge but also acquiring the psychomotor skills needed when performing diagnostic and curative procedures, which are considered essential skills for graduation as a medical professional. Clinical skills cannot be fully learnt online due to the psychomotor component of learning a clinical skill [4,82], and the literature has, to a lesser extent, examined the utilisation of e-learning to enhance clinical procedural skills training [16,82,86,94–96]. A blended learning (or hybrid learning) approach may allow for the integration of e-learning into clinical skills training [16,82].

Third-year medical students at Stellenbosch University, South Africa, attend clinical skills modules that run concurrently with their clinical rotations as they attend certain sessions in the SCSU that relate to the discipline that they are rotating through. In preparation for the clinical skills session, information is made available on the online learning management system (SUNLearn).

The study aimed to determine the perceived value of an e-learning bundle related to the learning of injection skills for third-year medical students, to identify factors that enabled or limited their learning and to explore the motivators and barriers experienced by these students.

3.2 Methods

3.2.1 Design

A quantitative, descriptive research design was selected for this study, with the use of descriptive statistics to report on the perceptions of the students.

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3.2.2 Setting

At Stellenbosch University, South Africa, third-year undergraduate medical students complete five clinical rotations throughout the year. During their Internal Medicine clinical rotation, they have a face-to-face contact session in the SCSU where they learn how to administer subcutaneous and intramuscular injections. To gain entry to the summative clinical examination, attendance of all the Skills Unit sessions are required. Students have open and free access to the online learning management system (SUNLearn) on campus, and a specific clinical skills page is made available to students. This page contains additional resources related to the third-year procedures, such as demonstration videos, articles, images and peer-assessment tools. Anecdotal evidence suggests that students do not typically prepare for their face-to-face contact sessions and that the online material is used mainly to prepare for the multiple-choice questions portion of the objective structured clinical examination (OSCE). During the procedural skills sessions, students receive another demonstration, discussions and explanations, and are granted the opportunity to ask questions and engage in practice sessions. Groups consist of approximately 15 students with one facilitator, and one 45-minute session per group is facilitated on learning to perform intramuscular and subcutaneous injections.

For this study, an e-learning bundle was created using iSpring, a PowerPoint plugin. The e-learning bundle contained text, images, silent and narrated demonstrations, short video clips, narrated animations, interactive slides and a quiz with multiple-choice questions and drug calculation exercises. See Box 1 for the details on the aspects that were covered by the e-learning bundle.

The bundle covered the following aspects

- General overview
- Scope of Practice
- Definitions
- Complications and prevention
- Outcomes (cognitive, affective, psychomotor)

Topics addressed

- Gathering equipment
- Communication and identification
- Critical checks
- Connecting the needle and syringe
- Safely opening ampoules
- Drawing up from a vial
- Drawing up the correct dose
- Exchanging needles
- Sharps safety
- Documentation

Intramuscular/subcutaneous injections

- Rationale
- Site selection
- Injection technique

Box 1 Content & topics included in the e-learning bundle

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3.2.3 Participants and recruitment

The Stellenbosch University third-year MBChB class consisted of 336 students in 2021. The study population was 133 students who underwent the Internal Medicine clinical rotation during February and April 2021. As students have to attend all Skills Unit sessions as part of their entry to the end-of-year objective structured clinical examination, they had to attend the injection session irrespective of their participation in the study. As the sampling was done from two rotations (February and April), students were recruited one week before the scheduled injection session and the researcher addressed the two groups in person. The terms and conditions of participation were described, and students were informed that they could win one of ten lucky-draw coffee shop vouchers (per data collection) should they fulfil all the requirements. Consent forms were placed in the classroom to be completed by interested individuals. The researcher then instructed the students to place the completed consent forms in the classroom. The forms were collected later during the day after the sessions had concluded, so participation was voluntary.

Convenience sampling [97–99] was done from these 133 students, and 98 students gave signed consent and were sent questionnaires. Fifty-five students responded, of which eight partially completed the questionnaire and six more indicated in the questionnaire that they had accessed the e-learning bundle zero times. This led to 41 students' being included in the study (Table 2).

Collection	Study population	Questionnaires sent	Questionnaires received Respondent	Incomplete	Complete	Ticked 'zero' when asked how many times e-learning was accessed
February 2021	n = 67	48	31	3	28	3
April 2021	n = 66	50	24	5	19	3
Total	n = 133	98	55	8	47	6

Table 2 Process of exclusion to determine participants

3.2.4 Data instrument

An existing validated online Medical E-learning Evaluation Survey (MEES) [100] was used to gather data from the participants. The MEES was originally aimed at postgraduate students but is also applicable to undergraduate students as they also learn in an adult learning space. The questionnaire contained a variety of question types, allowing an understanding of the opinions, attitudes and ideas of the learners [101]. The MEES covers a large majority of the content found in many similar online surveys and encompasses many aspects of individually researched components of e-learning. Some studies have attempted to gather data on what is deemed as quality e-learning [102,103] and have explored barriers to and enablers of e-learning [16,82,104]. In addition, factors that influenced the adoption of e-learning [13,14,18] were explored. This questionnaire was therefore deemed appropriate for gathering data relevant to the topic at hand and could be adapted to include exploring the perception of an e-learning bundle in preparation for a clinical skills session.

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3.2.5 Data collection and handling

REDCap (Research Electronic Data Capture – https://www.project-redcap.org) was used to send out the questionnaires to the participants, with a double verification process in place to protect data. The double verification system included a password and Google authenticator process. REDCap is a browser-based software and workflow methodology for designing research databases. Data were collected anonymously without any identifiers. In total, 41 fully completed questionnaires in which students indicated that they had attended the injection session were identified. Questionnaires that were flagged by REDCap as being incomplete were excluded.

3.2.6 Analysis

Data were downloaded from REDCap, and missing data were identified and excluded. The remaining data were exported to IBM SPSS (Statistical Package for the Social Sciences) software and analysed using frequencies, descriptives and cross-tubulations. Results were expressed in tables and bar graphs.

3.3 Results

Demographically, the age range of the students was 20-33 years (mean 22 years) with a gender distribution of 30 females (73.2%), 8 males (19.5%) and 3 non-binary persons (7.3%). Of the 41 students, 4 (9.8%) had received prior training in the administration of injections and 28 (68.3%) had seen an injection administration before.

3.3.1 Access

Most students (39%) self-reported spending around 40-60 minutes engaging with the e-learning bundle content, and the majority of students (61%) indicated that they had accessed the bundle once (Table 3).

Accessed			
	Frequency	Percent	Cumulative Percent
Once	25	61,0%	61%
Twice	15	36,6%	97,6%
Thrice	1	2,4%	100%
Total	41	100%	
Time spent			
<20 min	2	4,9%	4,9%
20-40 min	11	26,8%	31,7%
40-60 min	16	39,0%	70,7%
>60min	12	29,3%	100%
Total	41	100%	

Table 3 Frequency with which the e-learning bundle was accessed and time spent engaging with the bundle

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3.3.2 Motivation

The percentage of students who were positively motivated to engage in the e-learning bundle on a scale of 1 to 10, was 90.2 % (Figure 4).

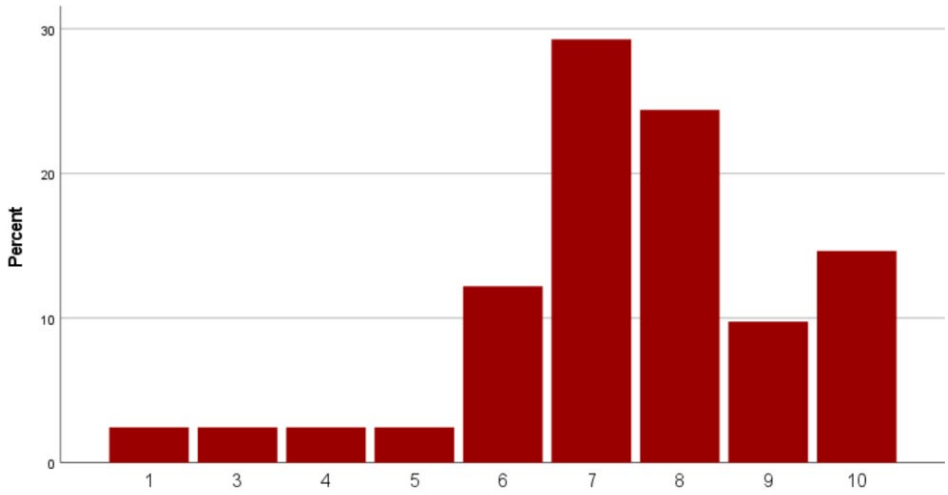

Fig 4 Motivation levels to start with the e-learning bundle

The most important motivating factor for students to engage in the e-learning content (figure 5) was that they believed it was important to do so (73.2%), followed by the fact that it was aimed at the level of their experience (65.9%) and that they understood the general purpose of the e-learning bundle (65.9%).

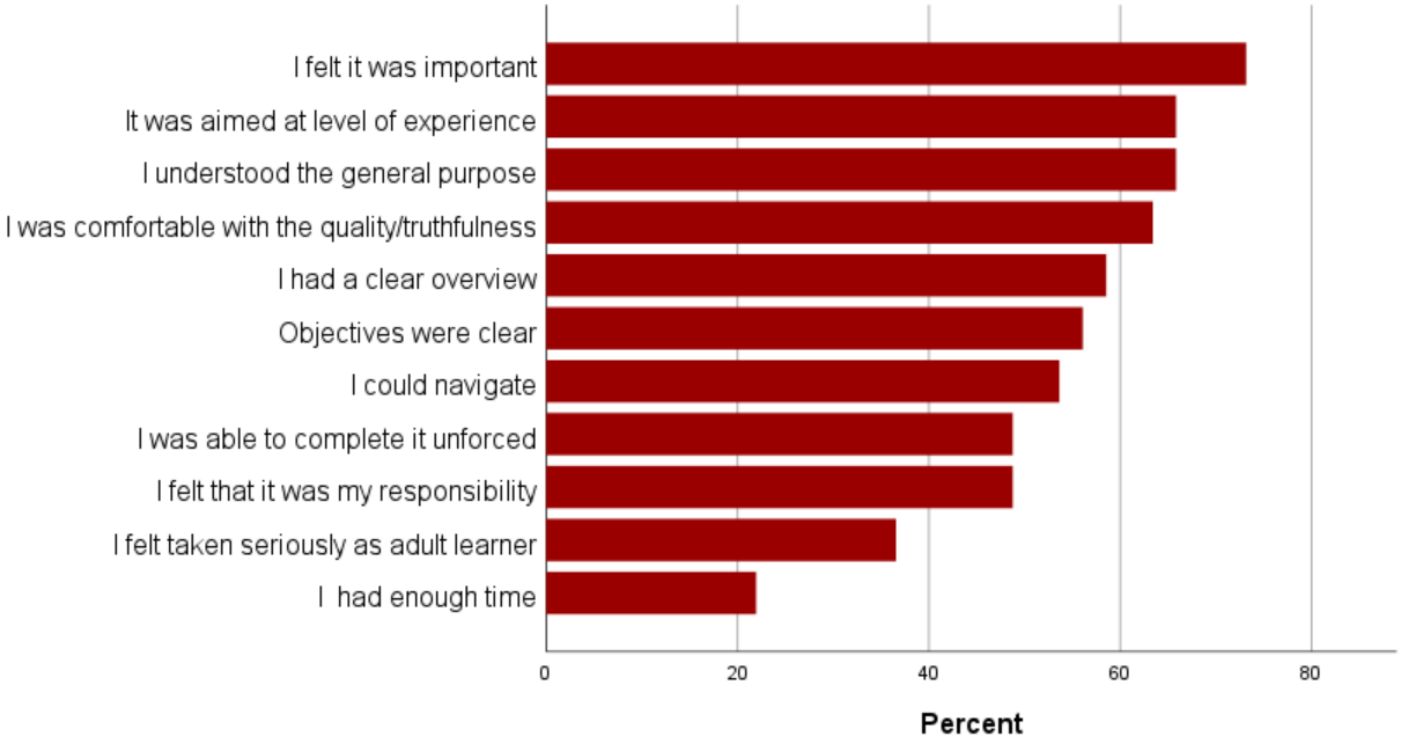

Fig 5 Motivating factors to start with the e-learning bundle

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3.3.3 Learning enhancers

The fact that the content of the bundle was interactive was identified as the aspect that enabled learning and remembering the most (82.9%), followed by the fact that the bundle contained exercises (78%) and that feedback to answers was available (68.3%). The summaries provided were found helpful by 61% of students (Figure 6).

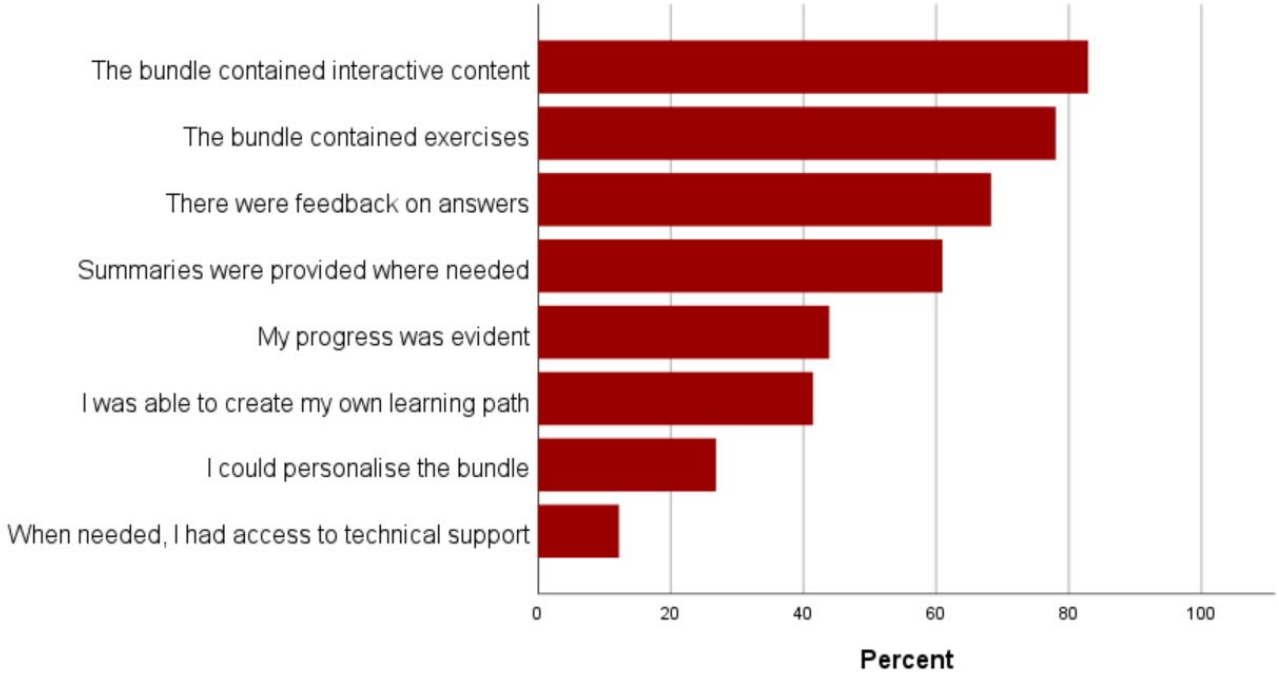

Fig 6 Aspects that assisted students to learn and remember content

3.3.4 Real-world translation

When asked to rate how valuable and relevant respondents found the e-learning bundle in their application of the new knowledge, skills and attitudes (figure 7) the majority of students (41.5%) scored a 10.

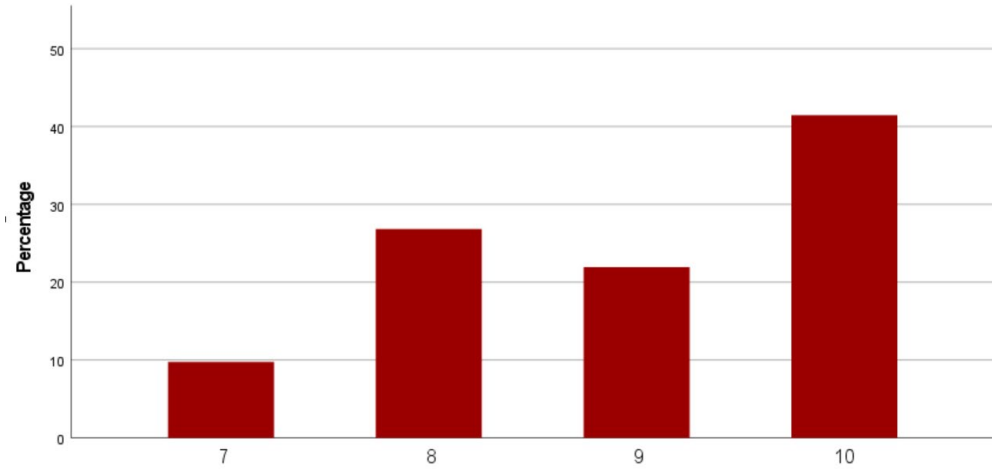

Fig 7 How valuable respondents perceived the e-learning bundle to their daily work

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The percentage of students who believed that the e-learning bundle was translatable to their daily work was 87.5%.

3.3.5 Perceived value of the e-learning bundle

In terms of *informational value*, 24 (58.8%) students scored the maximum value, with a mean of 9,28 (figure 8). No students rated below 6.

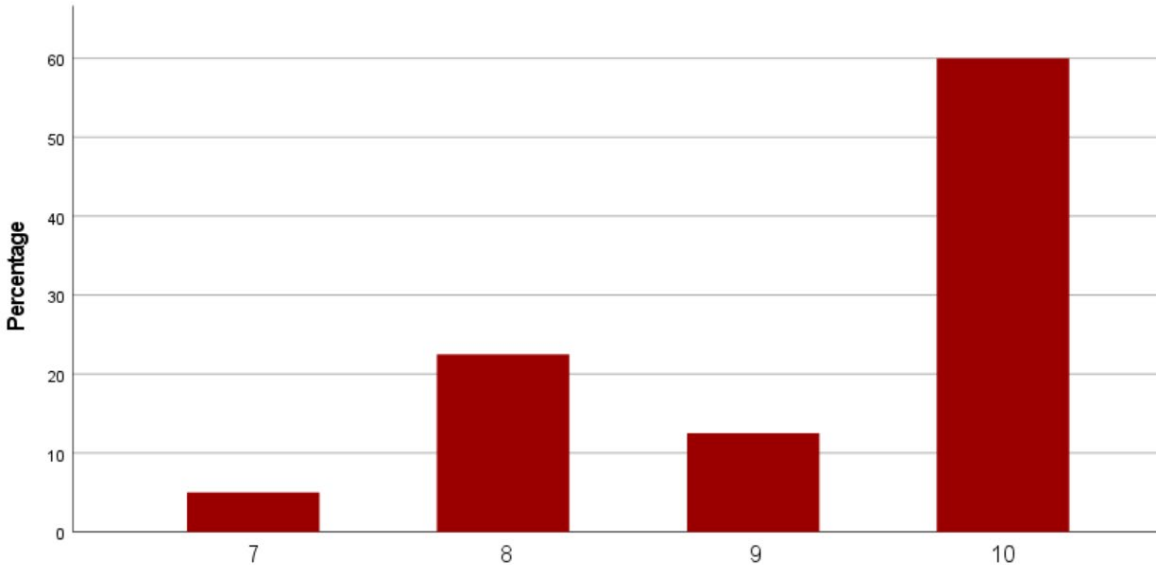

Fig 8 Informational value from the perception of the students

In terms of the value of the e-learning bundle as *preparation for the face-to-face contact session,* 20 (48.8%) students allocated a maximum score of 10 (figure 9)

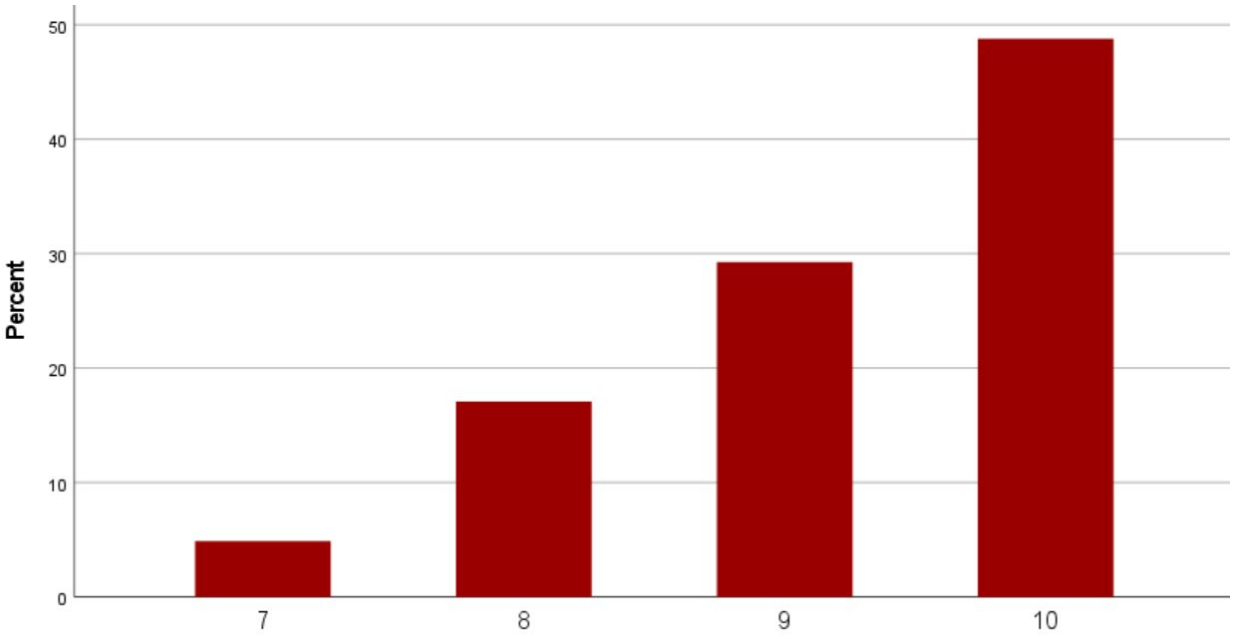

Fig 9 Value of the e-learning bundle in preparation for learning a clinical skill

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When cross-tabled with prior training and exposure (figure 10), it was apparent that students who had had prior training or exposure still found the bundle to be valuable.

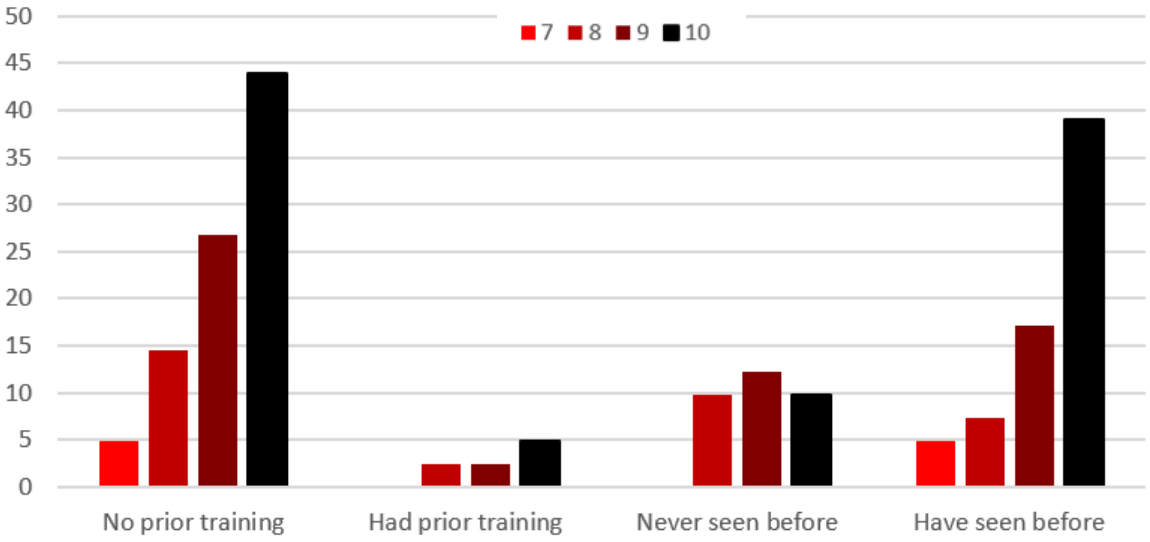

Fig 10 Perceived value of students with and without previous training, as well as students that have and have not been exposed to administration of injections.

3.3.6 Barriers and limitations

When reporting the severity of the barriers to starting with the e-learning bundle (figure 11), 78% of students found minimally significant barriers, 19.6% found moderately significant barriers and 2.4% found severe barriers.

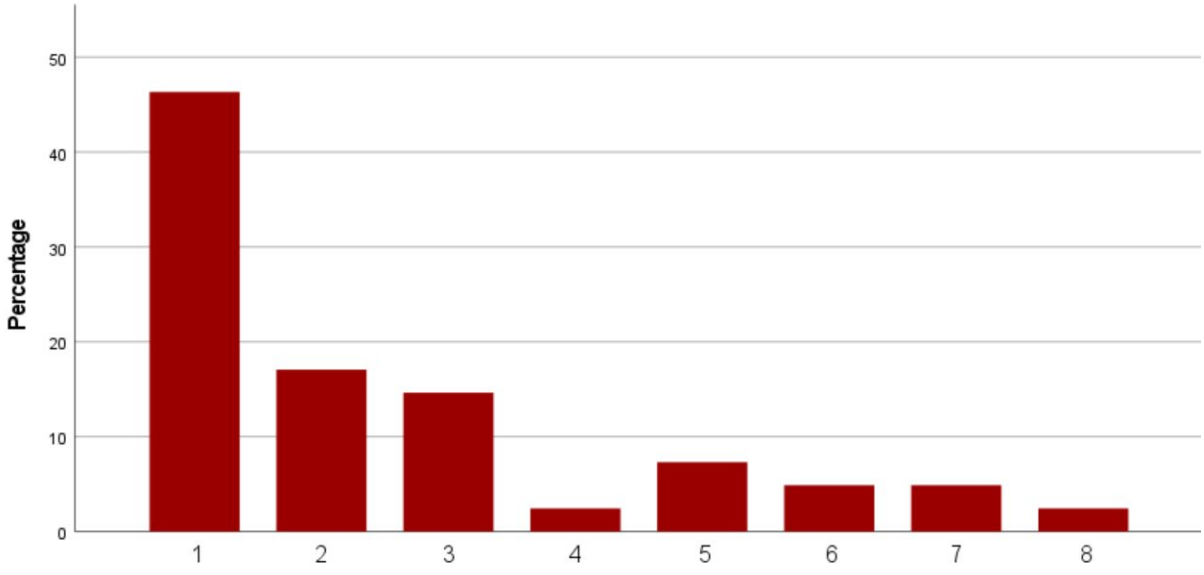

Fig 11 Rating of the severity of barriers to starting with the e-learning bundle

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The most common barriers that students experienced (figure 12), were that they did not have enough time to engage with the online material (48.5%) followed by 30.3% of students who reported that the bundle was too long and 18.2% who believed that the bundle was too slow and took too long to load.

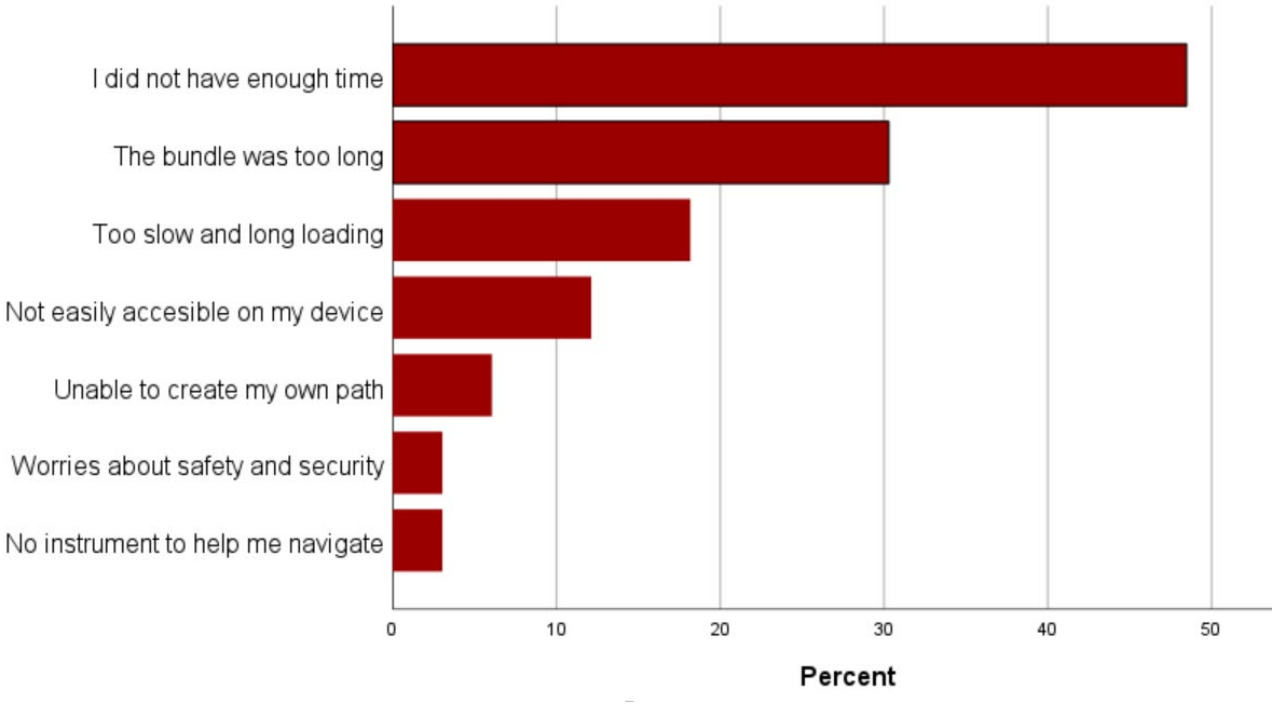

Fig 12 Perceived barriers to starting with the e-learning bundle

At the end of each section, students were asked to leave any related comments that were not included, and 14.6 %of students reported not having experienced any barriers, 4,9% reported not having had enough time and 9.8% reported having experienced technical difficulties.

The e-learning bundle took most students between 20 minutes and one hour to complete, but this time reference does not specify whether the most time spent was on the content itself or on the quiz portion. One student specifically referred to this in the comment section, stating the following:

> "The bundle was quite large and it took a lot of time to get through it, but there was also no information that I thought was not necessary - thus I felt that everything in the bundle was applicable and important. So maybe split it into two sessions: one for "subcut" + IM injections and the other for the dosage calculations. I also felt that I needed more help with the dosage calculations."

Students had to report on the experienced limitations of the e-learning bundle. On the question of whether they had experienced any stress or frustration while completing the bundle, 48.8% responded positively and 21.3% had experienced issues because the content was not adaptable to their devices. In the comments sections, 19.5% of students reported no barriers, 7.3% commented on time constraints and 12.2% commented on technical challenges.

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	Reponses N	**Responses Percent**	**Percent of cases**
Stressed or frustrated in any way	20	41,7%	48,8%
Content not adaptable to device	10	20,8%	24,4%
Visuals were too distracting	1	2,1%	2,4%
Other	17	35,4%	41,5%
	48	100%	117,1%

Table 4 Perceived limitations of the e-learning bundle

3.3.7 General comments and recommendations

The following comments and recommendations were made by the participants.

"It was really good. LOVED THE SOUND EFFECTS!"

"More videos for seeing things."

"Perhaps making a downloadable version of the entire e-learning bundle after one has completed it so that a person can access the information at any time in the easy format that the e-learning bundle provides."

"Continue keeping it as informative, fun and interactive as it was. The questions do help with understanding the content."

"Please do this for all clinical skills! Very helpful."

"The User Interface of SCORM packages could really use an update. Also, a proper menu please."

"The extensions from the main slides were taxing and made users unable to plan how long the e-bundle would take to complete."

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4. Discussion

The discussion section is structured using the three positive and two negative domains from the MEES that were identified by De Leeuw et al. [100]. The positive domains are motivation, learning enhancers and real-world translation. For our context, a fourth domain was added in this study namely educational value (in terms of information transfer and preparation for a clinical skills contact session). The negative domains as identified by De Leeuw et al. explore barriers to starting as well as learning discouragers.

We will start our discussion of the positive domains with motivation. Motivation levels were scored high by most of the students, and even the students who were not motivated to start ended up voicing a positive experience and scored high on the perceived value of the e-learning bundle. Motivation is a very complex concept and has been proven to be central to meaningful learning [105]. Motivation is described in the literature as being of intrinsic or extrinsic origin [106–108], and while the MEES explored both, it did not differentiate between the two types. A plethora of studies have explored motivating factors concerning engagement with e-learning, and De Leeuw et al. [83] conducted an extensive integrated literature search on the topic, leading to the development of the MEES.

The second positive domain is that of learning enhancers, which have been identified in this study as the presence of interactive content, exercises, feedback on answers and provision of summaries. The literature supports the fact that interactive content enhances learning and remembering content [109–112]. Interactivity in this e-learning bundle was integrated into the activities – students had to click to activate content and could choose different sections to complete. A natural flow of content was attempted, but students could select different topics to review at different times or in a different order, which gave them a sense of control over their learning. (figure 13)

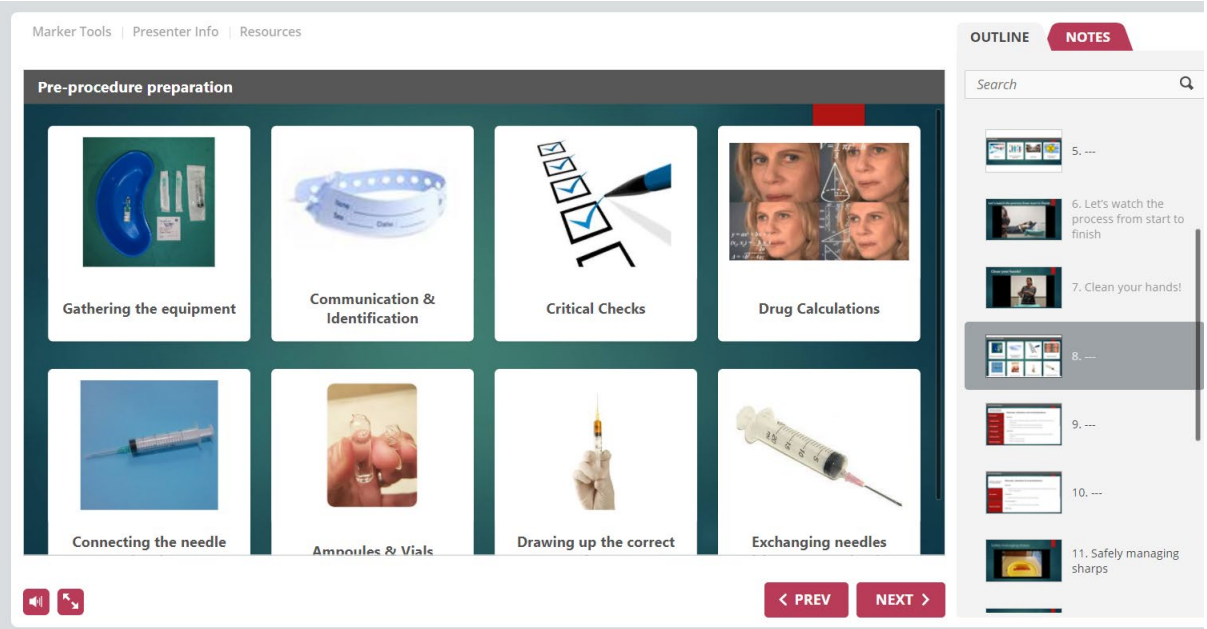

Fig 13 A screenshot of one of the interactive e-learning bundle slides

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A quiz containing multiple-choice questions and drug calculations assisted students to consolidate the content in the bundle. Students could locate landmarks on images, identify plunger positions for correct dosing and practise drug calculations using medications readily available in the clinical area for different contexts. Application of knowledge utilising a formative quiz format has been identified as a benefit to students in their e-learning, in terms of motivation, revision and assessment [43,46,113,114]. Students could identify whether they had sufficiently mastered the content while receiving real-time feedback and could revisit the information that they had not mastered yet and retake the quiz multiple times without any repercussions.

The third positive domain is the translation of the content to the real world, which has been proven to influence the efficacy of e-learning. [115]. The e-learning bundle was perceived by students to add value to their daily knowledge utilised in clinical practice. The examples and exercises in the bundle were relevant in that they contained drug calculations of medications commonly available in the clinical areas, and knowledge was consolidated with a quiz and application of different scenarios in the contact session. This application of foundational knowledge could help students to better navigate situations where they had to administer intramuscular or subcutaneous injections.

The fourth and final domain is perceived educational value. Students perceived the bundle to be valuable in preparation for a clinical skills session in this specific context, but students can only benefit from e-learning bundles if they engage with the content before the contact session. This has proven to be problematic, but the literature suggests methods to overcome this lack of preparation. A suggestion from the literature is that the contact session should start with a quiz to encourage engagement with the material beforehand [47]. The results indicate that most students found the e-learning bundle very informative and may also indicate that this bundle contains information that most students have not encountered before. Students who had previously attended training on the topic or had seen an injection administered found the bundle as valuable as their counterparts who had not. This finding is in contrast with a study done in 2019 in which a small subset of students with prior experience in a skill was not as motivated to prepare for a clinical contact session [116]. In line with the literature found on the general perceptions of e-learning and flipped classrooms [49,106,111–113], comments from the open sections were mainly positive and conveyed enjoyment of the activity and enthusiasm for using e-learning in the acquisition of a clinical skill.

The first negative domain is barriers to starting. It would appear that students when retrospectively completing the questionnaire looked not at barriers to starting but more at barriers before and during accessing the e-learning bundle; this became evident in the comment section. One of the main limitations indicated by students was a lack of time to engage with the content, and this finding is supported by literature that concludes that despite e-learning's allowing flexibility and self-directed learning, sufficient time still needs to be allocated to complete the required activities [14,28,87,113–115]. In a blended (or hybrid) system in which not all the material is presented online and students

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still have clinical responsibilities, creating time for added activities may be challenging. Medical students are juggling many academic and clinical responsibilities, and in a typically overloaded curriculum, not much time is available for added ‘work’.

Students prioritise their tasks, and it was evident when looking at the SUNLearn data. As some students left completing the bundle until the last minute (completing it after midnight or on the morning on which the session was scheduled), it would appear that this was not a high priority for some students. However, the fact that they did deem it important enough to complete at all was a positive sign. Most students reported accessing the bundle once, but cognisance has to be taken of the fact that students could access the bundle multiple times to ‘break up’ the activity, allowing them to continue where they left off. Therefore, a student who accessed the bundle three times did not complete the bundle three times but rather split it into three parts.

Another aspect emerging from the data was that technical difficulties were hindering engagement with and completion of the activity. The e-learning bundle was not compatible with all browsers and prevented some videos from playing properly. Students mentioned slow internet speeds with subsequent buffering as well as slow loading of the bundle as a frustration but acknowledged that this was probably a connectivity issue on their side. The literature points out that insufficient internet stability and/or speed, lack of devices and technical issues were some of the biggest barriers to utilising e-learning [4,88,116–118]. The comments were received from the students who had completed the bundle and filled in the questionnaire, so we do not know how many students were discouraged from participating at all. Software applications and plug-ins rarely can accommodate all the requirements set by all the different devices, manufacturers, operating systems and browsers, so this may be an issue when selecting software to develop e-learning bundles. The assumption was that all the students wanting to participate in the study had access via their devices, had multiple access options of devices (such as phone, tablet, laptop and/or desktop) and had internet access. The online learning management system (SUNLearn) at Stellenbosch University assisted students in obtaining devices during the COVID-19 period, and almost all lectures moved to an online format, so most students would have access to at least one device. The learning management system is zero-rated, so students would not need data to work through the e-learning bundle, but they would still need an internet connection to participate in the activity. This may have excluded students who did not have internet access off-campus since they had one week only to complete the activity.

The second and final negative domain is learning discouragers, and almost half of the students reported that they were stressed or frustrated at some point during accessing the bundle. While the questionnaire did not explore these stressors, the comments revealed very similar results to those in the barriers to starting section, namely lack of time and technical challenges.

The limitations of the study include the following: The study was small, making it advisable to launch this study on a larger scale and to include other clinical skills, perhaps in different years of study.

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The study was quantitative, but perhaps one could explore items outside the MEES that may give valuable insight into the true experience of e-learning in the acquisition of a clinical skill by utilising qualitative methods such as focus group interviews. The fact that the data collection was anonymous also led to some analysis complications as students could not be tracked through their journey from the learning management system to the completion of the questionnaire and the data of multiple quiz attempts could not be analysed. An additional limitation is that no assumptions can be made on the perceptions of students who chose not to participate in the study.

Recommendations for further studies originating from this research are to compare the experience of students in a flipped classroom to that of students attending a conventional skills session regarding attitude, preference, overall experience and skills retention. It would be helpful to study what aspects specific to this e-learning bundle were beneficial or detrimental for the students and why they made those claims. Items for consideration for further studies include ways to quantify the cognitive load of clinical skills that can indicate the notional hours that should be allocated to prepare for a clinical skills session.

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5. Conclusion

Due to the COVID-19 pandemic, a radical shift to e-learning occurred in all spheres of education, including medical education. E-learning can be used in a wide variety of settings and allows for creative approaches to dealing with the new norm. It can also be a very valuable addition to all general and medical educational systems due to its flexibility and relatively low cost. If designed carefully, e-learning bundles can stimulate participation and active learning and consolidate the knowledge that is required for learning a clinical skill. However, the place of e-learning in clinical skills training has been debated. Learning clinical skills involves both cognitive and psychomotor components. The cognitive component lays the foundation for the clinical skills – the 'what', 'why', 'where' and 'when'. The 'how' is where the student tries his/her hand at physically performing the skills. Flipped classrooms can incorporate the cognitive component by utilising e-learning as a strategy and allow for the restructuring of contact session time, with the focus to consolidate the skill.. This process of deliberate practice with feedback has proven to be effective in establishing clinical competence.

Third-year medical students at Stellenbosch University found an e-learning bundle on the administration of injections valuable in gaining new knowledge, skills and attitudes, and as a form of preparation for a contact session. In essence, the e-learning experience was positive and the barriers and limitations have been correlated with those found in the literature. Overcoming these limitations could include creating protected time for engaging in e-learning and investigating potential solutions to the technological challenges that characterise e-learning universally. E-learning has found its rightful place in education, but how it is utilised will determine future successes in the field.

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References

1. Brame CJ. Effective educational videos: principles and guidelines for maximizing student learning from video content. CBE Life Sci Educ. 2016;15:1–6. http://doi.org/10.1187/cbe.16-03-0125

2. Evenhouse D, Kandakatla R, Berger E, Rhoads JF, DeBoer J. Motivators and barriers in undergraduate mechanical engineering students' use of learning resources. Eur J Eng Educ. Taylor & Francis; 2020;45:879–899. https://doi.org/10.1080/03043797.2020.1736990

3. Davids MR, Halperin ML, Chikte UME. Optimising cognitive load and usability to improve the impact of e-learning in medical education. African J Heal Prof Educ. 2015;7:147–152. https://doi.org/10.7196/ajhpe.659

4. Al-Balas M, Al-balas HI, Jaber HM, Obeidat K, Al-balas H, Aborajooh EA. Distance learning in clinical medical education amid COVID-19 pandemic in Jordan : current situation , challenges , and perspectives. BMC Med Educ. 2020;20:1–7. https://doi.org/10.1186/s12909-020-02257-4

5. Ekenze SO, Okafor CI, Ekenze OS, Nwosu JN, Ezepue UF. The value of internet tools in undergraduate surgical education: perspective of medical students in a developing country. World J Surg. 2017;41:672–680. https://doi.org/10.1007/s00268-016-3781-x

6. Sangra A, Vlachopoulos D, Cabrera N. Building an inclusive definition of e-learning: an approach to the conceptual framework. Int Rev Res Open Distance Learn. 2012;13:145–59. https://doi.org/10.19173/irrodl.v13i2.1161

7. Dhawan S. Online learning: a panacea in the time of COVID-19 crisis. J Educ Technol Syst. 2020;49:5–22. https://doi.org/10.1177/0047239520934018

8. Academy of Science of South Africa. Essential facts about COVID-19: the disease , the responses and an uncertain future. For South African learners, teachers and the general public [Internet]. Pretoria, South Africa: Academy of Science of South Africa; 2021. p. 1–171. Available from: https://research.assaf.org.za/bitstream/handle/20.500.11911/194/Covid-19 bookletVersion17august2021.pdf?sequence=8&isAllowed=y.https://doi.org/10.17159/assaf.2021/0072. Accessed 25 September 2021.

9. Huynh R. The role of e-learning in medical education. Acad Med. 2017;92:430. https://doi.org/10.1097/ACM.0000000000001596

10. Hejase HJ, Chehimi GM. E-learning : what to look for amid the pandemic. J Econ Econ Educ Res. 2020;21:21–24. https://doi.org/10.13140/RG.2.2.17011.35369

11. Singh G, Singh R. Evaluation of e-learning of undergraduate medical students during the

Stellenbosch University https://scholar.sun.ac.za

COVID-19 pandemic lockdown by an objective structured practical examination. MGM J Med Sci. 2020;7:3–8. https://doi.org/10.4103/mgmj.mgmj_56_20

12. Seymour-Walsh AE, Weber A, Bell A, Smith T. Teaching psychomotor skills online: exploring the implication of novel coronavirus on health professions education. Rural Remote Health. 2020;20:1–6. https://doi.org/10.22605/RRH6132

13. Arkorful V, Abaidoo N. The role of e-learning , the advantages and disadvantages of its' adoption in higher education . Int J Educ Res. 2014;2:397–410.

14. Abbad MM, Morris D, De Nahlik C. Looking under the bonnet : factors affecting student adoption of e-learning systems in Jordan. Int Rev Res Open Distance Learn. 2009;10:1–24. https://doi.org/10.19173/irrodl.v10i2.596

15. Rossi PG. Learning environment with elements of artificial intelligence. J e-Learning Knowl Soc. 2009;5:191–199. https://doi.org/10.20368/1971-8829/306

16. Bloomfield JG, Jones A. Using e-learning to support clinical skills acquisition: exploring the experiences and perceptions of graduate first-year pre-registration nursing students - A mixed method study. Nurse Educ Today. 2013;33:1605–1611. https://doi.org/10.1016/j.nedt.2013.01.024

17. Sandars J, Patel RS, Goh PS, Kokatailo PK. The importance of educational theories for facilitating learning when using technology in medical education. Med Teach. 2015;37:1039–1042. https://doi.org/10.3109/0142159X.2015.1019438

18. King E, Boyatt R. Exploring factors that influence adoption of e-learning within higher education. Br J Educ Technol. 2015;46:1272–1280. https://doi.org/10.1111/bjet.12195

19. Shah S, Stefaniak J. A Review of the Effectiveness of e-learning on Knowledge and Skill Acquisition in Medical Education [Internet]. Assoc. Educ. Commun. Technol. Virginia: Association for Educational Communications and Technology; 2016. p. 160–168. Available from: https://members.aect.org/pdf/Proceedings/proceedings18/2018/18_20.pdf. Accessed 28 October 2019.

20. Saadé RG, Morin D, Thomas JDE. Critical thinking in e-learning environments. Comput Human Behav. 2012;28:1608–1617. https://doi.org/10.1016/j.chb.2012.03.025

21. Giesbers B, Rienties B, Tempelaar D, Gijselaers W. Investigating the relations between motivation, tool use, participation, and performance in an e-learning course using web-videoconferencing. Comput Human Behav. 2013;29:285–292. https://doi.org/10.1016/j.chb.2012.09.005

22. Druce M, Howden S. New perspectives on health professions students' e-learning: looking

Stellenbosch University https://scholar.sun.ac.za

through the lens of the “visitor and resident” model. Med Teach. 2017;39:704–709. https://doi.org/10.1080/0142159X.2017.1301657

23. Charbonneau-Gowdy P. Beyond stalemate: seeking solutions to challenges in online and blended learning programs. Electron J e-Learning. 2018;16:56–66.

24. De Leeuw RA, Westerman M, Nelson E, Ket JCF, Scheele F. Quality specifications in postgraduate medical e-learning: An integrative literature review leading to a postgraduate medical e-learning model. BMC Med Educ. BMC Medical Education; 2016;16:1–10. https://doi.org/10.1186/s12909-016-0700-7

25. Te Pas E, De Waard MW, Blok BS, Pouw H, van Dijk N. Didactic and technical considerations when developing e-learning and CME. Educ Inf Technol. Education and Information Technologies; 2016;21:991–1005. https://doi.org/10.1007/s10639-014-9364-2

26. O’Doherty D, Dromey M, Lougheed J, Hannigan A, Last J, Mcgrath D. Barriers and solutions to online learning in medical education – an integrative review. BMC Med Educ. BMC Medical Education; 2018;18:1–11. https://doi.org/10.1186/s12909-018-1240-0

27. Obi IE, Charles-Okoli AN, Agunwa CC, Omotowo BI, Ndu AC, Agwu-Umahi OR. E-learning readiness from perspectives of medical students: a survey in Nigeria. Niger J Clin Pract. 2018;21:293–300. https://doi.org/10.4103/njcp.njcp_108_17

28. Lai KW, Hong KS. Technology use and learning characteristics of students in higher education: Do generational differences exist? Br J Educ Technol. 2015;46:725–738. https://doi.org/10.1111/bjet.12161

29. Sandars J, Lafferty N. Twelve Tips on usability testing to develop effective e-learning in medical education. Med Teach. 2010;32:956–60. https://doi.org/10.3109/0142159X.2010.507709

30. Gagné RM. Mastery Learning and Instructional Design [Internet]. First. Mastery Learn. Instr. Des. Tallahassee, Florida: Learning Systems Institute; 1988. p.107–124. Available from: https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1937-8327.1988.tb00003.xhttps://doi.org/10.1111/j.1937-8327.1988.tb00003.x. Accessed 14 September 2020.

31. Ramlatchan M. Multimedia learning theory and instructional message design. Instr Messag Des Theory, Res Pract. Norfolk, Virginia: Kindle Direct Publishing; 2019. p. 1–29.

32. Cheung L. Using an Instructional Design Model to Teach Medical Procedures. Med Sci Educ. Medical Science Educator; 2016; https://doi.org/10.1007/s40670-016-0228-9

33. Cheung JJH, Kulasegaram KM, Brydges R. Knowing How and Knowing Why : testing the effect

Stellenbosch University https://scholar.sun.ac.za

of instruction designed for cognitive integration on procedural skills transfer. Adv Heal Sci Educ. 2018;23:61–74. https://doi.org/10.1007/s10459-017-9774-1

34. Khogali SEO, Davies DA, Donnan PT, Gray A, Harden RM, Mcdonald J. Integration of e-learning resources into a medical school curriculum. Med Teach. 2011;33:311–318. https://doi.org/10.3109/0142159X.2011.540270

35. Moskal P, Dziuban C, Hartman J. Internet and Higher Education Blended learning : A dangerous idea? Internet High Educ. 2013;18:15–23. https://doi.org/10.1016/j.iheduc.2012.12.001

36. Milic NM, Trajkovic GZ, Bukumiric ZM, Cirkovic A. Improving education in medical statistics : implementing a blended learning model in the existing curriculum. PLoS One. 2016;11:1–10. https://doi.org/10.1371/journal.pone.0148882

37. Derbel F. Blended Learning : Concept , Emerging Practices and Future Prospects. Kidmore End: Academic Conferences International Limited; 2017.p.142–149.

38. Hyll M, Schvarcz R, Manninen K. Exploring how medical students learn with the help of a digital presentation : a qualitative study. BMC Med Educ. BMC Medical Education; 2019;19:1–9. https://doi.org/10.1186/s12909-019-1569-z

39. Warnecke E, Pearson S. Medical students' perceptions of using e-learning to enhance the acquisition of consulting skills. Australas Med J. 2011;4:300–307. https://doi.org/10.4066/AMJ.2011.73

40. Bishop J, Verleger M. The flipped classroom : a survey of the research. 120th ASEE Annu Conf Expo. Atlanta, Georgia; 2013. p. 1–18. https://doi.org/10.18260/1-2--22585

41. Bouwmeester RAM, de Kleijn RAM, ten Cate OTJ, van Rijen HVM, Westerveld HE. How do medical students prepare for flipped classrooms? Med Sci Educ. 2016;26:53–60. https://doi.org/10.1007/s40670-015-0184-9

42. Lai C, Hwang G. Computers & Education A self-regulated flipped classroom approach to improving students ' learning performance in a mathematics course. Comput Educ. 2016;100:126–140. https://doi.org/10.1016/j.compedu.2016.05.006

43. Miles C, Lee A, Foggett K, Kichu B. Reinventing medical teaching and learning for the 21st century : blended and flipped strategies. Arch Med Heal Sci. 2017;5:97. https://doi.org/10.4103/amhs.amhs_53_17

44. Cabi E. The Impact of the Flipped Classroom Model on Students ' Academic Achievement. Int Rev Res Open Distrib Learn. 2018;19:203–221. https://doi.org/10.19173/irrodl.v19i3.3482

45. Kim HR, Jang YK. Flipped learning with simulation in undergraduate nursing education. J Nurs

Stellenbosch University https://scholar.sun.ac.za

Educ. 2017;56:329–336. https://doi.org/10.3928/01484834-20170518-03

46. Ramnanan C, Pound L, Ramanan C, Pound L. Advances in medical education and practice: student perceptions of the flipped classroom. Adv Med Educ Pract. 2017;8:317–20. https://doi.org/10.2147/AMEP.S133328

47. Hew KF, Lo CK. Flipped classroom improves student learning in health professions education: A meta-analysis. BMC Med Educ. BMC Medical Education; 2018;18:1–12. https://doi.org/10.1186/s12909-018-1144-z

48. Roehling P, Root Luna L, Richie F, Shaughnessy J. The Benefits , Drawbacks , and Challenges of Using the Flipped Classroom in an Introduction to Psychology Course. Teach Psychol. 2017;44:183–192. https://doi.org/10.1177/0098628317711282

49. Wu J, Chi S, Wu C, Kang Y. Help from flipped classroom in learning suturing skill : The medical students ' perspective. PLoS One. 2018;13:1–13. https://doi.org/10.1371/journal.pone.0204698

50. Siemens G, Gašević D, Dawson S. Preparing for the digital university: A review of the History and Current State of Distance, Blended and Online Learnin. Edinburgh; 2015. p. 1–234. https://doi.org/10.13140/RG.2.1.3515.8483

51. Atesok K, Hurwitz S, Anderson DD, Satava R, Thomas GW, Tufescu T. Advancing simulation-based orthopaedic surgical skills training: an analysis of the challenges to implementation. Adv Orthop. 2019;2019:1–7. https://doi.org/10.1155/2019/2586034

52. McDonald EW, Boulton JL, Davis JL. E-learning and nursing assessment skills and knowledge – An integrative review. Nurse Educ Today. 2018;66:166–174. https://doi.org/10.1016/j.nedt.2018.03.011

53. Aebersold M. Simulation-based learning: No longer a novelty in undergraduate education. Online J Issues Nurs. 2018;23:1–11. https://doi.org/10.3912/OJIN.Vol23No02PPT39

54. Motola I, Devine LA, Chung HS, Sullivan JE, Issenberg SB. Simulation in healthcare education : A best evidence practical guide . AMEE Guide No . 82. Med Teach. 2013;35:1511–1530. https://doi.org/10.3109/0142159X.2013.818632

55. Scalese RJ, Obeso VT, Issenberg SB. Simulation technology for skills training and competency assessment in medical education. J Gen Intern Med. 2008;23:46–49. https://doi.org/10.1007/s11606-007-0283-4

56. Rivière E, Saucier D, Lafleur A, Lacasse M, Rivière E, Saucier D. Twelve tips for efficient procedural simulation. Med Teach. 2018;40:743–51. https://doi.org/10.1080/0142159X.2017.1391375

Stellenbosch University https://scholar.sun.ac.za

57. Lamé G, Dixon-Woods M. Using clinical simulation to study how to improve quality and safety in healthcare. BMJ Simul Technol Enhanc Learn. 2020;6:87–94. https://doi.org/10.1136/bmjstel-2018-000370

58. Couto TB, Barreto JKS, Marcon FC, Mafra ACCN, Accorsi TAD. Detecting latent safety threats in an interprofessional training that combines in situ simulation with task training in an emergency department. Adv Simul. Advances in Simulation; 2018;3:1–7. https://doi.org/10.1186/s41077-018-0083-4

59. Coyne E, Rands H, Frommolt V, Kain V, Plugge M, Mitchell M. Investigation of blended learning video resources to teach health students clinical skills: An integrative review. Nurse Educ Today. 2018;63:101–107. https://doi.org/10.1016/j.nedt.2018.01.021

60. Offiah G, Ekpotu LP, Murphy S, Kane D, Gordon A, O'Sullivan M. Evaluation of medical student retention of clinical skills following simulation training. BMC Med Educ. BMC Medical Education; 2019;19:1–7. https://doi.org/10.1186/s12909-019-1663-2

61. Dreyfus S, Dreyfus H. A Five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition [Internet]. California; 1980. p. 1–18. Available from: https://www.researchgate.net/publication/235125013_A_Five-Stage_Model_of_the_Mental_Activities_Involved_in_Directed_Skill_Acquisition. Accessed 16 October 2019.

62. Dreyfus SE. Formal Models vs Human Situational Understanding: Inherent Limitations on the Modeling of Business Expertise. California: University of California, Berkeley; 1981. p. 1–30.

63. Dreyfus SE. The five-stage model of adult skill acquisition. Bull Sci Technol Soc. 2004;24:177–181. https://doi.org/10.1177/0270467604264992

64. Kirkpatrick K, MacKinnon RJ. Technology-enhanced learning in anaesthesia and educational theory. Contin Educ Anaesthesia, Crit Care Pain. Published by Elsevier Ltd. All rights reserved.; 2012;12:263–267. https://doi.org/10.1093/bjaceaccp/mks027

65. Miller G. The Assessment of Clinical Skills, Competence and Performance. Acad Med. 1990;65:s63–67.

66. Peyton J. Teaching in Theatre. Teach Learn Med Pract. First. Hertfortshire: Manticore Europe Limited; 1998. p. 171–80.

67. George JH, Doto FX. Simple Five-step Method for Teaching Clinical Skills. Fam Med. 2001;33:577–578.

Stellenbosch University https://scholar.sun.ac.za

68. Nikendei C, Huber J, Stiepak J, Huhn D, Lauter J, Herzog W. Modification of Peyton ' s four-step approach for small group teaching – a descriptive study. BMC Med Educ. 2014;14:1–10. https://doi.org/ 10.1186/1472-6920-14-68.

69. Ericsson K., Krampe R, Tesch-Römer C. The Role of Deliberate Practice in the Acquisition of Expert Performance. Psychol Rev. 1993;100:363–406. https://doi.org/10.1037//0033-295X.100.3.363

70. Knutson D, Cain T, Hurtubise L, Kreger C. Lessons learned: Developing e-learning to teach physical examination. Clin Teach. 2006;3:163–169. https://doi.org/10.1111/j.1743-498X.2006.00094.x

71. El-Seoud MS, Islam AT, Seddiek N, El-Khouly M, Nosseir A. E-Learning and Students ' Motivation : A Research Study on the Effect of E-Learning on Higher Education. Int J Emerg Technol Learn. 2014;9:20–26. https://doi.org/10.3991/ijet.v9i4.3465

72. Kigundu S. Engaging e-Learning in Higher Education : Issues and Challenges. Int J Educ Sci. 2014;6:125–132. https://doi.org/10.1080/09751122.2014.11890125

73. Belani Z. Online formative assessment in higher education: Its pros and cons. Electron J e-Learning. 2015;13:228–236.

74. Nielsen DG, Moercke AM, Wickmann-Hansen G, Eika B. Skills Training in Laboratory and Clerkship: Connections, Similarities, and Differences. Med Educ Online. 2003;8:4334. https://doi.org/10.3402/meo.v8i.4334

75. Lynach M, Burton R, Sanson-Fisher R. A systematic review of medical skills laboratory training: Where to from here? Med Educ. 2007;41:879–887. https://doi.org/10.1111/j.13652923.2007.02821.x

76. Arigbede A, Denloye OO, Dosumu OO. Transferability of clinical skills acquired on simulator to real life clinical practice. [Internet]. Oral Health Dent. Manag. 201. p. 300–304. Available from: https://pubmed.ncbi.nlm.nih.gov/24984637. Accessed 27 October 2020.

77. Lauter J, Branchereau S, Herzog W, Johannes Bugaj T, Nikendei C. Tutor-led teaching of procedural skills in the skills lab: complexity, relevance and teaching medical competence from the medical teacher, tutor and student perspective. Z Evid Fortbild Qual Gesundhwes. 2017;122:54–60. https://doi.org/10.1016/j.zefq.2017.03.005

78. Jwayyed S, Stiffler KA, Wilber ST, Southern A, Weigand J, Bare R. Technology-assisted education in graduate medical education : a review of the literature. Int J Emerg Med. 2011;4:1–13. https://doi.org/10.1186/1865-1380-4-51

Stellenbosch University https://scholar.sun.ac.za

79. Tenison E, Touger-Decker R. Impact of e-learning or blended learning versus face-to-face learning in regard to physical examination skills, knowledge, and attitudes among health professions students. Top Clin Nutr. 2018;33:259–270. https//doi.org/10.1097/TIN.0000000000000149

80. Corner EJ, Handy JM, Brett SJ. eLearning to facilitate the education and implementation of the Chelsea Critical Care Physical Assessment : a novel measure of function in critical illness. Br Med J Open. 2016;6:1–7. https://doi.org/10.1136/bmjopen-2015-010614

81. Bloomfield J, Roberts J, While A. The effect of computer-assisted learning versus conventional teaching methods on the acquisition and retention of handwashing theory and skills in pre-qualification nursing students : A randomised controlled trial. Int J Nurs Stud. 2010;47:287–294. https://doi.org/10.1016/j.ijnurstu.2009.08.003

82. Gormley G, Collins K, Boohan M, Bickle I, Stevenson M. Is there a place for e-learning in clinical skills? A survey of undergraduate medical students' experiences and attitudes. Med Teach. 2009;31. https://doi.org/10.1080/01421590802334317

83. De Lima Lopes J, Baptista R, Lopes C, Rossi M, Swanson E, De Barros A. Efficacy of a video during bed bath simulation on improving the performance of psychomotor skills of nursing undergraduates: A randomized clinical trial. Int J Nurs Stud. 2019;99:8–12. https://doi.org/10.1016/j.ijnurstu.2019.04.001

84. Van Duijn A, Swanick K, Donald E. Student Learning of Cervical Psychomotor Skills Via Online Video Instruction Versus Traditional Face-to-Face Instruction. 2014;28:94-102. https://doi.org/10.1097/00001416-201410000-00015

85. Forbes H, Oprescu FI, Downer T, Phillips NM, McTier L, Lord B. Use of videos to support teaching and learning of clinical skills in nursing education: A review. Nurse Educ Today. 2016;42:53–56. https://doi.org/10.1016/j.nedt.2016.04.010

86. Jang HW, Kim K. Use of online clinical videos for clinical skills training for medical students : benefits and challenges. Biomed Cent Med Educ. 2014;14:1–6. https://doi.org/10.1186/1472-6920-14-56

87. Katz L, Finch A, Mckinnish T, Gilliland K, Tolleson-Rinehart S, Marks B. Teaching procedural skills to medical students : a pilot procedural skills lab. Educ Heal. 2017;30:79–83. https://doi.org/10.4103/1357-6283.210516

Stellenbosch University https://scholar.sun.ac.za

88. Herrmann-Werner A, Nikendei C, Keifenheim K, Bosse HM, Lund F, Wagner R. “Best practice” skills lab training vs. a “see one, do one” approach in undergraduate medical education: a RCT on students’ long-term ability to perform procedural clinical skills. PLoS One. 2013;8:1–14. https://doi.org/10.1371/journal.pone.0076354

89. Bloomfield JG, While AE, Roberts JD. Using computer assisted learning for clinical skills education in nursing: integrative review. J Adv Nurs. 2008;63:222–235. https://doi.org/10.1111/j.1365-2648.2008.04653.x

90. Wartman SA, Combs CD. Reimagining Medical Education in the Age of AI. AMA J ethics. 2019;21:146–152. https://doi.org/10.1001/amajethics.2019.146

91. Del-Ben CM, Shuhama R, Costa MJ, De Almeida Troncon LE. Effect of changes to the formal curriculum on medical students’ motivation towards learning: A prospective cohort study. Sao Paulo Med J. 2019;137:112–118. https://doi.org/10.1590/1516-3180.2018.0264090119

92. Barisone M, Bagnasco A, Aleo G, Catania G, Bona M, Gabriele Scaglia S. The effectiveness of web-based learning in supporting the development of nursing students’ practical skills during clinical placements: A qualitative study. Nurse Educ Pract. 2019;37:56–61. https://doi.org/10.1016/j.nepr.2019.02.009

93. Zalat M, Hamed M, Bolbol S. The experiences , challenges , and acceptance of e-learning as a tool for teaching during the COVID-19 pandemic among university medical staff. PLoS One. 2021;16:1–12. https://doi.org/10.1371/journal.pone.0248758

94. Khamis NN, Satava RM, Alnassar SA, Kern DE. A stepwise model for simulation-based curriculum development for clinical skills , a modification of the six-step approach. Surg Endosc. Springer US; 2016;279–287. https://doi.org/10.1007/s00464-015-4206-x

95. Jacobs ZG, Michael Elnicki D, Perera S, Weiner DK. An E-learning module on chronic low back pain in older adults: Effect on medical resident attitudes, confidence, knowledge, and clinical skills. Pain Med (United States). 2018;19:1112–1120. https://doi.org/10.1093/pm/pnx333

96. Wentzell S, Moran L, Dobranowski J, Levinson A, Hannigan A, Dunne CP. E-learning for chest x-ray interpretation improves medical student skills and confidence levels. BMC Med Educ. 2018;18:1–8. https://doi.org/10.1186/s12909-018-1364-2

97. Creswell J, Ebersohn L, Eloff I, Ferreira R, Ivankova N, Jansen J. First Steps in Research. Maree K, editor. Pretoria, South Africa: Van Schaik; 2007.

Stellenbosch University https://scholar.sun.ac.za

98. Denscombe M. The Good Research Guide. Third. Berkshire, England: Open University Press; 2007.

99. Curtis E, Drennan J. Quantitative Health Research. Berkshire, England: Open University Press; 2013.

100. De Leeuw RA, Westerman M, Walsh K, Scheele F. Development of an instructional design evaluation survey for postgraduate medical E-learning: Content validation study. J Med Internet Res. 2019;21:1–13. https://doi.org/10.2196/13921

101. Tavakol M, Sandars J. Quantitative and qualitative methods in medical education research: AMEE Guide No 90: Part II. Med Teach. 2014;36:838–848. https://doi.org/10.3109/0142159X.2014.915297

102. Rudaleva I, Kabasheva I, Kovaleva E. The effectiveness of e-learning: Based on students' evaluation. SHS Web Conf. 2016;26:1–7. https://doi.org/10.1051/shsconf/20162601128

103. Ehlers U. Quality in e-learning from a learner's perspective. Eur J Open, Distance e-learning. 2004;1–7.

104. Shahmoradi L, Changizi V, Mehraeen E, Bashiri A, Jannat B, Hosseini M. The challenges of e-learning system: higher educational institutions perspective. J Educ Health Promot. 2018;7:1–16. https://doi.org/10.4103/jehp.jehp_39_18

105. Cook DA, Beckman TJ, Thomas KG, Thompson WG. Measuring motivational characteristics of courses: Applying Keller's instructional materials motivation survey to a web-based course. Acad Med. 2009;84:1505–1509. https://doi.org/10.1097/ACM.0b013e3181baf56d

106. Law KMY, Geng S, Li T. Student enrollment, motivation and learning performance in a blended learning environment: The mediating effects of social, teaching, and cognitive presence. Comput Educ. 2019;136:1–12. https://doi.org/10.1016/j.compedu.2019.02.021

107. Islam S, Baharun H, Muali C, Ghufron MI, Bali MEI, Wijaya M. To Boost Students' Motivation and Achievement through Blended Learning. J Phys Conf Ser. 2018;1114. https://doi.org/10.1088/1742-6596/1114/1/012046

108. Behforouz B, Gaithi A, Fekri N. Omani EFL learner perceptions and motivation toward online learning. J Univ Teach Learn Pract. 2021;18. https://doi.org/10.53761/1.18.4.13

109. Davis D, Chen G, Hauff C, Houben GJ. Activating learning at scale: A review of innovations in online learning strategies. Comput Educ. 2018;125:327–344. https://doi.org/10.1016/j.compedu.2018.05.019

Stellenbosch University https://scholar.sun.ac.za

110. Frantz J. Learning styles among nursing students, the implications for higher education institutions: A systematic review. South African J High Educ. 2017;28:1814–1829. https://doi.org/10.20853/28-6-427

111. Chang BY, Chang CY, Hwang GH, Kuo FR. A situation-based flipped classroom to improving nursing staff performance in advanced cardiac life support training course. Interact Learn Environ. 2018;0:1–13. https://doi.org/10.1080/10494820.2018.1485709

112. Wong G, Greenhalgh T, Pawson R. Internet-based medical education: a realist review of what works, for whom and in what circumstances. BMC Med Educ. 2010;10:1–10. https://doi.org/10.1186/1472-6920-10-12

113. Van Alten DCD, Phielix C, Janssen J, Kester L. Effects of flipping the classroom on learning outcomes and satisfaction: a meta-analysis. Educ Res Rev. 2019;28:1–18. https://doi.org/10.1016/j.edurev.2019.05.003

114. Låg T, Sæle RG. Does the Flipped Classroom Improve Student Learning and Satisfaction? A Systematic Review and Meta-Analysis. AERA Open. 2019;5:1–17. https://doi.org/10.1177/2332858419870489

115. Fleming J, Becker K, Newton C. Factors for successful e-learning: does age matter? Educ Train. 2017;59:76–89. https://doi.org/10.1108/ET-07-2015-0057

116. Dinndorf-Hogenson GA, Hoover C, Berndt JL, Tollefson B, Peterson J, Laudenbach N. Applying the flipped classroom model to psychomotor skill acquisition in nursing. Nurs Educ Perspect. 2019;40:99–101. https://doi.org/10.1097/01.NEP.0000000000000411

117. Sezer B, Abay E. Looking at the Impact of the Flipped Classroom Model in Medical Education. Scand J Educ Res. 2019;63:853–868. https://doi.org/10.1080/00313831.2018.1452292

118. Deshpande S, Ritzenthaler D, Sun A, Rudert N, Lewis J. A unique flipped classroom approach shows promising results in physician assistant education. Med Teach. 2020;42:285–290. https://doi.org/10.1080/0142159X.2019.1679360

119. Blair R, Caton J, Hamnvik A. A flipped classroom in graduate medical education. Clin Teach. 2020;17:195–199. https://doi.org/10.1111/tct.13091.A

120. Nalliveettil G, Sreehari P, Al-Rubaat AM. Challenges and implications of virtual e-learning platform in EFL context: Perceptions of teachers. nternational J English Lang Teach. 2019;7:100–116.

121. Appleyard JW. Using a flipped classroom approach in medical education: a medical student's perspective. Med Teach. Taylor & Francis; 2020;42:839–840.

Stellenbosch University https://scholar.sun.ac.za

https://doi.org/10.1080/0142159X.2019.1700220

122. Regmi K, Jones L. A systematic review of the factors – enablers and barriers – affecting e-learning in health sciences education. BMC Med Educ. 2020;20:1–18. https://doi.org/10.1186/s12909-020-02007-6

123. Olum R, Atulinda L, Kigozi E, Nassozi DR, Mulekwa A, Bongomin F. Medical education and e-learning during COVID-19 pandemic : awareness , attitudes , preferences and barriers among undergraduate medicine and nursing students at Makerere University , Uganda. J Med Educ Curric Dev. 2020;7:1–9. https://doi.org/10.1177/2382120520973212

124. Ibrahim N, Al Raddadi R, AlDarmasi M, Al Ghamdi A, Gaddoury M, AlBar H. Medical students ' acceptance and perceptions of e-learning during the Covid-19 closure time in King Abdulaziz University , Jeddah. J Infect Public Health. King Saud Bin Abdulaziz University for Health Sciences; 2021;14:17–23. https://doi.org/10.1016/j.jiph.2020.11.007

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Addendum A: Ethics Approval

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Approved with Stipulations

New Application

12/04/2020

Project ID: 14499

HREC Reference No: S20/03/069

Project Title: Third-year medical students' perception of the value of an e-learning bundle in the acquisition of a clinical skill

Dear Mrs. Lizanne Van der Walt

The **New Application** received on 11/03/2020 was reviewed by members of the **Health Research Ethics Committee** via Minimal Risk Review procedures on 12/04/2020 and was approved with a stipulations

Please note the following information about your approved research protocol:

Approval date:12 April 2020

Expiry date: 11 April 2021

The stipulation of your ethics approval is as follows:

1. Please submit your supervisors CV as this was not included as part of your initial submission.

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COVID19 Proviso:

Kindly note that although the study has been granted ethics approval, the study may not proceed during the current national lockdown as an embargo has been placed on studies that require interaction with research participants in order to prevent potential harm to participants. HREC will publish on the HREC website a date when the said embargo is to be lifted taking into consideration the best interest of participants and national interests around COVID-19.

Please remember to use your project ID 14499 and ethics reference number S20/03/069 on any documents or correspondence with the HREC/UREC concerning your research protocol.

Translation of the consent document(s) to the language(s) applicable to your study participants should now be submitted to the HREC.

Please note that this decision will be ratified at the next HREC full committee meeting. HREC reserves the right to suspend approval and to request changes or clarifications from applicants. The coordinator will notify the applicant (and if applicable, the supervisor) of the changes or suspension within 1 day of receiving the notice of suspension from HREC. HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:

Please note you can submit your progress report through the online ethics application process, available at: https://apply.ethics.sun.ac.za and the application should be submitted to the Committee before the year has expired. Please see Forms and Instructions on our HREC website for guidance on how to submit a progress report.

The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility, permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Please consult the Western Cape Government website for access to the online Health Research Approval Process, see: https://www.westerncape.gov.za/general-publication/health-research-approval-process. Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.

For standard HREC forms and instructions, please visit: Forms and Instructions on our HREC website (www.sun.ac.za/healthresearchethics)

If you have any questions or need further assistance, please contact the HREC office at 021 938 9657.

Addendum B: Institutional approval (full document available on request)

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INSTITUTIONAL PERMISSION:

AGREEMENT ON USE OF PERSONAL INFORMATION IN RESEARCH

Name of Researcher:	Lizanne van der Walt
Name of Research Project:	Third-year medical students' perception of the value of an e-learning bundle in the acquisition of a clinical skill.
Service Desk ID:	IRPSD-1720
Date of Issue:	03 April 2020

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Addendum C: Programme Committee approval (full document available on request)

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Feedback on proposed research involving MB,ChB students

Undergraduate

Research Office **4 May 2020**

Number of proposals reviewed: 1

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1. **Title:** Third-year medical students' perception of the value of an e-learning bundle in the acquisition of a clinical skill
   Researcher: Lizanne van der Walt
   Institution/department: Stellenbosch University
   Nature of research: MPhil (Health Professions Education)

SU institutional approval Y/N:	Yes (8 April 2020)
SU ethics approval Y/N:	Yes (S20/03/069)
Other ethics approval:	N/A
Proposed dates of research:	August/September 2020
Number of FMHS student participants:	Approximately 60
Number of MB, ChB student participants:	Approximately 60
Number of FMHS staff participants:	None
Participants from other institutions Y/N:	No
Requirements of students:	Online questionnaire after attending a clinical skills Simulation training session
Expected duration of required tasks:	10-20 minutes
Inside/outside academic schedule:	Clinical skills training – part of clinical rotation. Online questionnaire – outside of class time

Addendum D: Participant Consent Form

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CONSENT TO PARTICIPATE IN RESEARCH

Dear Participant

My name is Lizanne van der Walt, a student at the Stellenbosch University and I would like to invite you to take part in a survey, the results of which will contribute to a research project in order to complete my Masters in Philosophy in Health Professions Education.

Please take some time to read the information presented here, which will explain the details of this project.
Your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

The purpose of this study is to examine the value of an e-learning bundle when learning procedural skills.

The questionnaire will take approximately 20 minutes to complete and will contain a combination of questions covering usage, motivation, barriers and general experience related to the e-learning bundle. The questionnaire link will be emailed to participants, and must be completed within 72 hours.

At the end of the data collection period, a lucky draw will be held for participants who returned the questionnaire within the 72 hour window, where ten R100 coffee shop vouchers will be awarded. The data management system (REDCap) is completely secure and allows for anonymous responses. Data will be saved for potential future research projects, and will be stored securely online.

RIGHTS OF RESEARCH PARTICIPANTS:
You have the right to decline answering any questions and you can exit the survey at any time without giving a reason. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Mrs Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

Your information and response to the survey will be protected by password protection, and no publishing of the student number or any other personal demographic data will occur. However, data will be shared anonymously with the research supervisor, Prof M de Villiers; as well as the assisting statistician, Ms T Esterhuizen; and will be written up as my MPhil research assignment.

If you have any questions or concerns about the research, please feel free to contact the researcher Lizanne van der Walt (lvdwalt@sun.ac.za) and/or the Supervisor, Prof M de Villiers (mrdv@sun.ac.za).

I confirm that I have read and understood the information provided for the current study.	YES	NO
	☐	☐
I agree to take part in this survey.	YES	NO
	☐	☐

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Addendum E: Original Medical E-learning Evaluation Survey

The Evaluation Survey for postgraduate Medical E-learning (MEES) version 1.0-2019

1.1 On a scale of 1-10, how motivated were you to start the e-learning?

Unmotivated Motivated

1.2 Please select which of the following items motivated you (multiple options).

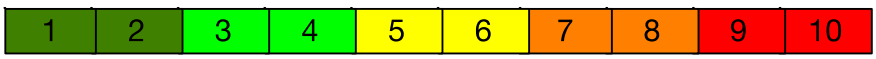
- ❑ I felt this e-learning was important
- ❑ I felt it was my responsibility to do this e-learning
- ❑ I had enough time to do the e-learning
- ❑ I had a good understanding of the general purpose of the e-learning
- ❑ The e-learning objectives (for each educational section) were clear to me
- ❑ There was a clear overview of all content
- ❑ I knew how to navigate to the content
- ❑ I felt comfortable with the quality / truthfulness of the content
- ❑ I was able to do this e-learning unforced
- ❑ I felt taken seriously as an adult learning
- ❑ The e-learning was aimed at my level of experience

- ❑ ADDED EXAMPLE(S)

- ❑ Please write down any other item(s) that motivated you

1.3 On a scale of 1-10, did you experience any barriers to starting the e-learning?

Stimulants Barriers



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1.4 Please select which of the following items you experienced as a barrier to starting the e-learning.

- ❑ I was not able to create my own learning path to my own needs
- ❑ The e-learning was not easily accessible at my location or with my device
- ❑ The navigation did not make sense to me
- ❑ The layout of the e-learning was too complicated
- ❑ There was no instrument to help me navigate the e-learning (for example a sitemap)
- ❑ I had worries about the security and safety of the e-learning, regarding my personal information
- ❑ The e-learning was slow and took too long to load
- ❑ I did not know which devices the e-learning was compatible with and I might have used the wrong one
- ❑ The e-learning was too long
- ❑ The e-learning did not divide the content into proper sections
- ❑ ADDED EXAMPLE(S)
- ❑ Other item(s) that I experienced as a barrier:

2.1 On a scale of 1-10, how educative was the e-learning for you?

Uninformative Educative

1	2	3	4	5	6	7	8	9	10

2.2 Please select which of the following 8 items helped you to learn and remember or add your own.

- ❑ I could personalize the e-learning (for example by saving and continuing, filling out questionnaires and getting my personal score, etc)
- ❑ I could create my own learning path, and was not forced to follow the directed path (for example by skipping parts or returning to previous sections if needed)
- ❑ I had an idea of the progress I had made and what was left to do (for example by a progress bar)
- ❑ If needed, I had access to technical support
- ❑ The e-learning provided summaries where needed
- ❑ The e-learning provided feedback on my answers
- ❑ There were exercises and/or assignments in the e-learning
- ❑ I could interact with the content of the e-learning (for example questions, exercises or other interactivities)
- ❑ ADDED EXAMPLE(S)

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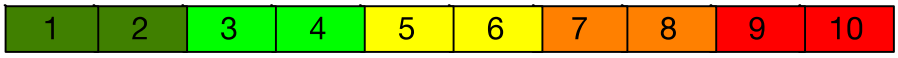
Other item(s) that helped me learn and remember

2.3 On a scale of 1-10, did you experience limitations in the e-learning that prevented you learning?

Advantages Limitations



2.4 Please select which of the following 3 limitations you experienced or add your own.

- ❑ I got stressed or frustrated by the e-learning for any reason
- ❑ The content was not able to adapt to my device when needed (for example, the e-learning should work on a mobile device, but the icons were way too small for that)
- ❑ The e-learning design and visuals were too distracting for me
- ❑ ADDED EXAMPLE(S)
- ❑ Other limitation(s) in my learning from this e-learning:

3.1 On a scale of 1-10, how do you think you can apply the newly learned knowledge, skills or attitude to your daily work?

Irrelevant Applicable

3.2 Please select which of the following 4 items helped you to apply the e-learning, or add your own.

- ❑ The e-learning content and examples are translatable to my daily real-world work
- ❑ The e-learning seems up-to-date and maintained
- ❑ The e-learning provided sources for the information which were also accessible after finishing it
- ❑ Besides this questionnaire, the e-learning was evaluated on topics like user experience, effectiveness, usability and/or costs

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- ❑ ADDED EXAMPLE(S)

Another way this e-learning helped me apply newly learned knowledge, skills or attitude to my daily work:

Addendum F: Adapted Medical E-learning Evaluation Survey

An Adapted Medical E-learning bundle Evaluation Survey (MEES)

This survey is aiming to evaluate your perception of the value of the e-learning bundle on administration of intramuscular and subcutaneous injections, in relation to the session that you have attended in the SCSU.

There are 18 questions in total: 4 demographic questions (yes-or-no), 2 usage questions, 6 Likert-scales (rate between 1 and 10), 6 open questions, and 37 examples. You are asked to select multiple options and to add examples, depending on your learning aims and unique experience utilising this e-learning bundle.

On completion of the survey, please submit it via Google forms. If you would like to participate in the lucky draw to win one of ten R100 coffee shop vouchers, please supply your student number as well.

1.1 Please state your year of birth

1.2 Please select your gender

- ❑ Female
- ❑ Male
- ❑ Other

1.3 Have you attended any other training or workshop on the administration of intramuscular and/or subcutaneous injections before today?

- ❑ Yes
- ❑ No

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1.4 Have you seen an intramuscular and/or subcutaneous injection being administered in any clinical setting before?

- ❑ Yes
- ❑ No

2.1 On a scale of 1-10, how motivated were you to start with e-learning bundle?

Unmotivated Motivated

2.2. Please select which of the following items motivated you (you may select multiple options)

- ❑ I felt this e-learning bundle was important
- ❑ I felt it was my responsibility to do this e-learning bundle
- ❑ I had enough time to do the e-learning bundle
- ❑ I had a good understanding of the general purpose of the e-learning bundle
- ❑ The e-learning bundle objectives were clear to me
- ❑ There was a clear overview of all content
- ❑ I knew how to navigate to the content
- ❑ I felt comfortable with the quality / truthfulness of the content
- ❑ I was able to do this e-learning bundle unforced
- ❑ I felt taken seriously as an adult learner
- ❑ The e-learning bundle was aimed at my level of experience
- ❑ Other (please specify in question 2.3)

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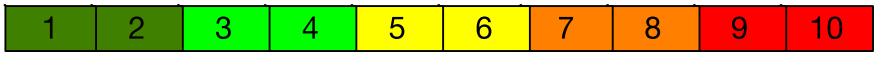
2.3 If you selected "other" in question 2.2, please describe other factors (not on the list above) that motivated you to start the e-learning bundle

2.4 On a scale of 1-10, please rate the barriers to starting the e-learning bundle?

Stimulants Barriers



2.5 Please select which of the following items you experienced as a barrier to starting the e-learning bundle (you may select multiple options)

- ❑ I was not able to create my own learning path to my own needs
- ❑ The e-learning bundle was not easily accessible at my location or with my device
- ❑ The navigation did not make sense to me
- ❑ The layout of the e-learning bundle was too complicated
- ❑ There was no instrument to help me navigate the e-learning bundle (for example a sitemap)
- ❑ I had worries about the security and safety of the e-learning bundle, regarding my personal information
- ❑ The e-learning bundle was slow and took too long to load
- ❑ The e-learning bundle was too long
- ❑ The e-learning bundle did not divide the content into proper sections
- ❑ I did not have enough time to engage with the e-learning bundle
- ❑ Other (please specify in question 2.6)

2.6 If you selected "other" in question 2.5, please describe other factors (not on the list above) that you consider as barriers to starting the e-learning bundle.

2.7 How many times (in total) did you access the e-learning bundle before the session? (Please select only one)

- ❑ Zero
- ❑ Once
- ❑ Twice
- ❑ Three times
- ❑ More than three times

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2.8 How much time did you spend (in total) preparing for the session utilizing the e-learning bundle? (Please select only one)

- ❑ Less than 20 minutes
- ❑ 20-40 minutes
- ❑ 40-60 minutes
- ❑ More than 60 minutes

3.1 On a scale of 1-10, how informative was the e-learning bundle for you?

Uninformative Informative

3.2 Please select which of the following 8 items helped you to learn and remember (you may select multiple options)

- ❑ I could personalize the e-learning bundle (for example by saving and continuing, filling out questionnaires and getting my personal score, etc)
- ❑ I could create my own learning path, and was not forced to follow the directed path (for example by skipping parts or returning to previous sections if needed)
- ❑ I had an idea of the progress I had made and what was left to do (for example by a progress bar)
- ❑ If needed, I had access to technical support
- ❑ The e-learning bundle provided summaries where needed
- ❑ The e-learning bundle provided feedback on my answers
- ❑ There were exercises in the e-learning bundle
- ❑ I could interact with the content of the e-learning bundle (for example questions, exercises or other interactivities)
- ❑ Other (please specify in question 3.3)

3.3 If you selected "other" in question 3.2, please describe other factors (not on the list above) that helped you learn and remember

3.4 On a scale of 1-10, rate the limitations in the e-learning bundle that prevented you from learning?

Advantages Limitations

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3.5 Please select which of the following 4 limitations you experienced (you may select multiple options)

- ❑ I got stressed or frustrated by the e-learning bundle for any reason
- ❑ The content was not able to adapt to my device when needed (for example, the e-learning bundle should work on a mobile device, but the icons were way too small for that)
- ❑ The e-learning bundle design and visuals were too distracting for me
- ❑ I am not comfortable with learning in English
- ❑ Other (please specify in question 3.6)

3.6 If you selected "other" in question 3.5, please describe which other limitations prevented you from learning.

4.1 On a scale of 1-10, how valuable did you find this e-learning bundle in preparation for the skills laboratory session?

No value Invaluable

4.2 On a scale of 1-10, how do you think you can apply the newly learned knowledge, skills and attitude to your daily work?

Irrelevant Applicable

4.3 Please select which of the following 4 items helped you to apply the e-learning bundle (you may select multiple options)

- ❑ The e-learning bundle content and examples are translatable to my daily real-world work
- ❑ The e-learning bundle seems up-to-date and maintained
- ❑ The e-learning bundle provided sources for the information which were also accessible after finishing it
- ❑ Besides this questionnaire, the e-learning bundle was evaluated on topics like user experience, effectiveness, usability and/or costs
- ❑ Other (please specify in question 4.4)

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4.4 If you selected "other" in question 4.3, please describe the way this e-learning bundle helped you apply newly learned knowledge, skills or attitude to your daily work

5. Do you have any other suggestions for the developer for future e-learning endeavours?

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Addendum G: Author guidelines for Medical Science Teacher

Instruction for Authors

Title Page

Please make sure your title page contains the following information.

Title

The title should be concise and informative.

Author information

- The name(s) of the author(s)
- The affiliation(s) of the author(s), i.e. institution, (department), city, (state), country
- A clear indication and an active e-mail address of the corresponding author
- If available, the 16-digit ORCID of the author(s)

If address information is provided with the affiliation(s) it will also be published.

For authors that are (temporarily) unaffiliated we will only capture their city and country of residence, not their e-mail address unless specifically requested.

Abstract

Please provide an abstract of 150 to 250 words. The abstract should not contain any undefined abbreviations or unspecified references.

For life science journals only (when applicable)

Trial registration number and date of registration

Trial registration number, date of registration followed by “retrospectively registered”

Keywords

Please provide 4 to 6 keywords which can be used for indexing purposes.

Text Formatting

Manuscripts should be submitted in Word.

- Use a normal, plain font (e.g., 10-point Times Roman) for text.
- Use italics for emphasis.
- Use the automatic page numbering function to number the pages.

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- Do not use field functions.
- Use tab stops or other commands for indents, not the space bar.
- Use the table function, not spreadsheets, to make tables.
- Use the equation editor or MathType for equations.
- Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).

Headings

Please use no more than three levels of displayed headings.

Abbreviations

Abbreviations should be defined at first mention and used consistently thereafter.

References

Citation

Reference citations in the text should be identified by numbers in square brackets. Some examples:

1. Negotiation research spans many disciplines (3).

2. This result was later contradicted by Becker and Seligman (5).

3. This effect has been widely studied (1-3, 7).

Reference list

The list of references should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text.

The entries in the list should be numbered consecutively.

If available, please always include DOIs as full DOI links in your reference list (e.g. “https://doi.org/abc”).

- Journal article

  Smith JJ. The world of science. Am J Sci. 1999;36:234–5.

- Article by DOI

  Slifka MK, Whitton JL. Clinical implications of dysregulated cytokine production. J Mol Med. 2000; https://doi.org/10.1007/s001090000086

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- Book

  Blenkinsopp A, Paxton P. Symptoms in the pharmacy: a guide to the management of common illness. 3rd ed. Oxford: Blackwell Science; 1998.

- Book chapter

  Wyllie AH, Kerr JFR, Currie AR. Cell death: the significance of apoptosis. In: Bourne GH, Danielli JF, Jeon KW, editors. International review of cytology. London: Academic; 1980. pp. 251–306.

- Online document

  Doe J. Title of subordinate document. In: The dictionary of substances and their effects. Royal Society of Chemistry. 1999. http://www.rsc.org/dose/title of subordinate document. Accessed 15 Jan 1999.

- Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations

Tables

- All tables are to be numbered using Arabic numerals.
- Tables should always be cited in text in consecutive numerical order.
- For each table, please supply a table caption (title) explaining the components of the table.
- Identify any previously published material by giving the original source in the form of a reference at the end of the table caption.
- Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data) and included beneath the table body.

Artwork and Illustrations Guidelines

Electronic Figure Submission

- Supply all figures electronically.
- Indicate what graphics program was used to create the artwork.
- For vector graphics, the preferred format is EPS; for halftones, please use TIFF format. MSOffice files are also acceptable.
- Vector graphics containing fonts must have the fonts embedded in the files.
- Name your figure files with "Fig" and the figure number, e.g., Fig1.eps.

Color Art

- Color art is free of charge for online publication.

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- If black and white will be shown in the print version, make sure that the main information will still be visible. Many colors are not distinguishable from one another when converted to black and white. A simple way to check this is to make a xerographic copy to see if the necessary distinctions between the different colors are still apparent.
- If the figures will be printed in black and white, do not refer to color in the captions.
- Color illustrations should be submitted as RGB (8 bits per channel).

Figure Lettering

- To add lettering, it is best to use Helvetica or Arial (sans serif fonts).
- Keep lettering consistently sized throughout your final-sized artwork, usually about 2–3 mm (8–12 pt).
- Variance of type size within an illustration should be minimal, e.g., do not use 8-pt type on an axis and 20-pt type for the axis label.
- Avoid effects such as shading, outline letters, etc.
- Do not include titles or captions within your illustrations.

Figure Numbering

- All figures are to be numbered using Arabic numerals.
- Figures should always be cited in text in consecutive numerical order.
- Figure parts should be denoted by lowercase letters (a, b, c, etc.).
- If an appendix appears in your article and it contains one or more figures, continue the consecutive numbering of the main text. Do not number the appendix figures,"A1, A2, A3, etc." Figures in online appendices (Supplementary Information (SI)) should, however, be numbered separately.

Figure Captions

- Each figure should have a concise caption describing accurately what the figure depicts. Include the captions in the text file of the manuscript, not in the figure file.
- Figure captions begin with the term Fig. in bold type, followed by the figure number, also in bold type.
- No punctuation is to be included after the number, nor is any punctuation to be placed at the end of the caption.
- Identify all elements found in the figure in the figure caption; and use boxes, circles, etc., as coordinate points in graphs.

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- Identify previously published material by giving the original source in the form of a reference citation at the end of the figure caption.

Figure Placement and Size

- Figures should be submitted separately from the text, if possible.
- When preparing your figures, size figures to fit in the column width.
- For large-sized journals the figures should be 84 mm (for double-column text areas), or 174 mm (for single-column text areas) wide and not higher than 234 mm.
- For small-sized journals, the figures should be 119 mm wide and not higher than 195 mm.

Permissions

If you include figures that have already been published elsewhere, you must obtain permission from the copyright owner(s) for both the print and online format. Please be aware that some publishers do not grant electronic rights for free and that Springer will not be able to refund any costs that may have occurred to receive these permissions. In such cases, material from other sources should be used.

Accessibility

In order to give people of all abilities and disabilities access to the content of your figures, please make sure that

- All figures have descriptive captions (blind users could then use a text-to-speech software or a text-to-Braille hardware)
- Patterns are used instead of or in addition to colors for conveying information (colorblind users would then be able to distinguish the visual elements)
- Any figure lettering has a contrast ratio of at least 4.5:1

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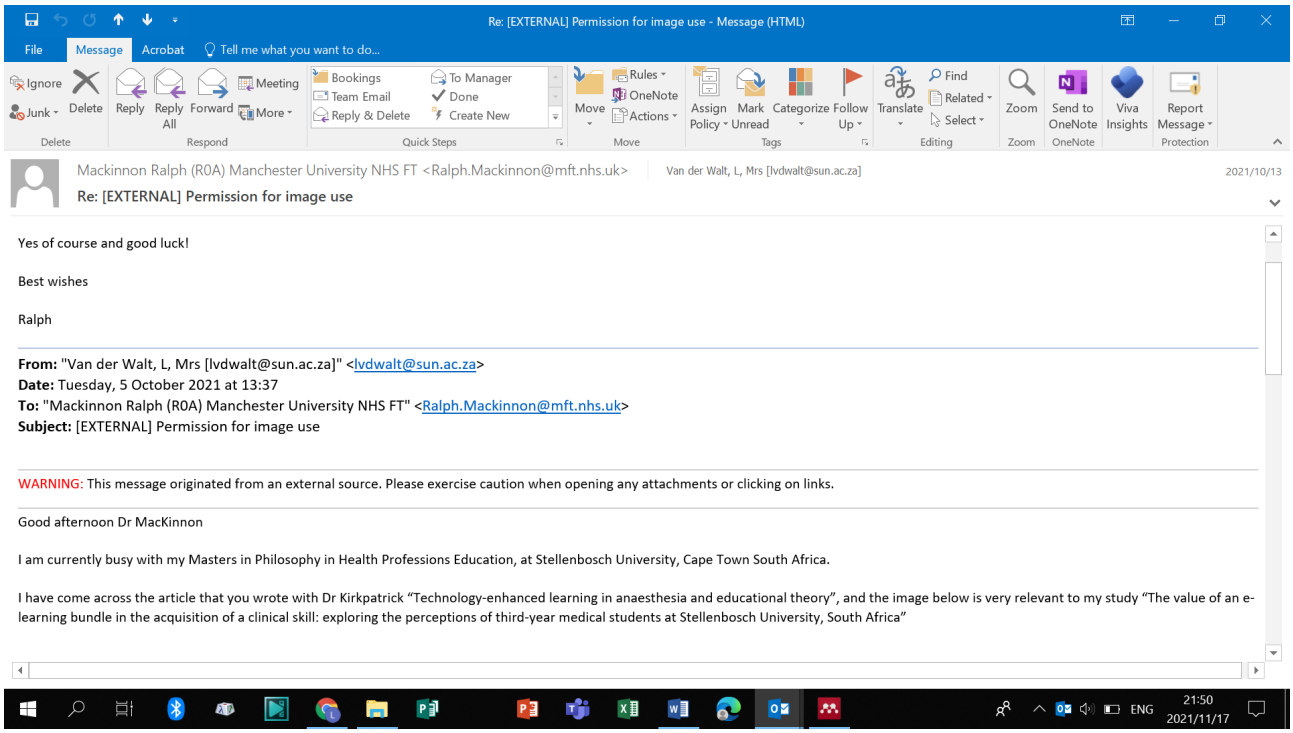
Addendum H: Image permissions [64]



Re: [EXTERNAL] Permission for image use - Message (HTML)

File Message Acrobat Tell me what you want to do...

Ignore Junk Delete Reply Reply All Forward Meeting More Delete Respond

Bookings Team Email Reply & Delete To Manager Done Create New Quick Steps

Move Rules OneNote Actions Move

Assign Policy Mark Unread Categorize Follow Up Tags

Translate Find Related Select Editing

Zoom Zoom

Send to OneNote OneNote

Viva Insights

Report Message Protection

Mackinnon Ralph (R0A) Manchester University NHS FT <Ralph.Mackinnon@mft.nhs.uk> Van der Walt, L, Mrs [lvdwalt@sun.ac.za] 2021/10/13

Re: [EXTERNAL] Permission for image use

Yes of course and good luck!

Best wishes

Ralph

From: "Van der Walt, L, Mrs [lvdwalt@sun.ac.za]" <lvdwalt@sun.ac.za>
Date: Tuesday, 5 October 2021 at 13:37
To: "Mackinnon Ralph (R0A) Manchester University NHS FT" <Ralph.Mackinnon@mft.nhs.uk>
Subject: [EXTERNAL] Permission for image use

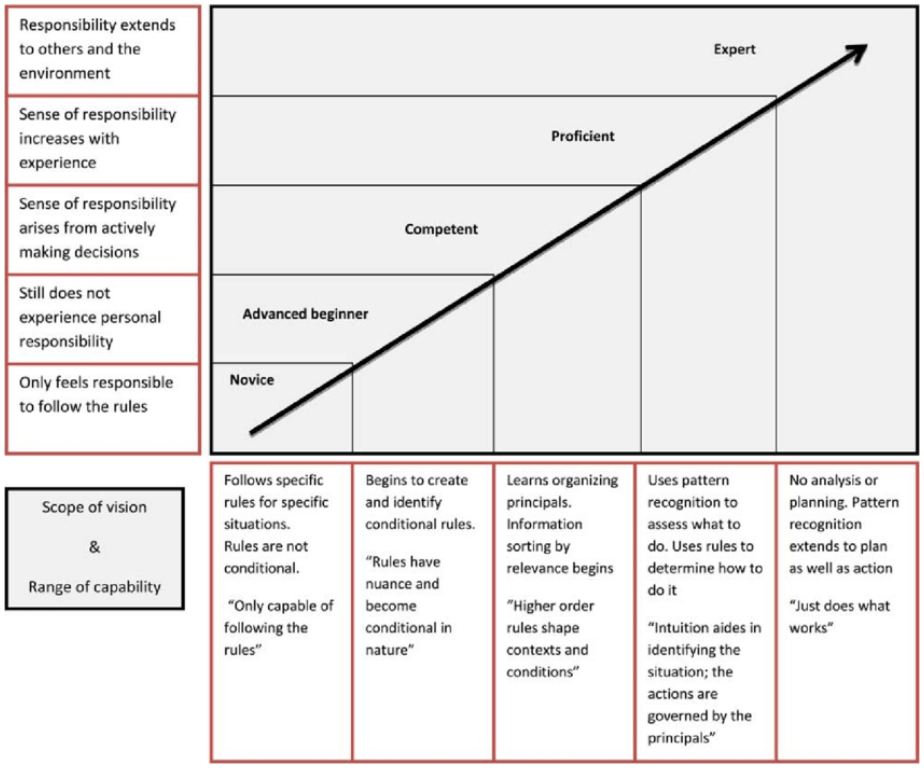
WARNING: This message originated from an external source. Please exercise caution when opening any attachments or clicking on links.

Good afternoon Dr MacKinnon

I am currently busy with my Masters in Philosophy in Health Professions Education, at Stellenbosch University, Cape Town South Africa.

I have come across the article that you wrote with Dr Kirkpatrick "Technology-enhanced learning in anaesthesia and educational theory", and the image below is very relevant to my study "The value of an e-learning bundle in the acquisition of a clinical skill: exploring the perceptions of third-year medical students at Stellenbosch University, South Africa"

ENG 21:50 2021/11/17



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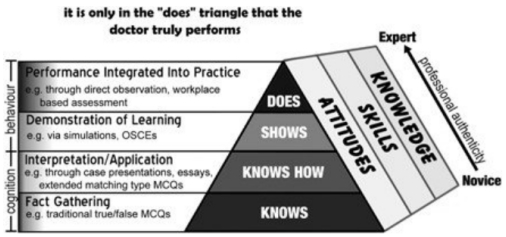
Addendum I: Image permissions (Miller's Prism of Clinical Competence)



Figure

Caption

Figure 1: Miller's prism of clinical competence (aka Miller's pyramid). Based on the work by Miller GE, The Assessment of Clinical Skills/Competence/Performance; Acad. Med. 1990; 65(9): 63–67. Adapted by Drs. R. Mehay and R. Burns, UK (Jan 2009).

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Addendum J: Image permissions (Chamunyonga et al, 2018)