Paper	data collected	data published	Country	Participants	Type	Function	Research approach	Aim	Sampling, number/rate	Study design --- Data collection method	Level L1-L6	Strength Grade: S1-S5	Findings and conclusions	Kirkpatrick K-level: K1-K4	'highest' Kirkpatrick K-level: K1-K4	Maxwell	Notes
Alegría et al. 2014	2012-2013	2014	USA	3rd year medical students	iPad	repository	qualitative	"[To understand better] the manner in which students use tablet computers on clinical rotations and plan how they might be better employed... ...to describe the manner in which students in an LIC [longitudinal integrated clerkship] employ tablet computers for self-regulated learning."	"...15 students were enrolled during the 2012-2013 academic year." --- "All 15 study participants were invited in person and by email..."	"Third-year medical students are assigned to a faculty or resident preceptor for each core discipline and 15 students were enrolled during the 2012-2013 academic year." --- "Students were provided with an Apple iPad 2..." --- "...two 1-hour long focus groups, one 3 months into the clerkship and one 3 months [before] end of the clerkship to understand changes in the use over... the year."	4	4	"More than half... used the tablet to [show] faculty that they were learning, either by sending [or] presenting a learning issue..." "Students were ...concerned that their preceptors would think that they were 'texting or doing email' but... tablet was more likely to be perceived as work than using a smart phone." "Students used the tablet to support their self-regulated learning in ways that were unique to their learning styles and increased access to resources and [use] of down-time. Students who used the tablet to self-monitor and target learning demonstrated the utility of tablets as learning tools." Tablets can enhance students' ability to develop and employ self-regulatory skills in a clinical context (longitudinal integrated clerkship), and students value this educational support more than its use as a clinical tool at the bedside.	K2b, K3	K3	appropriateness, accessibility, acceptability, effectiveness, efficiency	
Autry et al. 2002	Nov-2000 to Jun-2001	2002	USA	medical students	personal digital assistant (PDA)	logbook	quantitative	"To assess in 'real time' the degree to which women's health competencies are addressed in the clinical curriculum by using a personal digital assistant."	"Twelve students (6 women and 6 men) were selected to participate on the basis of their third-year track schedule and prior involvement in medical school-related organizations..." "There were 2690 total encounters."	"Competencies for women's health were developed. Twelve students were supplied with a personal digital assistant, pre-loaded with a patient log system, for use in assessment of the inclusion of these... The students received [1-hour] instruction on completing the log for each patient for whom they were primarily responsible." --- "The students downloaded their logs to a central computer every 2 weeks."	4	4	"...students completing the obstetrics and gynecology clerkship reported that 64% of infectious disease encounters and 85% of oncology encounters included discussions regarding gender, whereas only 12% of gastroenterology encounters and 14% of preventative medicine encounters included discussions of gender." --- "...the personal digital assistant is an effective tool with which to monitor curriculum content in the clinical setting, [as illustrated with gender-specific discussions differing across specialties and across diagnostic categories revealing a disappointing gap beyond obstetrics and gynaecology]." --- "...teacher gender did not affect amount of gender-specific education."	K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, efficiency, equity	
Bogossian et al. 2009	2007	2009	Australia	nursing students	tablet	logbook	mixed methods	"...a pilot study [of] the use of tablet PCs further investigated the use of the CPPeP [clinical practice performance electronic portfolio] in the clinical environment ['to determine the effectiveness, of the strategy']. The participants' ability to collect evidence and receive feedback at the point of care would result in a greater degree of authenticity and accuracy in the education and assessment processes."	"Three students undertaking the final semester of the University's Bachelor of Nursing program... located within clinical settings. All were female, aged less than 25 years and... were either extremely or very comfortable working with computers."	"A focus group utilising a semi-structured interview and a survey collected data from the students [after pilot use of the device]..."	4	2	"...lack of space, busy wards and concerns about the security of the PCs limited their use in clinical setting ['to access their portfolios']. [Most] journal entries were made at home and within similar time frames to those prior to access to tablet PCs. Participants also used the PCs to provide education to other students and staff but were reluctant to use them in front of patients [re concerns of security, competence, inappropriate]." "[They used the devices] to mentor other students about the portfolio and to email them educational information." --- "[They] felt the need to 'tread softly' when using the tablet PC' in front of staff, given disapproval experienced (despite positive reception from other staff). Use of the device is thus limited by the clinical culture and busy setting, usefulness (technical barriers and perceptions that patients would disapprove), and security issues, but good for portfolio completion and nurse education.	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, efficiency	S3 evidence was extracted from overall S2.
Brown and McCrorie 2015	No details	2015	Australia	undergraduate nursing (1st year, 3rd year) and midwifery students (1st year)	iPad	repository, decision-making, assessment	mixed methods	"explored the impact of tablet technology, in the form of Apple iPads, on undergraduate nursing and midwifery students' learning outcomes" -- "research objectives... 1. understand the user experience of tablets in simulation generally, and specifically to access bedside information in a time efficient manner, and 2. understand the extent to which student learning was enhanced through the use of the tablet"	n=30 1st year nursing students, n=88 3rd year nursing students, n=25 1st year midwifery students --- n=45/143 (31.5%) students completed questionnaire	"pilot study" --- "In simulated clinical learning environments, first-year nursing students (n = 30) accessed apps and reference materials on iPads. Third-year nursing students (n = 88) referred to clinical guidelines to aid their decision making when problem solving [with randomly allocated simulated patients]. First-year midwifery students (n = 25) filmed themselves undertaking a skill and then immediately played back the video file. A total of 45 students completed an online questionnaire that allowed for qualitative comments." --- Subsequent online survey with convenience sample	4	3	"Students [found] use of iPads easy [in the simulated clinical setting, 76/100] and [providing] point-of-care access to resources [clinical guidelines], ensuring an evidence-based approach to clinical decision making. iPads reportedly improved student efficiency, and time management, while improving their ability to provide patient education. Students who used iPads for the purpose of formative self-assessment appreciated the immediate feedback and opportunity to develop clinical skills." --- "Students' comments [showed use of evidence] to guide clinical and care decision making at the point of care." --- "...students assisted those who were less confident with the iPads, and this created a peer-to-peer supportive learning environment." --- In the simulated clinical setting, the iPad helped the learning of 80/100 and the work efficiency of 71/100.	K1, K3	K3	appropriateness, accessibility, acceptability, effectiveness, efficiency	
Cho and Lee 2015	2012	2015	South Korea	nursing students: freshman, sophomore, junior, senior	smartphone	smartphone use (social networking, internet, texting/calling)	mixed methods	"...to develop a scale to measure smartphone addiction and test its validity and reliability."	"...interviews were conducted with six nursing students who had more than 2 years' experience using a smartphone and felt, based on input from peer nursing students, that they overused the smartphone." --- "A total of 428 students who had a clinical practicum during their coursework answered the items on distractions and the development of a policy to ban smartphone use in hospitals."	"Smartphone addiction and the need for a scale to measure it were identified through a literature review and in-depth interviews with nursing students [which informed development of the scale]."	4	4	They developed a 4-factor 18-item smartphone addiction scale ("withdrawal...: irritation or anxiety about not being able to take smartphone messages; tolerance...: using the smartphone for longer than intended and feeling the urge to use it again right after using it; interference with daily routines...; and positive expectations: ...something special and beneficial..."). They found that "nursing students who had a greater addiction to smartphone use were more likely to be distracted at work... [r_p=0.352 (p<0.01) and] disagreed with establishing policies to guide the use of smartphones in healthcare settings."	K3, K4a	K4a	appropriateness, acceptability, effectiveness	r=−0.089 in Table 4 yet r=−0.890 in commentary, p220. If table were correct then there would be no correlation.
Cho and Lee 2016	2012	2016	South Korea	3rd year nursing students	smartphone	smartphone use (social networking, internet, texting/calling, music/cinema/games)	quantitative	"...assessed nursing students' smartphone use as a source of distraction in clinical practice and identified their opinions about policies restricting smartphone use during patient care."	"...students from two nursing schools... in a metropolis and small city in South Korea, with over six months of clinical practicum experience in hospital settings. ...302 participants were required to detect an effect size of 0.04, with a power (1−β) of 0.85 and a two-tailed alpha of 0.05..., ...an allocation ratio of 1:3... for each group for the independent t test." --- Convenience sampling	"A cross-sectional descriptive design..." --- "A self-report questionnaire—based on addiction theories for problem behaviors [and] cellular phone use—was used to assess smartphone use, experiences of distraction caused by smartphone use, and opinions about restriction policies on smartphone use during clinical practice."	4	3	They developed a 3-factor 13-item scale re smartphone distraction (use and distractions in nursing students and as witnessed in nurses, plus perceptions re restriction policies). Despite a policy not to use smartphones on clinical placement, they found that 28% had been externally distracted, 25% had distracted themselves, and 43% had witnessed other students being distracted by smartphones on clinical placement. "Nearly half (46.2%) of the nursing students used smartphones at least sometimes during clinical practice... A few... (15.7%) agreed or strongly agreed with the policy for restricting smartphone use in hospitals. Students who used smartphones more often tended to disagree with [such] restriction policies... [r=−0.245, p <0.0001]."	K1, K3, K4a, K4b	K4a K4b	accessibility, acceptability, equity	
Cornelius 2005	Jul- and Aug- 2005	2004	USA	senior nursing students	PDA	decision-making	mixed methods	"1 To evaluate the effectiveness, of handheld personal computers, equipped with an assessment tool, in the development of clinical decision-making skills among undergraduate nursing students" i.e. "What is the relationship between the use of handheld personal computers (PDAs) and student's ability to identify the three top patient care needs (nursing diagnosis)? What is the user experience associated with using this technology in the clinical setting?" 2 To identify user issues associated with this technology in the clinical setting."	[There had been a pilot study of n=5.] --- "Twenty-six senior nursing students and two clinical faculty... [assessed] 212 patients... [follow-up] in-depth interviews with 21 students and 2 faculty..." "[Field observations] 26 students... two clinical days per week for 4 weeks."	"...the top three nursing care priorities [were] analyzed to identify similarities between [clinical faculty, students, and researcher]. [Students used the Gerontological Reasoning Informatics Project (GRIP) tool, and there were clinical field observations and 'on-the-spot' informal interviews.] [In-depth interviews followed up students and faculty.]	4	4	"[Pilot study] results demonstrated that the tool is accurate in identifying patient risk levels and consistent in scoring across raters [and identified] several minor problem areas with the user interface..." Main study: "The results suggest that handheld technology, equipped with a tool such as GRIP, effectively develops clinical competency and clinical decision-making skills in undergraduate nursing students [but one-third] of participants reported that the PDA was a barrier to the nurse-patient interaction. [...] Students remarked that they were spending much of the interview focusing on the tool when the patient just wanted to [talk]." [While students could identify well 'the top three nursing care priorities', the PDA contribution was unclear.] "Four stated [in follow-up interviews] that the positive response from patients was surprising, and that the elderly patients seemed genuinely interested and open to the technology. ...Only one student stated that she was surprised by the negative response from a patient."	K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness	Doctor of Philosophy thesis --- p74: "one third of the students reported that they felt the device was a barrier"; p100: "one third (N=7) of the study participants reported that they believed that using the GRIP tool interfered with the nurse-patient relationship and created a barrier to establishing rapport"; plus Table 12: "Device as Barrier 7"; yet Abstract (pxii): "About two thirds of participants reported that the PDA was a barrier to the nurse-patient interaction."

e-Appendix 2: n=45 primary research, n=4 systematic reviews: Data extracts for: "What works best for health professions students using mobile (hand-held) devices for educational support on clinical placements?"

Paper	Time: data collected	data published	Place: Country	Person: Participants	Device: Type	Function	Research approach	Aim	Sampling, number/rate	Study design --- Data collection method	Level L1-L6	Strength Grade S1-S5	Findings and conclusions	Kirkpatrick K-level: K1-K4	'highest' Kirkpatrick K-level: K1-K4	Maxwell	Notes
Davies et al. 2012	2007/08, 2008/09, 2009/10	2012	UK	3rd, 4th, 5th year medical students	PDA	repository	mixed methods	"The main questions... were: how the medical students used the technology, how it enabled them to learn, what learning theories contributed, what barriers were encountered and what could be done to overcome them."	"[Of] 419 students... in years 3-5... 387 chose to participate..." --- "Pre-study survey: 302/387 (78%) responded..." --- "Post study survey: 140 students responded (74/133 year 3 students, 66/123 year 4 students)... 54.7%." --- No Year 5 as they had graduated.	"Outcomes were assessed by a mixed-methods triangulation approach using qualitative and quantitative analysis of surveys, focus groups and usage tracking data." --- "The study was an extension of a successful pilot study of 20 year 3 students in 2006/7."	4	4	"[They] describe the learning ecology and pedagogic basis behind the use of mobile learning technologies [by] medical students in the clinical environment" --- "Four ways in which learning was enabled emerged from the focus group analysis. 1. Timely access to key facts -learning in context 2. Consolidation of knowledge through repetition 3. A supplement rather than a replacement 4. Making use of wasted time" --- "Many of them felt that using the PDA whilst in a clinical context interrupted the ongoing experience. [...] There was also a widely expressed [mostly hearsay] view that students had had negative experiences with patients and staff [disapproving]." --- "The conceptual model [built]... shows the contribution of repetition and contextual learning theories to the process of mobile learning" --- "The physical obtrusiveness of the PDA reflects the experiences [and] concerns regarding teacher and patient opinion, and of a perceived failure to engage in the clinical moment, leading to potential inhibition of PDA use despite accepting its utility. This constrained their optimal use of the PDA."	K1, K3	K3	appropriateness, accessibility, acceptability, effectiveness, efficiency	
Davydov 2010	students graduating 2009-2010	2010	USA	junior and senior undergraduate nursing students	PDA	decision-making	quantitative	"to determine if the use of PDA devices reduces state and trait anxiety levels related to learning and working in a clinical environment in a hospital during the junior and senior year of a baccalaureate nursing program"	"To achieve the appropriate sample size, approximately 100 students were invited to participate from the experimental group, and approximately 50 students... from each of the control group schools." [Of 215 giving informed consent overall, only 74 of the 79 eligible students could be included in the data analysis.]	"nonrandom design" --- "data were collected from... three baccalaureate nursing programs" "...online anxiety survey ['State Trait Anxiety Inventory for Adults (STAI-A)'] one hour prior to the students' clinical rotation... less than 10 minutes to complete. Following clinical rotation, ...online anxiety survey [again] within one hour of completing clinical rotation."	5	3	"PDAs may contribute in effective learning and transitioning into the nursing profession by decreasing performance-related anxiety of undergraduate nursing students." --- "Participants who used a PDA had a [slight, significant] decrease in state anxiety [pre- to post-test = difference in mean = -0.02 on scale of '1 (not at all) to 4 (very much so)'], while participants who did not use a PDA had an increase in [state] anxiety [+0.27]." --- "Participants with no device [vs with a device] reported having higher pretest trait anxiety." --- "Participants with a device reported having lower posttest state anxiety." --- "[Trait anxiety] from (almost never) to 4 (almost always)... [...] (No device M= 0.37; Yes device M=0.06)... Both groups had a slight increase in trait anxiety, but participants who used a PDA had a much smaller increase in trait anxiety."	K2a, K3, K4b	K4b	appropriateness, effectiveness	Doctor of Education thesis
Dearnley et al. 2008	Mar- to Jul- 2006	2008	UK	1st year student midwives and their lecturers	PDA	logbook	mixed methods	"To explore the feasibility and identify the issues of using mobile technologies in the assessment of health and social care students in practice settings". --- "Objectives... – Identify the readiness of [one of the five Assessment and Learning in Practice Settings] ALPS partner institutions to adopt mobile technologies for assessment in clinical settings. – Identify the infrastructure available and required for support in using mobile technologies. – Explore the impact of using mobile technologies on current assessment processes and outcomes."	"Twenty-nine student midwives initially agreed to take part [then] five ...withdrew leaving 24 five link lecturer participants."	"case study" --- "...three focus groups with student midwives and individual interviews with their link lecturers and ...short questionnaires..."	4	3	"...electronic portfolios supported in a PDA format may have some benefits in terms of supporting the assessment process and encouraging students to record and reflect on their practice experience." --- "However, the introduction of mobile technologies into both the learning and clinical environments will entail a significant shift in existing cultures and a significant development of skills." --- "Some students reported that they had been told by practice mentors not to get the PocketPC out in front of clients; note book and pen was acceptable, a PDA was not. However, others appeared to have regulated the use of the tool in practice themselves." --- "...45% of students did not regularly take the PocketPC with them into clinical practice. The most common reasons for this were the fear and anxiety of losing the device and the perception that it would not be acceptable to clinical colleagues and clients."	K1, K3	K3	appropriateness, accessibility, acceptability, effectiveness	
Deutsch et al. 2016	Feb- to Sep- 2014	2016	USA	"deans (n=2), curriculum directors (n=2), technology specialists (n=2), and library directors (n=1)" of medical schools	iPad	repository, logbook, decision-making	qualitative	"to explore the uses, recommendations, and pitfalls for the implementation of mobile technology initiatives during the clinical years of undergraduate medical education"	"Out of the nine schools identified [as a purposive sample having an iPad-based programme extending into the clinical years], seven participated in semistructured telephone interviews." --- One responder was a co-author.	"Interviews were conducted with key personnel at seven U. S. medical schools who introduced iPad programs during the clinical years. Interviews were qualitatively analyzed using a constant comparison technique." --- All seven schools started using the iPad 2010-12. --- "constructivist/interpretivist theory guided our research paradigm"	4	3	"About 360 quotes were coded and assigned one of 89 codes. Further analysis... resulted in seven major themes: (1) goals and pilot studies, (2) teaching and learning, (3) [Electronic health record] EHR access, (4) culture, (5) benefits, (6) barriers, and (7) suggestions for implementation" --- "Eight 'best practices' for introducing mobile technology in the clinical years were identified: (1) plan before implementation, (2) define focused goals, (3) establish a tablet "culture," [...Involvement of clerkship faculty is key to reinforce use on the wards] (4) recruit appropriate implementation team, (5) invest in training [orienting medical students to... both technical aspects and digital professionalism] [...including... [[compliance with law]] and maintaining the doctor-patient relationship while using the device], (6) involve students in mentoring, (7) accept variable use, [...Understand that some students will not invest the time to learn to integrate the device into their daily schedule] and (8) encourage innovation."	K1, K3, K4a, K4b	K4a K4b	appropriateness, accessibility, acceptability, equity	
Ellaway et al. 2014	Nov-2011 & Dec-2012?	2014	Canada	undergraduate medical students Years 1-4	iPad, iPhone, or iPod Touch	repository, logbook, communication	mixed methods	"to explore how our learners used their mobile devices, what enabling and inhibiting factors they experienced, what benefits and disadvantages the use of mobile devices conferred, and how learners' use of mobile devices interacted with the educational environment as a whole"	101/240 (42.0%) responded: n=43, n=27, n=16, n=15 ('67% of the class... 42%... 29%... 27%') for years 1, 2, 3, 4	"Notes from briefings, informal focus groups and individual learner encounters were collected" to inform development of a questionnaire of lists, ratings, and free-text comments (15 closed and 5 open items), which was piloted. --- "Incoming undergraduate medical learners received a laptop and an iPad and learners entering year three of the four-year program received a laptop and an iPhone [from paying a technology fee]." --- Questionnaire Year 1-4 Nov-2011, focus group with Year 4 Dec-2012 to offset low questionnaire response --- "A combination of quantitative and qualitative methods was used to analyze the data [from a survey of 'use of and attitudes toward these devices'] and to generate a series of themes that synthesized student behaviors, perceptions and attitudes." --- "[They used] constructivist grounded theory methods... to draw out common underlying themes... [superimposed on 'case study' approach]."	4	4	382 free-text comments from Years 1 and 2 and 122 from Years 3 and 4, with a 6,050-word transcript from the Year 4 focus group --- "...learners... preferred to use a laptop as their primary study device with mobile devices augmenting but rarely replacing them." "~~~Mobile technologies, like other [educational] technologies..., are not intrinsically good or bad, nor are they desired or rejected by learners. ~~~Learners use mobile devices in very different ways, [by] choice in response to different learning environments. ~~~Learners use mobile devices strategically, only using them where it confers an educational advantage. ~~~Learners encounter a hidden curriculum of mobile use, both from [disapproving] teachers and at the program level. ~~~Medical teachers need to understand the use of mobile technologies in the context of the dynamic educational ecologies in which they work": "The device was particularly useful in the clinical setting: for learners' personal use, as a way of supporting the healthcare teams they were working with, and occasionally to enhance communication with patients." "[Given asymmetry of prior experience of device, how they then used it, for what purposes, and how much they valued it, i.e.] later years learners saw their mobile devices as an increasingly important part of their learning environment... ...we cannot reliably consider a class to be a single homogeneous group that uniformly benefits or prefers the use of particular technologies in their learning." --- "Learners' approaches to using mobile devices are heterogeneous as is the extent to which they use them i.e 'asymmetries of use']. Learners adapt their use of mobile devices to the learning cultures and contexts they find themselves in." --- "Year 3 and 4... reported using their devices for communicating with their preceptors in preference to the pagers... issued in their clinical placements." --- Concerns included becoming dependent on the devices and being distracted from patient-centred care.	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, equity	The main themes of the findings cannot necessarily all be attributed to the clinical setting as they are have come from Y1-Y4 for personal, classroom, and clinical settings.
Farrell and Rose 2008	No details. Paper accepted 2006.	2008	Australia	2nd year nursing students	PDA	logbook	mixed methods	"to investigate whether the use of PDAs enhanced nursing students' pharmacological knowledge during clinical practice in the medical-surgical area. Secondary aims were to examine the influence of PDAs on the way nursing students' contextualize medical-surgical nursing knowledge and to identify factors that affect the nursing students' use of PDAs in the clinical practice setting"	"All second-year students in the medical-surgical course of the BN program were asked to participate... A total of 76 students participated of... 92 students in clinical placement on the medical-surgical wards at the time of the study."	"a quasi-experimental design with pretest and posttest of pharmacological knowledge and focus group discussions." ---- "Medical-surgical clinical placements were randomly allocated to the PDA... group or control group. Students were then allocated to clinical placements [as usual]." --- "pilot study"	6	3	Despite an increase being reported, there was no significant difference for the "Students using the PDAs... moderate increase in their mean score, which was double the increase in the control group [pre-placement mean scores 16.4 and 15.7 (of 35), 'increase' of 1.33 in intervention-group, not stated for control-group, and both not significant anyway]. --- "...all students frequently accessed the PDA-based pharmacology database for obtaining information about the drugs they were administering... Students said they accessed the... database up to 15 times per shift." "[They received] support from nurses in the clinical setting who encouraged students to use the PDA for accessing drug information in real time." --- "Some students thought using the PDA in front of patients seemed rude, was inconvenient, or wasted time when there were other clinical priorities."	K1, K2b	K2b	appropriateness, accessibility, acceptability, effectiveness	The quantitative data are not tabulated or summarized fully. The 1.33 'increase' in the intervention-group test-score is not statistically significant, but Discussion notes it as "a modest improvement" (p18) and Abstract as "a moderate increase". The figures for the control-group increase and post-test score are omitted. Outcome refers to difference in mean scores not mean differences on individuals.

Notes (top right):
- L1-L6 (Harden et al. 1999);
- S1-S5 grade (Colthart et al 2008; Hammick et al 2010)
- K-level 1-4 (Kirkpatrick 1995)

Paper	Time – data collected	Time – data published	Place – Country	Person – Participants	Device – Type	Device – Function	Research approach	Methods – Aim	Methods – Sampling, number/rate	Methods – Study design --- Data collection method	Robustness of evidence – Level L1-L6	Robustness of evidence – Strength Grade: S1-S5	Findings and conclusions	Kirkpatrick K-level: K1-K4	'highest' Kirkpatrick K-level: K1-K4	Maxwell	Notes
																	• L1-L6 (Harden et al. 1999); • S1-S5 grade (Colthart et al 2008; Hammick et al 2010) • K-level 1-4 (Kirkpatrick 1995)
Ferenchick et al. 2008	Sep-2005 to Mar-2006	2008	USA	3rd year medical students	Palm/Pocket PC	repository, logbook	quantitative	"We developed, implemented, and evaluated a Web-based process to disseminate the Clerkship Directors of Internal Medicine curricular objectives to students via handheld computers and for students to upload patient logs to a central database."	For an 8-week internal medicine clerkship: "From September 2005 to March 2006, 80 students downloaded the JIT knowledge resource and 60 used it. Through December 2005, 95 students used the JIT-Log for the 2005–06 academic year."	"Data for our evaluation came from several different sources. In 2005, 95 third-year medical students used both [Just-In-Time-Internal Medicine] JIT-IM and JIT-Log as a resource for the IM clerkship. Data collected from this cohort included log data (n = 95) [whole of 2005–06 academic year], curriculum "hits" (n =80) [September 2005 to March 2006 only], and satisfaction (n = 68) with the program."	4	4	"...[delivered] nationally recognized clerkship curricula and related administrative log via... mobile devices in our geographically dispersed system." --- "It is interesting that 2,411 (26.9%) of the total hits, and 54% of the hits on history and physical exam objectives, focused on two training problems—chest pain and back pain... These problems were the focus of two formative standardized patient experiences required during a statewide education day." --- "...the most popular categories accessed by the students were knowledge-based competencies (Differential Diagnosis, Knowledge, Management, and Laboratory Evaluation) and not skill-based competencies (Communication Skills, History, and Physical Examination)..."	K1, K3	K3	appropriateness, accessibility, acceptability, effectiveness	
Ferenchick et al. 2013	Jul-2010 to Feb-2012	2013	USA	3rd year medical students	Palm/Pocket PC	repository, logbook	quantitative	"We hypothesized that use of the CEX [clinical evaluation exercise] app for directly observing students' clinical skills would be feasible and acceptable, and would demonstrate adequate reliability and validity."	266 third-year medical students completed 5 to 10 formative CEXs during their internal medicine clerkship (2,523 CEXs by 411 observers); 17 observers for reliability/validity study	"The observers (attendings and residents), who performed the CEX, used the app to guide and document their observations, record their time observing and giving feedback to the students, and their overall satisfaction with the CEX app." --- "Interrater reliability and validity were assessed with 17 observers who viewed 6 videotaped student–patient encounters, and by measuring the correlation between student CEX scores [n=150] and their scores on subsequent standardized-patient Objective Structured Clinical Examination (OSCE) exams."	4	4	"[They developed, implemented, and assessed] a web-based clinical evaluation application for [smartphones and tablets]." --- "The use of this CEX app is feasible and it captures students' clinical performance data with a high rate of user satisfaction. Our embedded check-lists had adequate interrater reliability [0.69] and concurrent validity. The grades measured on this app, however, were not predictive of subsequent student performance."	K1, K2b, K3	K3	appropriateness, accessibility, acceptability, effectiveness	
Fisher and Koren 2007	No details	2007	USA	3rd and 4th year undergraduate nursing students	Palm/Pocket PC	repository, logbook	qualitative	"to explore the perceptions of students' lived experience using a palm hand held technical device (personal digital assistant) (PDA) in clinical practice at the point of care in undergraduate nursing clinical education"	"four focus groups... of participants who used PDAs and of those who did not use the PDAs in the clinical setting"	"Qualitative analysis of the focus groups data followed a procedure, audio review of tapes from focus groups, coding the transcriptions, identification of conceptual themes, and assignment of thematic construct... The four focus groups involved 28 students" --- "25 females and 3 males"	4	3	"themes... identified: information resource [mostly positive]; retaining information [suiting certain styles, allowing repetition, but concerns re 'dependence']; clinical critical thinking [aiding creativity inpoint-of-care decision-making and reducing medication errors]; professional image [tension between image with patients vs positivity from ward-staff]; communication skills [for clear, accurate, confident communication]; and quality of care [information for patient safety vs distraction]." --- "Participants stated that once the PDA technology became a tool rather than an obstacle to overcome, many students found creative uses of the PDA in clinical situations that enhanced their critical thinking and facilitated their own learning in the clinical setting. Several... used the PDA [in trying to give] information to patients or communicating with/to patients and family members." --- "Most [used the device] for drug information prior to the administration of the medications..." --- "...two conflicting experiences about the use of point of care technology on their image [were staff being impressed by it vs concern re] negative... professional image... [with patients.]" --- "Students commented that the use of the PDA in clinical practice enhanced their communication skills and contributed to the quality of care they delivered." --- "Some students viewed PDA use as a distraction. They were reluctant to access the PDA in front of the patient." --- "Nurses may consult the student's PDA to check a medication, procedure, and laboratory value or disease profile."	K1, K3, K4a	K4a	appropriateness, accessibility, acceptability, effectiveness	
Friederichs et al. 2014	No details	2014	Germany	3rd year medical students	tablet/smartphone	repository	quantitative	"1. To evaluate the internet use habits of students. 2. To reveal possible differences between the various tools and to assess whether the use of tablets and smartphones at the bedside or the classic use of PCs in doctors' rooms results in an improved self-assessment of the students' professional knowledge and skills. 3. To determine whether this new curriculum [of evidence-based medicine (EBM)] is being accepted by students."	"Of 120 surveys, 94 (78.3%) complete data sets were analyzed."	"In a randomized controlled pilot study [of a practical day of evidence-based medicine], 120 students were divided in three groups. [After training on a literature search via Unbound Medline,] one control group solved clinical problems on a [desktop] computer [in doctors' room on ward] and two intervention groups used mobile devices [iPod vs iPad] at the bedside [for 'three simulated patients' to 'find the corresponding Cochrane review']. In a questionnaire students were asked to report their internet use habits as well as their satisfaction with their respective search tool using a 5-point Likert scale." --- "The scale [was] one ("strongly disagree") to five ("strongly agree")."	6	4	"The baseline characteristics (age and gender) of students as well as students' habits regarding internet access, internet use, and literature search frequency did not differ significantly [across] groups." --- "No difference between was found concerning students' degree of confidence in performing a literature search at the bedside. The students in the PC group were significantly more motivated to deepen their knowledge (3.25) than the tablet group (2.58; p = 0 .016)." "The mobility of the tablet ([mean] 3.90) and the smartphone (4.39) was seen as a significant advantage over the computer (2.38, p < 0 .001). However, for performing an effective literature search at the bedside, the computer (3.22) was rated superior to both tablet computers (2.13) and smartphones (1.68). No significant differences were detected between tablets and smartphones except satisfaction with screen size (tablet 4.10, smartphone 2.00, p < 0.001)." "...those who used the PC (2.88) were most eager to try a literature search during their next internship com- pared with the tablet group (2.16, p < 0.001) and the smartphone group (1.87, p < 0.001)." --- "...it can be concluded that using a mobile device at the bedside to perform an extensive literature search is not yet suitable for students... [and is less motivating than using desktop-computing]."	K1, K2a, K2b, K3	K3	appropriateness, accessibility, acceptability, effectiveness	
Goldsworthy et al. 2006	No details. Findings presented at conference Apr-2005	2006	Canada	2nd year baccalaureate nursing students	PDA - iPAQ	repository	quantitative	"...examined the relationships between the use of personal digital assistants [PDAs] and self-efficacy and the preparation for medication administration" --- "1. Does [their] use of a PDA... in medical-surgical environment... influence ...preparedness for the safe administration of medications? b. enhance [their] self-efficacy? [...] ...chose to focus [on] 1a and 1b"	"36 students, of which two groups had [PDAs] and two groups served as a control"	"...36 second-year baccalaureate nursing students... were randomly assigned to either a PDA or a control group ['with paper resources equivalent'] ...in two southeastern Ontario community acute care hospitals under... two professors [each] responsible for one control group and one PDA group. All groups had a pre– ['before the study'] and post– [8 weeks later] general self-efficacy instrument administered. ...pilot project... at the point of care..."	6	3	"[At] self-efficacy pretest, all groups were homogeneous" --- "...as they navigated a new and potentially stressful clinical environment, it is not surprising that [they] felt more confident and effective..." "For the PDA students who took both tests, the mean score on self-efficacy [10-item General Self-Efficacy instrument /40] increased from 32.539... to 36.308 on the posttest. ...paired-sample t test... (P < 0.001). ...non-PDA students increased, on average, by only 0.667 (...32.500... to 33.167...) ...not significant (P = 0.166). [...] The 13 PDA students who took both tests increased... by a mean value of 3.769. The 12 non-PDA students increased... by only 0.667. ...P=0.002." --- "Many (76%) used the PDA more than five times in a shift... [finding it] 'immensely helpful as a drug book, laboratory book, PDQ/medical-surgical tips provider, and class notes recorder.'" --- "[Re monitoring drug-administration,] the designed instrument... [was] too cumbersome for the instructors to complete [when prioritizing] the safe oversight of nine student nurses in a real-time hospital setting."	K2a	K2a	appropriateness, effectiveness	p141: While evidence from reflective journals is noted, this is not in-depth and not in Methods: "These quantitative findings are consistent with evidence from the PDA students' entries in their reflective journals". --- The study is labelled a case-control study - it is not. --- It is unclear if 'self-efficacy' measurement referred to medicines administration only or placement activities in general. --- Mismatch between stated aims and conclusions is attributable to the stated change in project.
Green et al. 2015	Spring 2012	2015	UK	4th and 5th year medical students	iPhone	repository, logbook, decision-making	mixed methods	"to evaluate the impact of MBChB Mobile ['a pioneering mobile learning (M-Learning) programme... provides all senior medical students with iPhone handsets complete with academic applications, assessment software and a virtual reflective environment'] on student learning."	"A total of 278 of 519 (53.6%) invited participants responded."	"...a semi-quantitative questionnaire: data were collected anonymously with informed consent and analysed where appropriate using chi-squared test of association. Qualitative data generated through [medical student-led] focus group participation were subjected to both content and thematic analysis."	4	4	"Overall, 72.6% of students agreed that MBChB Mobile enhanced their learning experience; however, this was significantly related to overall usage (P < 0.001) and self-reported mobile technology proficiency (P < 0.001)." --- "All participants described themselves as regular iPhone users." --- "Four main themes [from focus groups]: (1) engagement with and understanding of 'MBChB Mobile'; (2) impact of 'MBChB Mobile' upon learning; (3) barriers to usage including student response to software/hardware provision [technical barriers; perceived patient disapproval; and 'only 37.4% of students agreeing that assessors respond well to completing mini-CEX on the iPhone]; and (4) [suboptimal] transferability [to other devices]" --- Only 29.2% (of 274) (strongly) agreed: 'I consider it professional to use an iPhone in a clinical setting': "a recurrent theme [from focus groups was that] participants expressed concern about how patients would view their use of smartphones in the clinical environment [so student received] a university-branded case... to facilitate use in clinical areas."	K1, K3	K3	appropriateness, accessibility, acceptability, effectiveness, equity	
Ho et al. 2009	2002-2003 academic year	2009	Canada	3rd year medical students	PDA - PalmPilot	repository, logbook, decision-making	mixed methods	"to examine the efficacy of PDA-based resources and patient-encounter logging systems among 3rd-year medical clerks during pediatrics rotations"	"...of the 125 third-year students, 94 (75%) participated [by choice]. Of these, 27 were categorized as a baseline data group, 29... control group, and 38... intervention group. Focus groups included from 7 to 12 students... facilitated by a medical educator"	"A multimethod approach..." --- "Students in rotations were assigned to control (using paper-based logs and references) or intervention groups (using PDA-based logs and resources [and reflection]). Students completed pre- and postrotation Paediatrics Competency Surveys [Likert-type scales, 1=least to 5=most competence], participated in focus groups ['to triangulate... usage and impact of PDAs in students' learning'], and were compared on year-end examination grades ['written multiple-choice question examination and Objective Structured Clinical Exam [OSCE]'] --- "At the posttest period, intervention students were also given a reflection survey to understand how the log (either paper or electronic) enhanced their learning... [items on] a 10-point visual analogue scale."	4	4	"PDA-based patient-encounter logs appear to be effective case documentation and reflection tools. ...for 'point-of-care' patient logging." "...students across the three groups were similar in age, gender, and technological competence." "Use of PDA logs far outweighed [was 11 times] that of paper logs (1,020 PDA logs and 87 paper logs). PDA logs were ranked significantly higher in enhancing learning and reflection than paper logs (...p <0.01 [mean 3.26 vs 2.00]). PDA logs also facilitated specific learning experiences." "Significant differences were found [in] their reflection, frequency of recording patient records, and the log's ability to support specific learning experiences... in favor of the intervention group." "Intervention-group performed similarly on their clinical supervisor performance-rating, significantly better on the written examination but worse on the OSCE. --- "...it was students' impression that the PDAs positively impacted their ability to self-reflect." "Perhaps most important, is the user's ability to review their own learning in one location that they can carry around with them [vs] paper logs that may sometimes be left away from patient encounter settings..." --- "...the PDA facilitated the production of a more comprehensive cumulative record of actual experiences [aiding monitoring of curriculum objectives for programme evaluation]..."	K3, K4a	K4a	appropriateness, accessibility, acceptability, effectiveness	Abstract: t-value=2.52, p<0.01. vs Table 4: t-value=2.067, p<0.05.

e-Appendix 2: n=45 primary research, n=4 systematic reviews: Data extracts for: "What works best for health professions students using mobile (hand-held) devices for educational support on clinical placements?"

Paper	Time — data collected	Time — data published	Place — Country	Person — Participants	Device — Type	Device — Function	Research approach	Aim	Methods — Sampling, number/rate	Methods — Study design --- Data collection method	Robustness of evidence — Level L1-L6	Robustness of evidence — Strength Grade: S1-S5	Findings and conclusions	Kirkpatrick K-level: K1-K4	'highest' Kirkpatrick K-level: K1-K4	Maxwell	Notes — • L1-L6 (Harden et al. 1999); • S1-S5 grade (Colthart et al 2008; Hammick et al 2010) • K-level 1-4 (Kirkpatrick 1995)
Johansson et al. 2013	No details	2013	Sweden	undergraduate nursing students	PDA - Palm TX	repository, decision-making	mixed methods	"exploring nursing students' experience of using a PDA in clinical practice"	Nursing students (n=120) were informed about the study; 67 volunteers were "randomly selected from the three final semesters (n=20, n=22, n=25) respectively, to correspond with the available number of PDAs." --- "...three final semesters of three consecutive undergraduate nursing degree programs."	"...nursing students (n=67) used PDAs [supplied to them] during a [psychiatry placement] of 15 weeks, replied to questionnaires ['a response rate of 87% (n=58) for the post-survey], and participated in focus group interviews." --- From 120 students, of those volunteering, 67 (20, 22, 25 for each of the three final semesters) were randomly selected according to the number of PDAs available. --- "The NSs (n=39), from the first two semesters, were divided into seven focus groups... [...] analyzed by content analysis.."	4	3	For 'Have you used the PDA at the patient bedside or together with patients?', only 26/58 (44.8%) said Yes (14/58 (24.1%) had only used it a few times at all over whole study-period). From focus groups: "...the [nursing students] NSs perceived that the PDA provides easy and immediate access to information integrated in one place. [Most] NSs believed that the PDA is very useful, especially in homecare [with] limited information [and] no computers..., whereas few were convinced that the PDA fills the same need in hospitals..." "This availability of information... [at the bedside] entails... more time with patients, [who receive timely answers], thus the NSs regarded it improved quality of care ...[and assists] patient education." "The NSs perceived that patients were positive and interested in their use of the PDA [and it improved patient safety not to leave patients alone]." "...some NSs had... used the PDA to answer relatives' questions. ...the NSs could supply patients and their relatives with instant information, e.g. about medicines..." --- There was a mixed reception from supervisors - rural supervisors were more positive but some hospital supervisors opposed used of the device in front of patients might be uncomfortable. --- "NSs believed that the PDA helped them to organize their clinical practice and made them more efficient, resulting in more time to be spent with the patients."	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, efficiency	While this is labelled an 'intervention study' (title and throughout), it is not a randomized controlled trial with a comparison-group, etc. It is more an observational study. There are two cross-sectional studies and no longitudinal element of linked individual data.
Khraim et al. 2015	No details	2015	Canada	nursing students	Blackberry Bold 9700	repository	mixed methods	"to investigate the benefits and barriers of using smartphone by nursing students enrolled in a clinical practice course"	n=13 answered both surveys out of n=27 (...1 answered pre-survey but then moved programmes).	Participants received "free-of-charge smartphones... voice- and data-enabled [with resources installed]" for use on a 10-week (40-hour/week) clinical placement at the end of their 2-year fast-track BN programme. --- "...pre- and post- web-based surveys... were [designed to explore] benefits and barriers of using smartphones to access nursing resources [re] drugs, diseases, and nursing care plans. [Closed and open-ended items explored pre-study] expectations concerning smart phone technology... and their experience with it during the study (example: 'Please explain why the smartphone... was useful or not useful...'. [Analysis used] descriptive statistics for the quantitative data and content analysis for the qualitative data to identify common themes."	4	3	"Prior to the study, participants' experience with smart phone technology ranged from [none to extensive]. One key finding is that students did not feel comfortable using smart phones in the clinical setting. Therefore, smart phones received little use as a learning resource. Unprofessional appearance and the time needed to learn the technology were the main deterrent of smart phone use."	K1, K3	K3	appropriateness, accessibility, acceptability, effectiveness, efficiency	S2 evidence was ignored.
Kuiper 2008	No details	2008	USA	undergraduate baccalaureate nursing students	PDA - Dell Axim	repository, decision-making	quantitative	"to assess clinical reasoning when personal digital assistants are used as an information resource for nursing students" --- "...two questions: What is the effect of PDA resources on the clinical reasoning activities of undergraduate nursing students? What are the differences in clinical reasoning of students who utilize PDA resources compared with students who utilize typical resources?"	"...primary study was conducted with 20 [nursing] students during an advanced adult health course using PDA devices while rotating through critical care units for 7 weeks."	"Personal digital assistant use was first evaluated with 46 students in a pilot project to prepare for this study [then the primary study focused on 20 nursing students in 'critical care units for 7 weeks', using 'PDA resources... for information about laboratory tests, pharmacologic interventions, medical and nursing diagnoses, and medical calculations']. [...] These students completed the PDA user survey, clinical reasoning worksheets [compared with n=9 non-PDA-users], a computer self-efficacy scale, and a clinical log [that recorded device-use and malfunctions]." --- "...students who used the PDAs volunteered to do so."	4	3	"There are no significant differences in rating scores between [n=2] PDA users ([mean] M = 65.10, SD = 9.23) and [n=9] non-PDA users (M = 68.1, SD = 6.67) in any week [on the Outcome Present State Test (OPT); total points=74; p-value and test-statistic not reported]. Thus, clinical reasoning... is similar between [PDA and non-PDA] students..." "[The Computer Self-Efficacy tool] revealed confidence in using the PDA resources for assignments, better organization, and improvement in clinical effectiveness,. However, the students were not confident that the device made them less reliant on others." Students reported a median of 3 on a scale of 1=Agree to 10=Disagree for: "I use PDA frequently in clinical setting", which the clinical log on the personal digital assistant supported.	K3	K3	appropriateness, accessibility, acceptability, effectiveness, efficiency	n=20 as one of the n=9 does not provide data? --- It is unclear if placements in main study are 7 weeks or 14 weeks.
Lai and Wu 2016	No details	2016	Taiwan	junior nursing students	netbook - ASUS Super 10A	logbook, decision-making, communication, assessment	mixed methods	"to investigate the effects of using [a mobile e-portfolio–based system, which was used to improve nursing education]"	"Ten second-year students from a 2-year continuing education program enrolled in the practicum session and volunteered to participate in the experiment. The students were all female, and their ages ranged from 19 to 30 years (the average was 21.3 years)."	"...[The] e-portfolio system was field tested in a 3-week psychiatric nursing practicum session..." --- The portfolio system facilitated reflection, forum interaction with the instructors, and sharing of assignments about patient care. --- "We collected both students' self-rated scores and the instructor-rated scores on the competency scale, as well as students' answers to a postactivity questionnaire (10 open-ended questions). [...] Our postactivity questionnaire was designed to learn how and why using the system was helpful in promoting students' self-regulated learning. Such learning included three important characteristics: self-observation, self-judgment, and self-reaction." --- Content analysis of data from open-ended questions	4	2	"...students made professional progress in both theory and practice after using the e-portfolio system. The system could also promote self-regulated learning in clinical context." "Students' overall average competence scores improved from a score of 2.7 [1=no theory and action to 5=full theory and action] at Stage 1 [end-of-Week 1] to 4.3 at Stage 2 [end-of-Week 3] (t =13.7, P < 0.001) as assessed by the instructor, indicating students progressed in both theoretical knowledge and practical skill [but there was no control-group]." --- "Our study disagreed with findings of Garrett and Jackson in that our students would routinely take out their netbook and immediately record what they observed with their patients... even in the short time intervals between routine clinical practices and supports the idea of e-mobile systems being a powerful tool in a clinical setting." --- "All 10 students agreed that using the e-portfolio helped them facilitate self-awareness." "Nine students said that the e-portfolio system helped them make good decisions and facilitated additional learning. Only one student commented negatively..." "Nine students confirmed that the e-portfolio system helped provide them with many additional learning resources. One student, however, commented that the instructor had led her into self-reaction learning, not the computer." --- "With the incorporation of the mobile e-portfolio technology, our students made substantial progress in their clinical competence, in particular on the abilities of reflection, teamwork and communication, sincere concern, active listening, and observation and recording of psychiatric cases [according to self-and tutor-ratings]."	K1, K2a, K2b, K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, efficiency	S3 evidence was extracted from overall S2.
Leung et al. 2003	2001	2003	Hong Kong	4th year medical students	PDA - iPAQ	decision-making	quantitative	"To assess the educational effectiveness, on learning evidence based medicine of a handheld computer clinical decision support tool [plus two 2-hour education sessions per intervention] compared with a pocket card containing guidelines and a control"	All 169 fourth year medical students. responded throughout.	"...a randomised [cross-over] controlled trial" --- "Main outcome measures: Factor and individual item scores from a validated questionnaire on five key self reported measures ['Likert-type scale (range 1-6)']: personal application and current use of evidence based medicine [EBM]; future use of [EBM]; use of evidence during and after clerking patients; frequency of discussing... evidence [on] rounds; and self perceived confidence in clinical decision making." --- "...sample size required [for] a medium effect size of 0.25, and alpha and beta levels of 0.05 and 0.2... [was 159 between three groups]" --- They were randomized to three groups, which were randomized to start one of three sequences of 8-week clinical placements (medicine, surgery, mixed specialties) and analysed by 'intention-to-treat'.	6	4	Baseline characteristics were similar (demographic, examination performance, study-measures). --- "The handheld computer [loaded with InfoRetriever for 'relevant, current, best medical evidence at the point of care'] improved participants' educational experience with evidence based medicine the most [compared with a pocket-card], with significant improvements in all outcome scores […and sustained after] ...an 8-week washout period..." --- For example, pooled effects of InfoRetriever vs pocket-card was improved item scores by a mean of 0.48 (95% confidence interval 0.22 to 0.74) on frequency of looking up evidence and 0.19 (0.04 to 0.33) on improved confidence in clinical decision-making and improved factor-score of 0.19 (0.08 to 0.30) on personal and current use of EBM. --- "Improving access to the medical literature through a [PDA] at the point of care yielded considerable positive changes in students' self reported actual use of evidence while clerking patients... [boosting] confidence in clinical decision making generally." "Rapid access to evidence on a portable computing device can improve learning of evidence based medicine in medical students. Other benefits are increased current and future use of evidence and more confidence in clinical decision making." --- Limitations included small sample-size and no control-group.	K3	K3	appropriateness, effectiveness	"Likert type scale (range 1-6)" came from the additional data-tables. --- "sample size required [for] a medium effect size of 0.25" (p1): It is unclear to which outcome-measure this refers.
Mann et al. 2015	Dec-2010 to Aug-2012	2015	Canada	undergraduate nursing students	iPod Touch	repository, logbook	mixed methods	"to explore the utility of mobile technology in undergraduate nursing education" --- "to explore the feasibility of using iPod Touch (Apple Inc) devices in undergraduate nursing education to access best practice resources and identify predictors of intention to use such technology after graduation?"	At Time 1 [after Dec-2010], [all] 33 students (100%) completed the questionnaire, and at Time 2 [completion of 2-year programme, August], 23 students (70%) completed the questionnaire. The respondents were primarily female (n = 29, 88%), with a median age of 23 years (min/max = 20/32, interquartile range = 18.5–21.5). Twenty-nine students (88%) reported prior use of a smartphone or similar technology at baseline."	"A feasibility study..." "...given an iPod Touch, which they were asked to use while in the clinical setting for the exclusive purpose of patient care." --- "Students downloaded recommended software (drugs/interactions, laboratory, disease, dictionary, calculation; population-/course-specific, etc.). --- "Feasibility... feedback [came from] group meetings [at] 7 and 11 months... [and] an online community... in the School of Nursing and a Facebook (Menlo Park, CA) group... ...at Time 2, students [commented] about... using the device." --- Two on-line questionnaires: 1. "...[based on] Theory of Planned Behavior [7-point Likert scales re] intent to use mobile devices to access resources in the classroom or clinical setting." 2. "...[modified] Computer Self-efficacy Questionnaire... rated their confidence [on] 10 stated actions... [1-10 'not at all...' to 10 'totally confident', 'possible score = 0–100'] ...high computer confidence [was] 50 or higher." --- "...after five contacts [non-responders] were considered lost to follow-up." --- "...comments were reviewed for commonly cited advantages, disadvantages, enablers, barriers, and issues..."	5	4	"Perceived disadvantages included... infection control issues (eg, use and cleaning of the device in an isolation room setting)... Barriers to use included difficulty accessing the agencies' wireless Internet, perceived disapproval from the staff (eg, the perception that students were using the devices to play games while in the clinical setting), and feeling too busy to use the devices." --- "Fifteen students reported feeling that staff and patients assumed they were using the device for personal reasons (eg, texting a friend) when... reading about a condition or medication... They attributed this perception to the minimal use of mobile technology for the provision of care by staff." --- "...lack of skill in using the devices and lack of support from staff in the clinical setting were commonly identified issues. Self-efficacy scores were high throughout the study. Attitudes, perceptions of the desirability of use, perceived personal control over use, and intentions of using the device were lowest postimplementation than at baseline." --- "...their use of the devices was limited by concerns, such as appearing unprofessional. Despite feeling at least moderately skilled and capable... students felt they would have benefited from training in innovative ways to use the iPodTouch to optimize device use [at T2]." --- "Attitude toward device use [at T2] was the principal predictor of intention to use the mobile device in the future [for overall model: '(r^2 = 0.79), after controlling for self-efficacy and subjective norm scores' at T2], which may be influenced by multiple elements of the students' experience over [time]." --- Using T1 variables, only subjective norm scores predicted T2 intention to use the device, after controlling for self-efficacy (overall model r2 = 0.45).	K1, K2a, K3	K3	appropriateness, accessibility, acceptability	

e-Appendix 2: n=45 primary research, n=4 systematic reviews: Data extracts for: "What works best for health professions students using mobile (hand-held) devices for educational support on clinical placements?"

Best evidence medical education review of 1998-2016

	Time		Place	Person	Device		Methods				Robustness of evidence		Findings and conclusions	Kirkpatrick	'highest' Kirkpatrick	Maxwell	Notes
Paper	data collected	data published	Country	Participants	Type	Function	Research approach	Aim	Sampling, number/rate	Study design --- Data collection method	Level L1-L6	Strength Grade: S1-S5	Findings and conclusions	K-level: K1-K4	K-level: K1-K4		• L1-L6 (Harden et al. 1999); • S1-S5 grade (Colthart et al 2008; Hammick et al 2010) • K-level 1-4 (Kirkpatrick 1995)
Mather and Cummings 2015	Jul- to Nov-2014	2015	Australia	clinical supervisors "who guide, support and facilitate learning of students" of nursing	mobile or portable devices	repository, logbook	qualitative	"[to explore] the current mlearning strategies undertaken by a group of clinical supervisors in tertiary and community-based healthcare settings to understand how they navigate [learning and teaching] opportunities within the current mlearning paradox that exists in healthcare environments in Australia"	"Six focus groups… were held with 27 clinical supervisors…"	"Six focus groups [of 3-7 for up to 1 hour] were conducted… by one researcher… Invitations to participate were emailed to clinical supervisors involved with guiding and supporting undergraduate students from one University" --- "…audio-recorded, then transcribed verbatim… [for] thematic analysis. Themes were developed independently by two researchers and then cross-checked, to ensure validity."	4	4	"Individual, organisation and systems level governance were sub-themes of professionalism that emerged as the main theme and impacts on learning and teaching in situ in healthcare environments." --- "[Re professionalism:] Positive attributes… enabled included increased time with patients at the bedside; reducing the need to look up information away from point of care; and the potential to involve patients in their own care [plus reducing errors, increasing collegiality, and supporting patient education]." "Participants indicated they felt it was unprofessional to use m-learning when they were aware organisational policy precluded its use. Clinical supervisors were also conscious of body language that indicated peer disapproval when they undertook m-learning activities. Clinical supervisors reported the m-learning paradox created by inability to access information prevented the 'side to side thing' of developing a learning partnership with students and patients." --- "[Re organizational governance:] …the need to 'announce use' to avoid the assumption they were using their mobile device inappropriately. …Clinical supervisors agreed mobile devices needed to be used properly and 'ground rules' were necessary to legitimise its use and ensure entrustability." --- "This research demonstrates that professionalism issues at systems and organisation levels, impact on individual governance and will continue to impede the progression of m-learning in the workplace until there is the development of policies and standards to guide its use in healthcare settings. …For progression of the use of mobile technology to become the norm in healthcare environments, and accepted as part of healthcare work, there is a need to further unveil the mlearning paradox by developing strategies for deployment of mlearning, in situ at point of care." "The study found that 'workarounds' are used by clinical supervisors to solve issues of timely, easy, access to information in the workplace. [They] are concerned about the impact of this behaviour on others' view, especially students, on their professionalism."	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, equity	
Nuss et al. 2014	Jul-2012 to Jun-2013	2014	USA	3rd year medical students	iPad	repository, logbook, decision-making	mixed methods	"1. In what ways did the students use mobile technology for learning and clinical decision support? 2. What apps did the students use in the care of patients? 3. Did the amount of time spent and the students' expertise in using mobile technology grow overtime?"	All n=37 3rd year medical students who rotated to this community hospital agreed to participate.	The 37 medical students received an iPad (as did the preceptors according to the Discussion). --- "…four data collection instruments: 1) beginning and end-of-year questionnaires [after 48 weeks of clerkships], 2) iPad usage logs weekly [of self-reported duration and type of use and software used] during 8-week Internal Medicine clerkship, 3) weekly [1-hour] rounding observations [by researchers], and 4) weekly medical student interviews [with each]." --- "Descriptive statistics… for the questionnaires and apps reported in the usage logs. The iPad usage logs, observation logs, and weekly interviews were analyzed via inductive thematic analysis."	4	4	The main uses were "1) clinical decision support [accessing patient data and finding other information for clinical decision-making, including for staff and for use in patient education]" 2) student learning and productivity." --- "…use (71%) and expertise (75%) using mobile technology grew overtime." …"[They used] the iPad… before, during, and after patient encounters." "While patient care accounted for the vast majority of the use… [they also used] the iPad for personal learning and productivity…" "…75%; n=21) also reported that their expertise in using the iPad for clinical decision support grew over time […] e.g. more comfortable in front of preceptor and] 'By the end of the year I was able to use the iPad in any clinical setting'." --- "…provides substantial evidence that medical students used mobile technology for [real-time] clinical decision support and learning [and productivity]. Integrating its use into… daily workflow was [thus] essential…"	K3, K4b	K4b	appropriateness, accessibility, effectiveness, efficiency	
O'Connor and Andrews 2016	Jul-2015	2016	UK	final year nursing students	smartphone	repository	qualitative	"to explore the co-design process when creating a clinical skills based smartphone app and identify the features and functions nursing students need in a personalised educational app. …to create m-learning solutions that better fit the needs of nursing students and ease some of the pressures they experience training in clinical settings"	"A convenience sample of final year undergraduate nursing students from a Bachelor of Science Nursing programme"	"This study ['grounded in the Theory of Mobile Learning'] adapted a socio-cognitive engineering approach and through a series of focus groups with final year nursing students explored the co-design process and gained their input on the design and functionality of a clinical skills based educational app." --- "Two in-depth co-design workshops [each n=10], lasting 60 minutes each, were held in July 2015 during a continuing professional development day at a local hospital where students were completing their clinical training. …[exploring needs, specific scenarios, learning challenges, and then brainstorming] how the educational app should look and function. Data was analysed thematically using the framework approach and informed by the Theory of Mobile Learning."	4	2	"…students required an uncluttered interface that was fast to navigate and easy to use in busy clinical environments. They… requested simple visual descriptions of key clinical skills and equipment to enable them to quickly refresh their memory so they could perform the skill in practice." "…nursing students wanted any educational app to be accepted by both patients and health professionals, which would require [to avoid any confusion and to maintain the professional image of nursing'] clear communication [to patients and staff] about its use to ensure the professional image of nursing was maintained and students were supported to use mobile technology in practice."	K1, K3	K3	appropriateness, accessibility, acceptability, efficiency	S3 evidence was extracted from overall S2.
Quant et al. 2016	Dec-2014 to Jan-2015	2016	USA	"medical students" [included osteopathy students]	mobile device	repository	quantitative	"To determine (1) the usage, reliability, and popularity of mobile medical apps and (2) medical students' perceptions of app usage effect on the quality of patient-provider interaction in healthcare settings."	"medical students in United States accredited MD or DO programs… contacted through medical student organizations." --- Over the two-month period, a total of 731 responses were received, with a response rate of 29% (731/2500). Equal numbers of participants were preclinical students (1st-2nd year of school) and clinical students (3rd-4th year of school). The majority (58%) were women, and most (89%) were under 30 years old."	"cross-sectional study" --- "An anonymous web-based [18-question] survey ['piloted within one hospital and altered accordingly'] was distributed to medical students. Frequency of use, type of app used, and perceptions of reliability were assessed via univariate analysis." --- No breakdown between medical and osteopathic students is given. No raw data were given for many of the percentages and precision of estimates were not reported.	4	3	"While students thought that mobile apps save time, improve the care of their patients, and improve diagnostic accuracy, 53% of participants believed that mobile device use in front of colleagues and patients makes one appear less competent." "Ninety-five percent of medical students who responded said medical app use saves time, 87% reported that it improves patient care, and 78% believed it increases diagnostic accuracy. […] More than 50% of participants believed their use of a mobile device made them appear less engaged in front of colleagues. …54%… in front of patients…" --- "More experienced students reported that app use in front of patients shows that a clinician 'cares enough to double check', whereas only 36% of less experienced students agreed with this statement." --- "[They] hesitate to use apps during patient encounters and with peers, due to a fear of being perceived as incompetent."	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, efficiency	
Rashid-Doubell et al. 2016	No details	2016	Bahrain	senior medical students --- "Fourth year of a 5-year medical programme"	mobile device	repository	qualitative	"to describe the experiences of senior students using mobile devices in a clinical setting while learning and interacting with clinical teachers, patients and each other, and to identify challenges that facilitated or impeded the use of such devices in the hospital"	"The sample was purposive and homogeneously selected to balance for gender and nationality." --- "(6 interviews, 3 men and 3 women and a mixture of 3 local and 3 international senior medical students) on the basis of their gender and nationality with the aim of ensuring that the sample was as representative of the senior cycle class as possible." --- "…one student after conducting the interview requested [removal] from the data. This request was honoured."	"Interpretative phenomenology was chosen to guide our enquiry. Semi-structured interviews were conducted ['from 30 min to 1½ hours'] to examine the experiences of five senior medical students using mobile devices in the clinical setting." --- "Convergence and divergence of data were noted, leading to the development of preliminary emergent themes [from first three]." --- "Based on no new data collected from the [next two] interviews, no further interviews were deemed necessary."	4	4	"Three main themes emerged from the data analysis: learning ['building knowledge and understanding, information gathering, distraction']; professional identity ['…with the patient, …with the clinical teacher, professional self-identity'] and transitioning from student to doctor ['the change process, clinical skills acquisition, negotiating relationships']. The findings showed that using mobile devices in the clinical area as a learning tool was not a formalised process. Rather, it was opportunistic learning at the bedside and on occasion a source of distraction from clinical teaching. Students needed to negotiate relationships between themselves, the clinical teacher and patients in order to ensure that they maintained an acceptable professional image. Participants experienced and negotiated the change from student to doctor making them mindful of using their devices at the bedside." --- "Several students explained how they found using mobile devices a distraction, particularly during patient observations. …It seemed that this was a balancing act between using the mobile device for checking information and building knowledge during clinical sessions and being distracted by the social connectivity opportunity." --- "[One student noted] tablet devices being acceptable and smaller smart phones not." --- "…learning using the devices was neither recognised nor formalised, with many participants unsure of the legitimacy of the use of the device in the hospital." "…students used the devices for rapid acquisition of information (often described as 'just in time information') which provides sufficient knowledge for bedside interactions between the student and the teacher or the patient. Although this knowledge gain is transient, it seemed to accommodate the need for a quick fix…"	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, efficiency, equity	
Reames et al. 2016	2013	2016	USA	3rd year medical students	smartphone	communication	mixed methods	"to evaluate the use of Twitter as a novel educational tool in a medical school surgery clerkship. We hypothesized that Twitter can enhance the educational experience of clerkship students."	"…of 66 students rotating through the [8-week] surgery clerkship, 61 (92%) completed the preclerkship survey, and 62 (94%) completed the postclerkship survey. All but 2 subjects completed both surveys."	"…a prospective observational study. We created a new Twitter account, and delivered approximately 3 tweets per day consisting of succinct, objective surgical facts [with their smartphones adjusted to show them as a banner]. Students were administered pre- and post- clerkship surveys, and aggregate test scores ['NBME Shelf Examination in Surgery'] were obtained for participating students and historical controls ['students taking the NBME Shelf Examination 1 year before the Twitter intervention']." --- "We also performed a brief qualitative content analysis of open-ended questions."	4	3	"Aggregate mean National Board of Medical Examiners Shelf Examination scores were not significantly different in a pre-postanalysis (p = 0.37." "Overall, 59% believed it positively influenced their educational experience and very few believed it had a negative influence (2%). However, many (53%) did not believe it influenced their clerkship engagement [either way]. " "…we found that 85% students who used the tool biweekly or daily had a positive overall impression. In contrast, 50% of students using Twitter occasionally had a positive impression [but the raw numbers and p-value are not given]." From the open-ended feedback: "Approximately half found that the tweets subjectively contributed to their knowledge acquisition during the clerkship. […] Those who used Twitter more frequently at baseline were, in general, more likely to view this learning tool more favorably." --- Only 22/60 (32.2%) used the Twitter-tool at least weekly.	K1, K2b, K3	K3	appropriateness, accessibility, acceptability, effectiveness	

	Time		Place	Person	Device		Research		Methods		Robustness of evidence		Findings and conclusions	Kirkpatrick	'highest' Kirkpatrick	Maxwell	Notes
Paper	data collected	data published	Country	Participants	Type	Function	approach	Aim	Sampling, number/rate	Study design --- Data collection method	Level L1-L6	Strength Grade: S1-S5	Findings and conclusions	K-level: K1-K4	K-level: K1-K4		• L1-L6 (Harden et al. 1999); • S1-S5 grade (Colthart et al 2008; Hammick et al 2010) • K-level 1-4 (Kirkpatrick 1995)
Scott et al. 2015	2012-2013	2015	Australia	2nd and 3rd year medical students	mobile device	repository, logbook, decision-making	mixed methods	"to determine use of mobile devices for learning, and beliefs and attitudes about others' use" --- "The research questions are: 1 How do medical students and physicians use mobile devices for learning in the clinical setting? 2 What is the comparison between students' and physicians' use? 3 What are medical students', physicians', patients' and carers' attitudes about others' use? 4 What are the ethical, etiquette, privacy and security implications?"	"Heterogeneity sampling" -- "Surveys were completed by 236/241 students (...98%) and 109/117 physicians (93%). Five to ten students participated in each of the student focus groups. The students who completed the surveys and participated in the focus groups were diverse in terms of age, gender, and educational and cultural backgrounds, reflecting the diversity of the student population."	"The research was conducted using a mixed-methods sequential explanatory design through survey and focus groups for students and physicians, and a separate survey for patients and carers. Each arm of the study was analysed individually, followed by integration of quantitative and qualitative data, which are the subject of this paper."	4	5	"Integration of all data... identified the benefits of using mobile devices and concerns about distraction. For many students and physicians, the benefits of using mobile devices for learning at the patient bedside outweigh the possible risks. As society grapples with norms governing appropriate use of mobile devices, many are devising their own rules to aid learning in clinical settings." --- 78% of students were: "Unsure of tutors'/clinicians' reaction"; 78% of students were: "Unsure of patients'/carers' reaction". Both were significantly lower than physicians' responses. From focus groups: "• Medical students and physicians are making individual decisions about whether or not to use a mobile device in the clinical setting. • Medical students, physicians, patients and carers have concerns about the potential of smartphones to harm the patient—doctor relationship. • Many, though not all, patients and carers understand the benefits of physicians using mobile devices in clinical settings for patient care."	K1, K3	K3	appropriateness, accessibility, acceptability, effectiveness, efficiency, equity	
Shurtz and von Isenburg 2011	Apr- to Dec- 2009	2011	USA	Duke University part of the study: 2nd year medical students and family medicine clerkship preceptors. [Texas A&M part of the study did not relate to students on clinical placement.]	Kindle e-reader	repository, decision-making	quantitative	"Can e-readers loaded with medical textbooks and other relevant material benefit medical students, residents, and preceptors in clinical settings?" --- Duke University part of the study: "to explore whether the selected e-reader could improve access to medical information in clinical settings with little or no wireless or networked computer access."	Duke University part of the study: "Twenty second-year medical students and fourteen family medicine clerkship preceptors, [...] ...seven family medicine clerkship rotations ...representing primary care clinics from thirteen counties across North Carolina." --- "Seven preceptors (a 50% response rate) and 15 students (a 75% response rate) completed the online survey evaluating the e-reader."	Duke University part of the study: "The Duke University Medical Center Library [pilot] project tested the selected e-reader as a point-of-care mobile device in primary care clinical settings." --- "Six Kindle 2s were purchased and loaded with relevant material, including family medicine and primary care books sold through Amazon's Kindle store." "For each clerkship rotation, two devices were sent to three separate locations, allowing one preceptor and one student at each site to test each e-reader for four weeks at a time. This allowed a comparison between clinical and educational use and provided a diverse pool of users..." --- "Students and preceptors provided feedback through an anonymous online survey [re using the Kindle in the 4-week clerkship: 'relevance of content, usability, efficiency,, and appropriateness for various settings, including direct patient care'... indirect patient care... educational support, and leisure reading]."	4	2	Duke University part of the study: "The most popular features on the e-reader were searching across books and items, searching the Internet, and searching PubMed." --- "Seventy-two percent of participants reported using the device in the clinical setting for indirect patient care (such as for preparation for clinical work), while only 8 used it for direct patient care (such as for answering clinical questions in the examination room). Only 6 students and preceptors used the device to answer a patient care question." --- "For use in the clinical setting, 17 rated the selected e- reader as tolerable (12) or terrific (5) for indirect patient care, while only 10 rated it as tolerable (9) or terrific (1) for direct patient care. A majority (11) rated it as terrible for direct patient care." --- "One major difference found ['using multivariate pairwise correlations'] between preceptors and students was that preceptors were more likely than students to recommend the selected e-reader for direct patient care (P<0.01)." --- "Criteria for evaluating e-readers in clinical settings should include portability, searchability, speed, navigation, and display."	K1, K4b	K4b	appropriateness, accessibility, acceptability	Findings from preceptors could not be separated from students, but student predominated. Some open-ended comments are reported from the Duke project, but these are not in-depth and do not feature in Methods. The research approach remains quantitative. The Methods are implied rather than reported in detail. --- S3 evidence was extracted from overall S2.
Snodgrass et al. 2016	No details. Ethics approval 2013	2016	Australia	physiotherapy, occupational therapy, and speech pathology students and clinical educators	iPad	logbook, assessment	quantitative	"to explore perceptions of clinical educators and allied health students regarding the impact of an iPad™-based feedback delivery system on student reflection and learning"	"Nine clinical educators [100% response] and 14 students [74% response] participated and completed the survey." --- "Purposive sampling [...] Clinical educators were clinicians who regularly supervised students in the healthcare settings in which they worked. [They] were specifically invited to participate in this study because of their ongoing involvement with the programs of their respective disciplines at the University." --- "All students (n = 19) that attended a clinical placement with the participating clinical educators during the [study] period were... invited to participate..."	"A pilot study [used] iPads™ with specialised software to deliver ['effective, frequent, and individualised'] electronic formative feedback to physiotherapy, occupational therapy and speech pathology students during [5-week, 12-week, 5-week] clinical placements ['...standardised feedback statements that were analogous to the assessment criteria on each discipline's assessment form and also by providing free text comments. ...emailed to students at the end of each clinical day']. Students and clinical educators completed a questionnaire exploring advantages and disadvantages of the technology." --- "Student attitudes and experiences using the electronic feedback system were assessed using a 13-question paper-based questionnaire."... "The questionnaire sought to capture basic demographic information of participating students as well as their perceptions of the impact of electronic feedback on their learning during clinical placements through both open-ended and Likert scale questions."	4	2	"Most students (n=10, 71%) reported electronic feedback facilitated reflection upon performance, and 64% (n=9) reported improved performance as a result. Disadvantages included... difficulties using iPads™ in settings requiring infection control (n=2 [22%] clinical educators)." "The only significantly different response between students of different ages, genders, or health professional disciplines observed was that fewer physiotherapy students (50%) agreed the feedback highlighted areas for improvement compared [with] other disciplines (100%; χ^2 (6, 14) = 13.6, p = 0.035)." "This pilot study suggests that electronic feedback, recorded and delivered through the use of iPads™ and the Mark-Rite™ software platform, successfully facilitates feedback delivery by clinical educators and assists with student self-reflection." --- "...the electronic feedback was aligned with national discipline-specific assessment instruments, and students were able to track their progress against competency criteria"	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, efficiency	While free-text comments were summarized (Table 3, Table 5), no details of analysis or epistemological stance were reported and the approach was not labelled as mixed methods. --- S3 evidence was extracted from overall S2.
Steinemann and Omori 2006	At midpoint of their 6-month Sep- 2004 to Mar- 2005 clerkship	2006	USA	3rd year medical students	PDA	logbook	quantitative	"to assess compliance with our medical student work hours policy [using a PDA], and to correlate work hours with sleep and performance"	"All 37 students enrolled completed work hours data, although 3 students failed to log sleep hours at home." --- "All 37 students had available clinical evaluations, and 33 students had available NBME subject examination scores."	"In 2003, our surgery department developed a written work hours policy for medical students [i.e. that they] should work an average of no more than 80 hours per week and have 1 full day off per week." --- "At the midpoint of their clerkship, students [estimated] their weekly work hours ['available for patient care in a clinical setting'], and were surveyed on their opinion toward work hour restrictions. [...] [Following that they] logged real-time work and sleep hours for 1 week [but not home study or leisure hours]. ...clinical evaluations, and score on the National Board of Medical Examiners (NBME) surgery examination were recorded." ---	4	3	"Thirty-seven students logged work hours, which correlated poorly with estimated work hours and sleep hours. [Most] students overestimated work hours by a mean of 19.5 hours. Twenty-four students transgressed written policy. Increased in-hospital study hours correlated with improved clinical ratings but poorer NBME examination scores [full data not shown]. Increased operating room hours correlated with higher NBME examination scores." --- "Medical students inaccurately estimate work hours; a PDA-based log facilitates hours monitoring. Unenforced work hour policies are frequently transgressed. Work activity patterns, but not total work hours, correlated with outcomes on standardized written tests and clinical ratings." --- "On average, students reported spending nearly half their working hours in rounds and patient care, 19% of working hours in the operating room, 14% of time in lectures and tutorials, 11% of time in independent study, and 8% of time sleeping [in-hospital]." --- "Our students [were familiar with] this PDA software for tracking patient encounters, and this likely facilitated the ease of adoption and 100% compliance with our work hours tracking program. Ensuring that the students log activities outside of clinical hours may be more difficult; 6% of our students failed to record these data." --- "Our study supports the need for real-time monitoring of medical student work hours to ensure compliance with written policies, and suggests use of a PDA as a facile way to implement this."	K4a, K4b	K4a K4b	appropriateness, effectiveness, efficiency, equity	Data-reporting should have been fuller, including more of the correlation coefficients.
Tews et al. 2011	Jul- to Oct- 2009	2011	USA	4th year medical students	iPod Touch	repository	quantitative	"to evaluate medical students' case presentation performance and perception when viewing short, just-in-time mobile learning videos using the iPod touch prior to patient encounters"	"A convenience sample..." --- "During the four-month study period, 30 fourth-year medical students rotated in the [emergency department] and were eligible for participation. Twenty-two students participated... by giving clinical presentations during this time..." --- "Twenty-two students completed the survey at the end of the rotation."	"a prospective pilot study" --- "...students were [block-] randomized to receive or not to receive instruction by video, using the iPod Touch, prior to patient encounters. After seeing a patient [no more than two each for chest pain, difficulty breathing or abdominal pain], they presented the case to their faculty [n=8 'trained in the study protocol' and blinded to students' instructional status], who completed a standard data collection sheet. Students were surveyed on their perceived confidence and effectiveness, after using these videos."	6	3	The 22 participants completed "67 case presentations: 29 for abdominal pain, 26 for chest pain and 12 for difficulty breathing". --- "There was a statistically significant improvement in presentations when the [5-minute] videos were viewed for the first time. There was no difference when the presentations were summed for the entire rotation (p=0.671). The reliable (alpha=0.97) survey indicated that the videos were a useful teaching tool and gave students more confidence in their presentations." "...when using the videos the students felt more confident in their ability to perform [median=5.0] and present [median=5.0] a focused history, physical exam and patient care plan ['scale from1 (strongly disagree) to 7 (strongly agree)']" --- "Clinical educators should consider whether, in an instance where live bedside or direct interactive teaching is unavailable, using just-in-time educational videos on a handheld device might be useful as a supplemental instructional strategy." --- "some students cited a concern that patients would think they are just playing video games or listening to music... if they were seen using the device in the clinical setting [...stated in Discussion, but no data were presented]."	K1, K2a, K2b	K2a K2b	appropriateness, accessibility, acceptability, effectiveness	

Paper	Time: data collected	data published	Place: Country	Person: Participants	Device: Type	Function	Research approach	Aim	Sampling, number/rate	Study design --- Data collection method	Level L1-L6	Strength Grade: S1-S5	Findings and conclusions	Kirkpatrick K-level: K1-K4	'highest' Kirkpatrick K-level: K1-K4	Maxwell	Notes
																	• L1-L6 (Harden et al. 1999); • S1-S5 grade (Colthart et al 2008; Hammick et al 2010) • K-level 1-4 (Kirkpatrick 1995)
Theroux 2013	May-2008 to Feb-2009	2013	Canada	3rd year baccalaureate nursing students	Palm Pilot or HP Pocket PC	repository, logbook	qualitative	"examined the relationships that handheld computers had with the ability of third year nursing students to establish and maintain caring relationships" --- "How does the use of handheld computers by a group of baccalaureate nursing students in a Canadian pre-service program support or interfere with their ability to establish and maintain caring relationships as a key competency? Sub-questions… • How do nursing students and patients describe "caring"? • What are the nursing students' and patients' perceptions about the use of handheld computers in supporting or interfering with caring relationships? • How do nursing students and patients describe the relationship of handheld computers with student learning about caring practice?"	"The four student participants in the study were recruited from a class of 79 students in the third year…"	"the case study approach" --- "The real-life context was the acute care adult surgical unit in a local hospital where students participated in clinical practice, students provided care for patients, and patients received care from nursing students and nurses."--- "[The policy stated:] Devices are not to be used in areas where patients are receiving service; Devices are not to be used while staff are providing service to public or clients'" --- "Data were collected including nursing student and patient interviews, documents, and artifacts such as the handheld devices and programs the students used." --- "purposeful sampling" --- Inductive and deductive approaches to content analysis.	4	4	"...computers positively contributed to safe administration of medications, and the confidence of students. The point-of-care where handheld computers were used was not typically at the patient's bedside: students used handheld computers most frequently at the medication cart... ...This use may be related to the students' desire to be knowledgeable when they came in to the patients' rooms to provide care." --- "Students and patients said that the time saved through use of handheld computers allowed them to have more time to practice their caring skills with patients. Students and patients stated the use of handheld computers supported more than interfered with... ability to establish and maintain caring relationships as a key competency." --- "...the handheld computer supported students' ability to establish and maintain caring relationships, but also had the potential to interfere with caring relationships with patients. Students and patients both identified time as an important component of caring. An important benefit of handheld computers was the time saved through students being able access current and accurate information quickly. Students spent this saved time with providing care for patients." --- "Both students and patients were concerned that handheld computers could draw the focus of the student away from patients. This change in focus away from patients was viewed as non-caring by students and patients."	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, efficiency	Doctor of Education thesis
Thomas and Goldberg 2007	No details	2007	USA	3rd and 4th year medical students	Palm or Pocket PC PDA	logbook, decision-making	mixed methods	"To explore the use of web and palm digital assistant (PDA)-based patient logs to facilitate reflective learning in an ambulatory medicine clerkship"	"The logs of 59 students were examined. These students entered 3,051 patient encounters, and 51 students entered 1,347 learning need entries (44.1% of encounters)." --- "...convenience sample of three successive rotations of medical students' patient log entries"	"We hypothesized that embedding a reflective cue within the web-based patient log would lead our students to document the status of 'mindful practice'." --- "Students are required to enter one's clinical work, a habit that has been associated with high-quality patient care]. Students were encouraged to use this field to enter goals for future study or teaching points related to the encounter." "To evaluate students' use of the field, a thematic analysis [named] categories according to the cognitive task [then grouped as: 'diagnostic thinking; primary interpretation; physician-patient relationship; management; fact']." --- They analysed end-of-clerkship written knowledge-test (50 multiple-choice items).	4	3	"...60 students. One student made no entries" --- "These 59 students entered... 3,051 patient encounters; with a mean of 52 (range 10–151) encounters per student for the 4-week clerkship. Eight students never used the 'Learning Need' field. Of the encounters, 1,347 (44.1%) had a 'Learning Need' entry; some encounters had more than 1..." --- "There was no relationship between the number of encounters, number of 'Learning Need' entries, frequency of use of any category and performance on the written knowledge test (data not shown). [...] There were significant correlations (r=0.36–0.47, p<.001) for numbers of entries in the categories: Clinical Reasoning, Differential Diagnosis, Question-asking, and Association Noted. These 4 [became the] 'Diagnostic Thinking' category [and comments therein then] correlated with interpretation of primary data, observations of physician–patient relationships, and management statements, but were not correlated with factual knowledge entries, suggesting that the use of categories differentiated students." --- "There were strong correlations between the use of diagnostic thinking comments and observations of therapeutic relationships (Pearson's r=0.42 [0.426 in T2 is 0.43], p<0.001), and between diagnostic thinking and primary interpretation skills (Pearson's r=0.60, p<0.001), but not between diagnostic thinking and factual knowledge (Pearson's r=0.10, p=0.46) [but that result appears only in abstract]. ...We found that when clerkship students were cued to reflect on each patient encounter with the electronic log system, student entries grouped into categories that suggested different levels of reflective thinking."	K1, K3	K3	appropriateness, accessibility, effectiveness	Abstract: "diagnostic thinking comments and observations of therapeutic relationships (Pearson's r=.42, p<0.001)" vs Table 2: "0.426", i.e. 0.43
Topps et al. 2009	No details	2009	Australia	5th year medical students and general practice registrars (residents)	PDA	logbook, communication, assessment	mixed methods	"to provide insight into the benefits and barriers of ['digital audio recordings of clinical supervisors' brief feedback' combining 'assessment of actual behaviour in the workplace with timely feedback']" --- "development, piloting and evaluation of a method for assessing professional behaviour using digital audio recordings of clinical supervisors' brief feedback. We evaluate the inter-rater reliability, acceptability and feasibility of this approach"	"the first six students who volunteered […] A number of GP residents were also approached..." --- "Six medical students in Year 5 and three GP registrars (residents) took part..." --- "Supervisors were sampled on a convenience basis by students."	"pilot study" --- "...learners were provided with free use of a PDA pre-loaded with relevant medical applications." --- "[Participants] approached their clinical supervisors to give approximately one minute of [oral] feedback on professionalism-related behaviours they had observed in the... clinical encounters. The comments, both in transcribed text format and audio, were scored by five evaluators ['faculty with experience in assessing student professionalism'] for competence (the learner's performance) and confidence (how confident the evaluator was that the comment clearly described an observed behaviour or attribute that was relevant)." --- "...we chose to focus on four key features or attributes of professionalism: professional behaviour, attitudes, communication and ethics (PACE)." --- "We asked learners to obtain up to four comments in each of the eight weeks [clerkship] of the study..." --- "[Over and above a digital audio recording device, the PDA allowed] additional on-screen prompts and information." --- "[At the end of the study,] students were asked to record their own 60-second responses... [...] Evaluators provided feedback on the acceptability and feasibility..."	4	3	29 comments were rated with "good inter-rater reliability (Cronbach α around 0.8) on competence scores. There was good agreement (paired t-test) between scores across supervisors for... comments in both written and audio formats [re: competence on one or more PACE attributes and re: confidence of evaluator in own judgement]. Students found the method helpful [for] feedback... Evaluators liked having a relatively objective approach... but found scoring audio comments to be time-consuming. This method [of] formative and summative assessment... is feasible and acceptable to students and evaluators. ...but to be valid, training of clinical supervisors is necessary [to comment] on defined behaviours and attributes... [especially for summative assessment, and] validity of the scoring method remains to be confirmed."	K1, K3	K3	appropriateness, acceptability, equity	Student and resident findings are not separated. --- Using the term 'students' for all participants (including the residents/registrars) is confusing.
Tran et al. 2014	Feb-2013	2014	Canada	4th (final) year medical students	smartphone	repository, logbook	quantitative	"to examine final-year medical students' experience with and attitudes toward using personal mobile technology in the clinical environment, with respect to the perceived impact on patient confidentiality and provider professionalism"	The overall response rate was 45.4% (99/218).	"Cross-sectional surveys [19-item, piloted on two focus groups and nine students]... [...] asked about the type of personal mobile phone [students] use, security features on their personal phone, experiences using [it] during clinical rotations, and attitudes [nine items, 5-point Likert scale] about using [it] for clinical work..."	4	4	"Smartphone ownership was prevalent (98%, 97/99) [78 owning iPhones] with the majority (86%, 85/99) [used] for patient-related communication during clinical rotations. A total of 26% (26/99) [had no security] on their personal phone, 94% (90/96)... agreed that using [it] for clinical work makes them more efficient, and 86% (82/95) agreed that [it] allows them to provide better patient care. Although 68% (65/95) [consider] that the use of personal phones for patient-related communication with colleagues poses a risk to the privacy and confidentiality of patient health information, 22% (21/96)... still use their personal phone to text or email identifiable patient data to colleagues." --- "...the threat to patient confidentiality... of unsecured [mobile devices should be addressed]." --- "[There was evidence that] increased connectivity may have a negative impact on professionalism such as 'distracted doctoring', which may disrupt patient care and education."	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, efficiency, equity	
Willemse and Bozalek 2015	No details	2015	South Africa	3rd year nursing students and their educators	mobile device, including limited number of… smartphones	repository, communication	qualitative	"To explore and describe the knowledge and points of view of students and educators about introduction of new technologies into an undergraduate nursing programme]" --- "Research objectives: •Explore and describe the knowledge and points of view of students and educators about... [and] •Identify the affordances of mobile devices... [both re 'introduction of new technologies'] ...to enhance integration of theory and clinical practice using mobile devices."	The participants included all third-year undergraduate nursing students (n = 100) registered for the PHC module, a semester module at a university, and their educators (n = 5) who facilitated that module.	"The qualitative design used Tesch's (1990) steps of descriptive data analysis to complete thematic analysis of the data collected in focus group discussions [each with n=6]... and individual interviews to identify themes." --- "four FGDs and eight semi-structured face-to-face individual interviews... with students, whilst one FGD, one discussion group and three semi-structured face-to-face individual interviews... with educators." "[After those,] no new or relevant data emerged, [i.e.] theoretical saturation had been reached." --- "The transcripts of the FGDs and individual interviews... were collated for each participant..." --- "thematically analysed and categorised into themes" --- "The discussion... was guided by assigning ['technological... social and educational] affordances to each of the findings with the purpose of creating a meaningful theoretical framework"	4	4	"Themes [from students] included: mobile devices as a communication tool; email, WhatsApp and Facebook as methods of communication; WhatsApp as a method of communication; nurses as role-models in the clinical setting; setting personal boundaries; and impact of mobile devices in clinical practice on professionalism [that patients would think students did not care and were not being professional]. Themes [from educators] included: peer learning via mobile devices; email, WhatsApp and Facebook as methods of communication; the mobile device as a positive learning method; students need practical guidance; and ethical concerns in clinical facilities about Internet access and use of mobile devices ['when students have to take pictures of patients']." --- "...[most students preferred to communicate by] email, followed by WhatsApp [perceiving 'WhatsApp conversations as natural and conversational'] and then Facebook to enhance integration of theory and clinical practice by incorporating m-learning..."	K1, K3	K3	appropriateness, accessibility, acceptability, equity	
Witt et al. 2016	Jan-2013 to Sep 2014	2016	Botswana	3rd and 4th year medical students	tablet	repository	mixed methods	"primary goal... to determine which applications on the tablets were most useful to undergraduate medical students, ...secondary goal... to determine how the devices and the infrastructure supporting their use could be optimized"	82 undergraduate medical students: n= 45 3rd year and n=37 4th year; n=68 for usage data and n=34 for focus groups ?? --- "convenience sample [re] availability"	"Tablets were preconfigured and pre-loaded with 15 applications [resources]". --- Data collection started after 6-8 months' use and "was assessed both quantitatively and qualitatively. Data regarding app usage... duration and frequency of use... were collected using Praxis©TM." --- Focus group discussions lasted 30-60 minutes, used the same semi-structured schedule, and were double-coded for themes.	4	3	Usage data showed much use of the applications. --- 28 themes emerged from the focus groups. --- "...the primary barrier to use of tablets was the lack of mobile cellular Internet beyond the Wi-Fi zones at the training sites." "[On clinical rotations, some health care providers] engage students to look up medical information such as drug doses, especially during ward rounds." --- "Participants [were] reluctant to use tablets during ward rounds [as] staff might think they were not paying attention and/or using non-academic tools. Participants were... concerned about patients' perceptions of their use of tablets, although one participant noted that patients were usually amenable when provided an explanation. ...[and concern about theft limited use in public places]." --- "Even in resource-limited settings where Internet access can be unreliable and intermittent, [medical students 'found that the use of tablets adds value to their learning and patient care' and valued] clinical resources with offline functionality... ...[and] improved training and technical support [would help]." --- "...students highlighted...: convenience (easy access), portability (anywhere access), and immediacy (anytime access)."	K1, K4b	K4b	appropriateness, accessibility, acceptability	Abstract and p72 states "between November 2012 and January 2013" [project implementation], but lower on p72 states "between November 2012 and January 2014" [expansion of project]. --- Figure 2 is not labelled as to the unit-time for rate of 'launches'. --- It was unclear whether some results related specifically to clinical placements or other settings for learning.
Best evidence medical education review of 1998-2016																	

e-Appendix 2: n=45 primary research, n=4 systematic reviews: Data extracts for: "What works best for health professions students using mobile (hand-held) devices for educational support on clinical placements?"

Paper	data collected	data published	Country	Participants	Type	Function	Research approach	Aim	Sampling, number/rate	Study design --- Data collection method	Level L1-L6	Strength Grade: S1-S5	Findings and conclusions	Kirkpatrick K-level: K1-K4	'highest' Kirkpatrick K-level: K1-K4	Maxwell	Notes
	Time		Place	Person	Device		Methods				Robustness of evidence		Findings and conclusions	Kirkpatrick	'highest' Kirkpatrick	Maxwell	• L1-L6 (Harden et al. 1999); • S1-S5 grade (Colthart et al 2008; Hammick et al 2010) • K-level 1-4 (Kirkpatrick 1995)
Wittmann-Price et al. 2012	No details	2012	USA	senior prelicensure nursing students	iPhone	repository, decision-making	mixed methods	"to descriptively quantify and qualitatively evaluate outcomes of prelicensure nursing students' use of MEDs [smartphones] [in the clinical area]" --- "to: ● Record the frequency of smartphone use during a semester-long (10-week) clinical rotation. ● Explore senior nursing students' perceptions about smart-phone use during a semester-long clinical rotation by having students reflect on their experience in a focus group. ● Explore staff nurses' perceptions of student smartphone use through an anonymous survey at the conclusion of the study."	"a convenience sample of one clinical group of second-semester seniors (n = 8) [on a medical–surgical unit] …two of whom did not then use the smartphone	"descriptive pilot study" --- "Senior students are randomly assigned to clinical groups in the nursing educational program. Students were [then] consented to participate in the study…" --- "The smartphones contained nursing diagnosis, pharmacology, and laboratory information; an encyclopedia; and the MEDLINE database. Student (n = 7) data about smartphone use during a 10-week clinical rotation were collected via student-recorded usage logs and focus group [n=8, 45-minute] recordings. Staff nurses' (n = 5) perceptions of students' use of smart-phones for clinical educational resources were collected by anonymous [open-ended] survey. Both the focus group transcript and staff surveys were evaluated and the themes summarized by content analysis."	4	3	"The average age of the eight students was 25 years. Two students did not complete the study—one student did not have Internet access because it was cost prohibitive, and the other student had difficulty using the technology and opted to not use it." --- "The overriding themes that emerged were resource, confidence, and safety." --- "The most often used resource was for medication administration, and many students cited themes of safety related to this use. Examples such as '[I] didn't have to run back and forth 15 times because I forgot what the med was—helped keep [my] train of thought' were common. [...] Several comments [illustrated] increased confidence, such as 'I had increased confidence that I was giving the right [medication]. [...] Another participant warned that it may not be the best learning mode for everyone, as was evidenced by the preference of one of our original participants to use books as references." --- All six students who used the smartphones reported that it "made providing patient care 'so much easier' and 'so much faster'." --- "...overall, the staff nurses indicated that the handheld device had a positive influence on patient care because they viewed the students as being 'more prepared and confident in their care of the patients.' All five of the staff nurses thought use of the handheld devices should be allowed as patient care tools."	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, efficiency	
Wu and Lai 2009	No details	2009	Taiwan	junior psychiatric nursing students	PDA - HP iPAQ 2210	repository, logbook, decision-making, communication, assessment	qualitative	"To evaluate the effectiveness, of the handheld learning environment" --- "(1) what were students' feedback on the features of the PDA-based environment in terms of perceived advantages and disadvantages?, (2) what were the benefits of the PDA-supported clinical practicum as compared to the previous ones?, and (3) what issues might occur when implementing such a PDA-based practicum session?"	"Six female students enrolled in the practicum session…"	"Six female students enrolled in the [3-week psychiatric nursing] practicum session were each provided a PDA to use throughout --- The PDA facilitated a forum (with peers/instructor), sharing assignments, reflective journal, information resources, support for assessing patients' mental status, concept-mapping, note-taking/audio-comments/recording, i.e. "recording information, organizing ideas, assessing patients, collaborating with peers, and interacting with the instructor". --- [Data collected] included: students' reflective journals; open-ended questionnaires answered by the students, the instructor, and the four nurses (including two nurse mentors) who worked in the same ward with the students; interviews with the students and the instructor after the practicum; and our field observation journals."	4	3	"Students indicated that [the device had saved much] time because they could record [a] patient's data on site and upload it for [an] instructor's feedback soon afterwards." "All [nurse participants] were very positive about students' use of PDAs and did not consider it a problem to the nursing practices. [...] The nurses envied students' access to PDAs and expressed the desire to use PDAs in their future practice. [...] We found patients' initial reaction to the PDAs was often that of curiosity... Patients quickly got used to the students' use of PDAs, eventually viewing them as almost routine tools of the clinical staff." --- "Ultimately, the PDAs acted as cognitive scaffolding tools..." "[The PDA-based tools] incorporated several key clinical learning instruments [and thus use extended beyond] electronic reference tools [to data recording and communication]..."	K1, K3, K4b	K4b	appropriateness, accessibility, acceptability, effectiveness, efficiency	
Systematic reviews (for context)																	
Garrity and El Emam 2006	1993-2006 search	2006	Canada	health care professionals: physicians, specialists, medical residents, medical students, and nurse practitioners/ students	PDA	---	systematic review	"to estimate current and future PDA use among health care providers and to discuss possible implications of that use on choice of technology in clinical practice and research"	"Response rates ranged from 5.7% to 92.6% across 13 of the included surveys; 10 surveys did not report such rates."	"[PDA usage] surveys were identified as part of an ongoing systematic review on the use of handheld devices. Reports from eight databases covering both biomedical sciences and engineering (1993-2006) were screened against distinct eligibility criteria. Data from included surveys were extracted and verified in a standardized way and were assessed descriptively."	systematic review	4	"...identified 23 relevant surveys, 15 of which were derived from peer-reviewed journals. ...published between 2000 and 2005" --- Of 15 articles, only 1 included undergraduate students: medical, i.e. Canadian National Physician Survey of 2004: 49% of Canadian medical students had a PDA or wireless device --- "It is worthy to note that, with the exception of one survey focusing on nurse practitioner students [not undergraduate students], little mention was made in the surveys of PDA use by students across health care disciplines, including medicine."	---	---	appropriateness, accessibility	
Kho et al. 2006	1993-2004 search	2006	USA	medical students and residents	PDA	---	systematic review	"to (1) describe medical trainees' use of PDAs for education or patient care, (2) catalog popular software applications, and (3) evaluate the impact of PDA use on patient care"	Sixty-seven studies met inclusion criteria.	"...MEDLINE (1993 to 2004), medical education-related conference proceedings, and hand search of article bibliographies. ...identified articles and abstracts that described the use of PDAs in medical education by trainees or educators. Reports presenting a qualitative or quantitative evaluation were included."	systematic review	4	"Only 1 randomized trial [Leung et al] with educational outcomes was found, demonstrating improved learning and application of evidence-based medicine with use of PDA-based decision support software. No articles reported the [objective] impact of PDA use on patient outcomes." "Among the 67 included reports, 27 (40%) evaluated handheld computer use among medical students [only]... " Studies of medical students with others did not necessarily separate out the medical student findings, but overall: "Further studies are needed to evaluate how PDAs impact learning and clinical outcomes." "...[re] both medical student and resident users, most studies focused on ...accessing electronic medical resources and ...tracking patients, diagnoses, and procedures"	---	---	accessibility, acceptability, effectiveness	
Lindquist et al. 2008	1996-2008 search	2008	Sweden	personnel and students in healthcare	PDA	---	systematic review	"to obtain an overview of existing research on the use of PDAs among personnel and students in health care"	"From the 900 references initially screened, 172 articles were selected and critically assessed until 48 articles remained. The majority originated in North-America (USA: n=24, Canada: n=11)."	"...included original peer-reviewed research articles written in English and published from 1996 to 2008. All study designs were considered for inclusion. We excluded reviews and studies focusing on the use of PDAs in classroom situations. From March 2006 to the last update in May 2008, we searched PubMed, CINAHL, Cochrane, IngentaConnect, and a local search engine (ELIN@Kalmar). We conducted a content analysis, using Nielsen's Model of System Acceptability as a theoretical framework in structuring and presenting the results."	systematic review	4	Of 48 articles, only 10 included undergraduate students: 6=nursing, 3=medical, and 1=nursing and medical [excluding one re nursing practitioner students and one by McLeod et al 2003 re residents that is incorrectly attributed to medical students]. "[They] found the [personal digital assistant] PDA to be a valuable tool for... students in various situations. The PDA allowed immediate and easy access to medical information that might improve patient care and the quality of health care." They considered the evidence to show that the PDA could "improve learning for students in clinical practice".	---	---	appropriateness, accessibility, acceptability, effectiveness, efficiency	
Mi et al. 2016	Jan-2010 to Apr-2015 search	2016	USA	"Health professions students were the target population… Among the 20 studies, 7 targeted medical students; 8 focused on residents; 7 studied nursing students; and 5 studies included other groups of participants from programs in physiotherapy, midwifery, sports medicine, and residency training."	mobile device	---	systematic review	"examines types of mobile devices used by health professions students, kinds of resources and tools accessed via mobile devices, and reasons for using the devices to access the resources and tools"	"The initial search of all databases and resources yielded 6,086 citations. After removing duplicated citations, 172 articles not meeting the selection criteria, 57 full-text articles were examined, from which 20 articles were selected for the final review." --- Sample-sizes n=9 to n=578	"The review included 20 studies selected from articles published in English between January 2010 and April 2015, retrieved from PubMed and other sources. Data extracted included participants, study designs, mobile devices used, mobile resources/apps accessed, outcome measures, and advantages of and barriers to using mobile devices."	systematic review	4	Of the 20 studies, six focused on residents only, i.e. not undergraduate health professions students. --- "Of the 20 studies, 8 reported the implementation of the iPad as an intervention or strategy to facilitate students' resources access, enhance learning, aid patient care, and meet other needs. Eleven studies reported the use of other mobile devices... The duration of mobile devices in use in the selected studies varied, ranging from two weeks to two years." --- "The review indicates significant variability across the studies in terms of research methods, types of mobile programs implemented, resources accessed, and outcomes. There were beneficial effects of using mobile devices to access resources as well as conspicuous challenges or barriers in using mobile devices."	---	---	appropriateness, accessibility, acceptability, effectiveness, efficiency	