

Virtual Patients: Where are we? Where are we going?



Paul Gauguin, *Where Do We Come From? What Are We? Where Are We Going?* 1897

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What is a virtual patient?

D
E
C
I
S
I
O
N

„The student [is presented] with a choice from a list of various drugs, activities, diet and nursing care, some of which would be beneficial to the patient, some of them harmful”

C
O
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X
T

„In order to help convey an image of a real patient (...) a three minute film is incorporated in the (...) lesson”

F
E
E
D
B
A
C
K

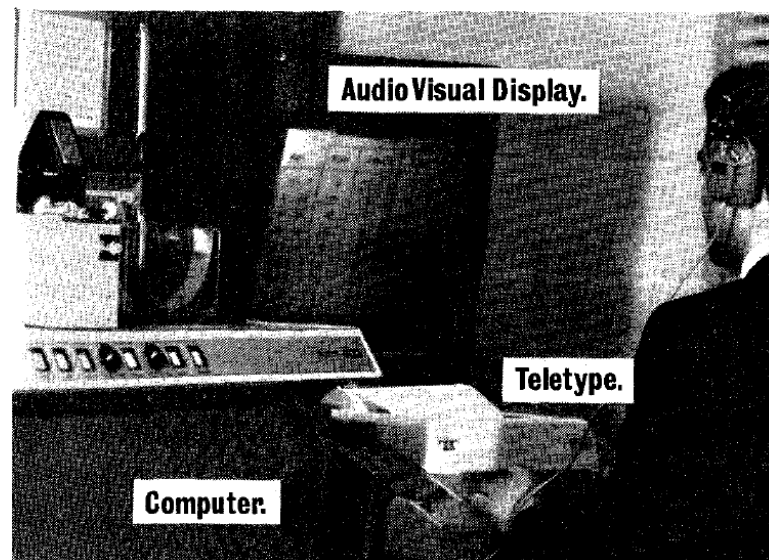
„Whenever the student performs an experiment, e.g., gives the patient oxygen, all of the information available on the patient changes accordingly to show the effect on the patient”

Bitzer M "Clinical nursing instruction via the PLATO simulated laboratory." *Nursing Research* 15.2 (1966): 144-150.

- tested with 1st year nursing students class at Mercy Hospital School of Nursing, Urbana, Illinois



Bitzer 1966, The Plato Simulated Laboratory



de Dombal et al. 1969, Leeds C.A.L. for clinical diagnosis

Virtual patients – What are we talking about?

- The term „Virtual Patients” first mentioned in 1991
- From 791 articles including this term in title or abstract by 2013
 - **330 (62%) Medical Education**
 - 135 (25%) Clinical research
 - 39 (7%) E-health
 - 26 (5%) Clinical procedures
- Classification by competency & technology

		Technology				
		Multimedia system	Virtual world	Dynamic simulation and mixed reality	Manikin and part task trainer	Conversational character
Competency	Knowledge	8 <i>Case presentation</i>		3 ●		
	Clinical reasoning	98 <i>Interactive patient scenario</i>	23	10		4
	Team training		<i>Virtual patient game</i>	1 ●		
	Procedural & basic skill	5	1 ●	50 <i>High fidelity software simulation</i>	3 ● <i>High fidelity manikin</i>	1 ●
	Patient communication	11 <i>Human standardized patient</i>	4			41 <i>Virtual standardized patient</i>

Interactive Patient Scenarios

CASUS

W trakcie osuszania, ogrzewania i stymulacji noworodka stwierdzacie, że noworodek jest siny, wiotki, nie oddycha, a czynność serca oceniona za pomocą sietoskopa i palpacyjnie u pozostałych przepowinny wynosi około 40/minutę.

Bezwzględnie powinniście rozpocząć czynności resuscytacyjne!

Question

Które z wymienionych czynności wykonasz?

Multiple Choice Answer:

Expert answer is displayed in green color.

- A 30 ucięnięć klatki piersiowej (1/3 dozna mostka, poniżej linii międzyżebrowej)
- B 15 ucięnięć klatki piersiowej (1/3 dozna mostka, poniżej linii międzyżebrowej)
- C 5 paraczkowych wdechów w celu upowietrzenia płuc, a następnie ponownie osma kolbrę, nacięcia mięśniowego, oddechu i czynności serca
- D 5 paraczkowych wdechów, a następnie 15 ucięnięć klatki piersiowej (1/3 dozna mostka, poniżej linii międzyżebrowej)

Comment:
Noworodek, z którym macie do czynienia nie odpowiedział na wstępne postępowanie i wymaga upowietrzenia płuc, czyli wprowadzenia powietrza do płuc i przesunięcia znajdującego się tam pnyu do kragzenia

Instruct AG; LMU Munich

Open Labyrinth

Patient presentation

Joseph Anisah is a 34 year old Ghanaian who presents at the GP, complaining of feeling unwell with a cough and high fever. The fever began almost two weeks ago and was associated with a headache, muscle pains and nausea.

Ask him how he is feeling

Reassure him, prescribe some paracetamol and send him home

<http://openlabyrinth.ca>

Web-SP

Patient: William Connors

- Biochemistry
- Immunology
- Microbiology
- Pathology
- Pharmacology
- Radiology
- Misses
- Show all

CT

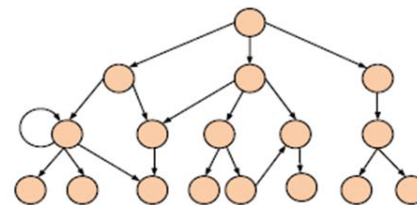
- Abdomen frontal
- Abdomen transversal
- C-Spine
- Facial Bones
- Head
- L-Spine
- Lower Extremity
- Maxillofacial Area
- Orbit, SelfAPST Fossa
- Pelvis
- Sella, SelfAPST Fossa
- Soft Tissue Neck
- T-Spine
- Thorax, detail
- Thorax, overview

No fractures, no intracranial lesions

Karolinska Institutet

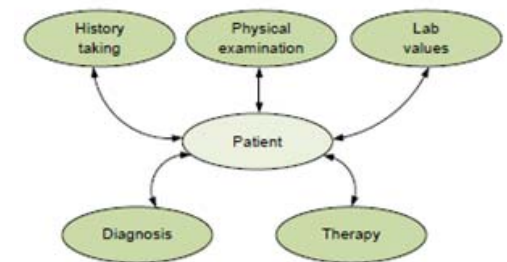


Linear („string of pearls”)



Branched

Narrative design



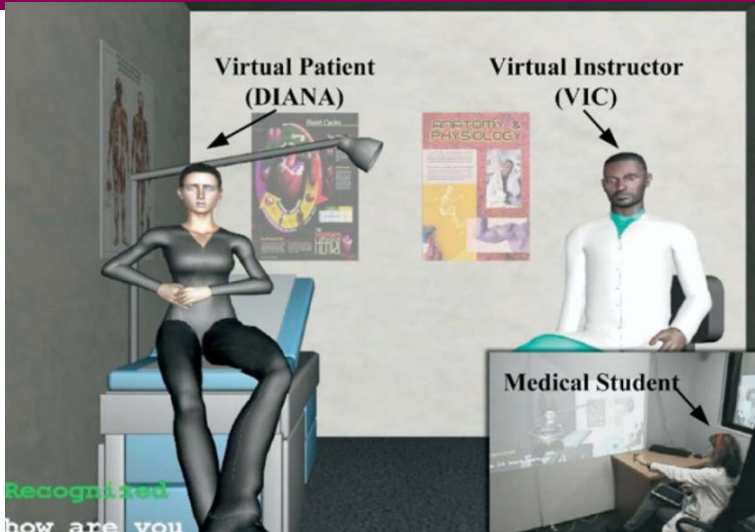
Problem-solving
(Template-based)

Virtual Patient Games (Virtual Worlds)

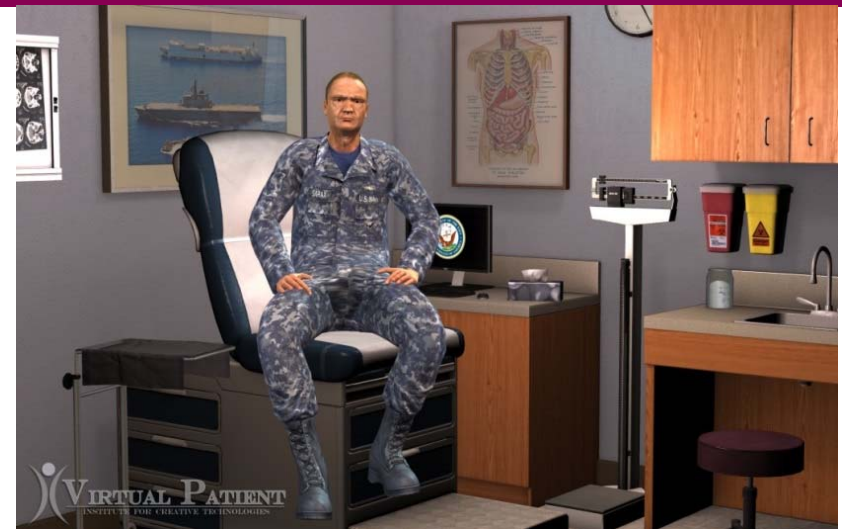


CliniSpace™ – A Virtual Patient Game CliniSpace. Immersive Learning Environments for Healthcare. Available from: <http://www.clinispace.com>

Virtual Standardized Patient



Stevens A, et al. The use of virtual patients to teach medical students history taking and communication skills. *Am J Surg.* 2006;191(6):806–11.



Talbot et al, 2012

File Edit View History Bookmarks Tools Help
https://pl.cba.uh.edu/VirtualPeopleFactory/publicScript.php?design_id=150&ba=anonymous
 Virtual People Factory - Interview

Consultation Area
 Virtual People Factory
 Name: VIC Johnson
 Description: In this interview you are a pharmacist in an outpatient clinic. You see new patients in order to conduct a medication history. Your patient, Vic Johnson, has come in complaining of stomach pains. He's brought his medication bottles with him, and put them on the table. You can read the details from the labels: Zestril: 30 mg/day and Synthroid: 125 mcg/day. Assess the stomach pain and take a history of current therapy. Please respond to the patient with empathy for his concerns. Provide advice if you identify a problem with...

Timer: 0 hours 2 minutes 41 seconds

Transcript

Vic Johnson: Hello. (Waves right hand)
 2) You: How are you feeling today?
 Vic Johnson: I'm not feeling too well.
 3) You: What's wrong?
 Vic Johnson: I've been having this awful stomach pain, and, um, it's actually starting to worry me.
 4) You: Why are you worried?
 Vic Johnson: I am afraid I might have cancer. My dad died of colon cancer.
 (Click here if this response did not make sense)

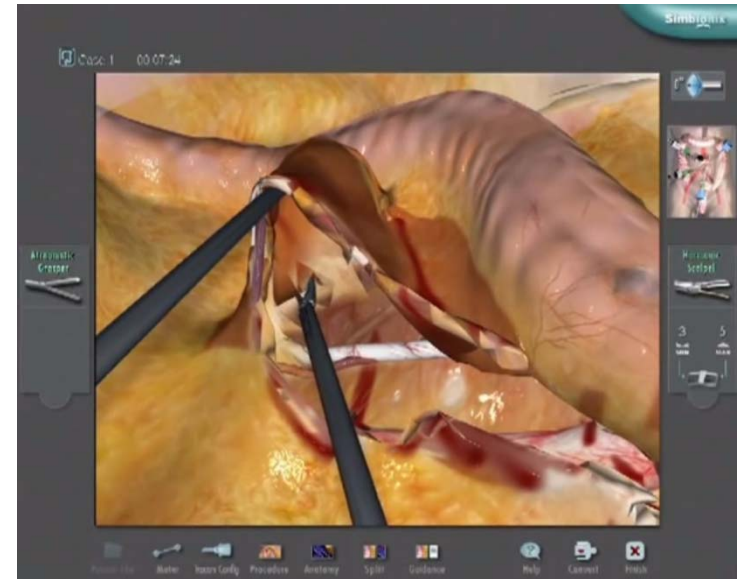
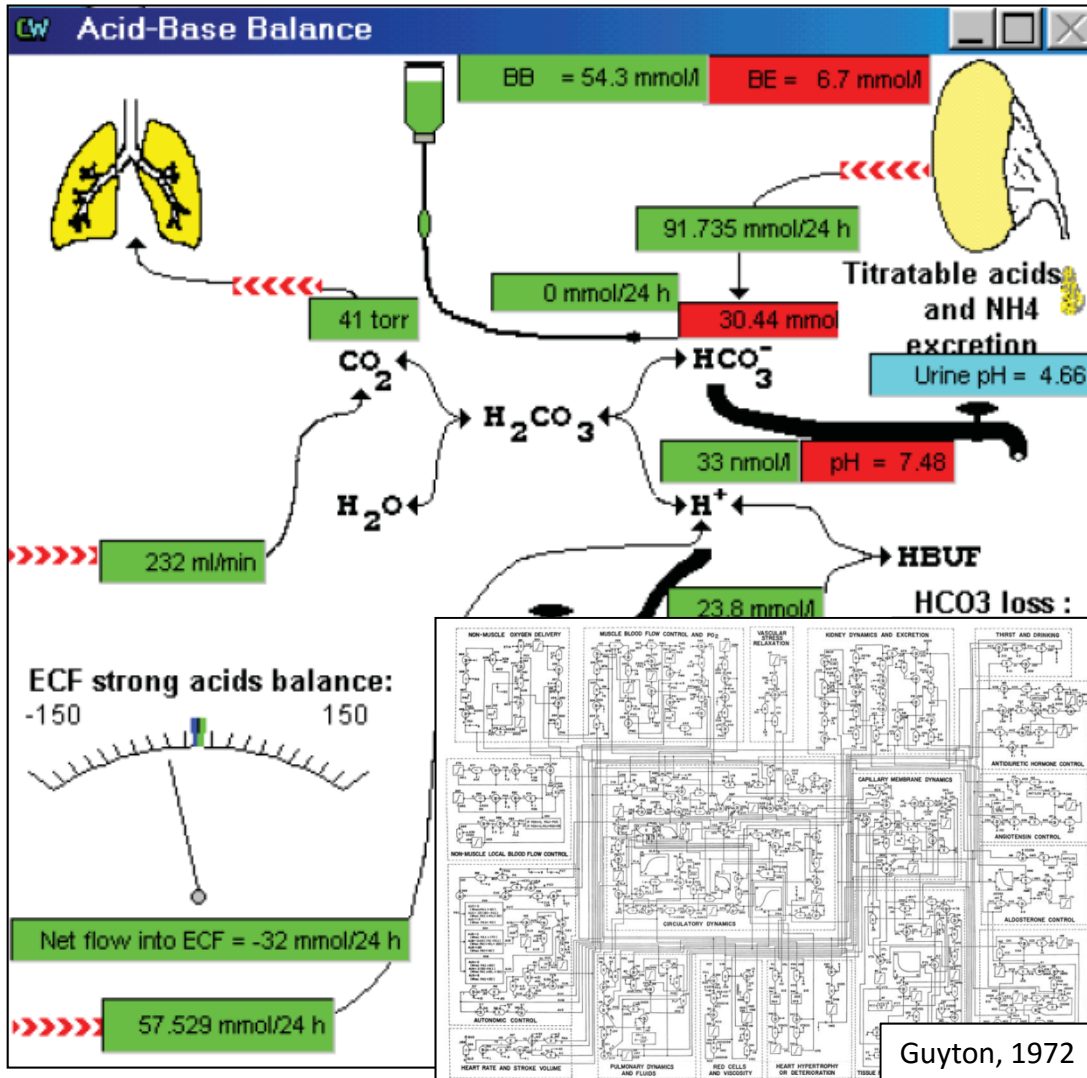
Ask a Question
 Press enter to submit
 Complete Interview

Rossen B & Lok B. A crowdsourcing method to develop virtual human conversational agents. *Int J Hum Comput Stud.* 2012;70(4):301–319.

High Fidelity Software Simulations

Dynamic simulations of physiology (e.g. GOLEM)

Complex geometric models



Simbionix LAP Mentor

High fidelity

- **Structural fidelity** – how the simulator appears? (*physical resemblance*)
- **Functional fidelity** – what the simulator does? (*functional task alignment*)

Kofránek, Jiří. "Komplexní modely fyziologických systémů jako teoretický podklad pro výukové simulátory." *Medsoft 2011*, pp. 73-105.

Hamstra SJ et al. "Reconsidering fidelity in simulation-based training" *Acad Med*. 2014 Mar;89(3):387-92.

Virtual patients in medical curricula

- Individual learning
 - Virtual patient repositories (e.g. eViP project repository)
 - Exam relevance (before formal assessment)
 - Prerequisite for practice (flipped classroom mode)
 - Extracurricular activities (e.g. student competitions)
 - Learn by design (construction of virtual patients by senior students)
- Collaborative learning
 - Discussion in small groups 2-3
 - Problem-based learning sessions
 - Interactive lectures
- Assessment
 - Practical skills examination (e.g. OSCE)
 - High-stakes testing

Virtual patients in Kraków

Kononowicz AA. et al. 2012

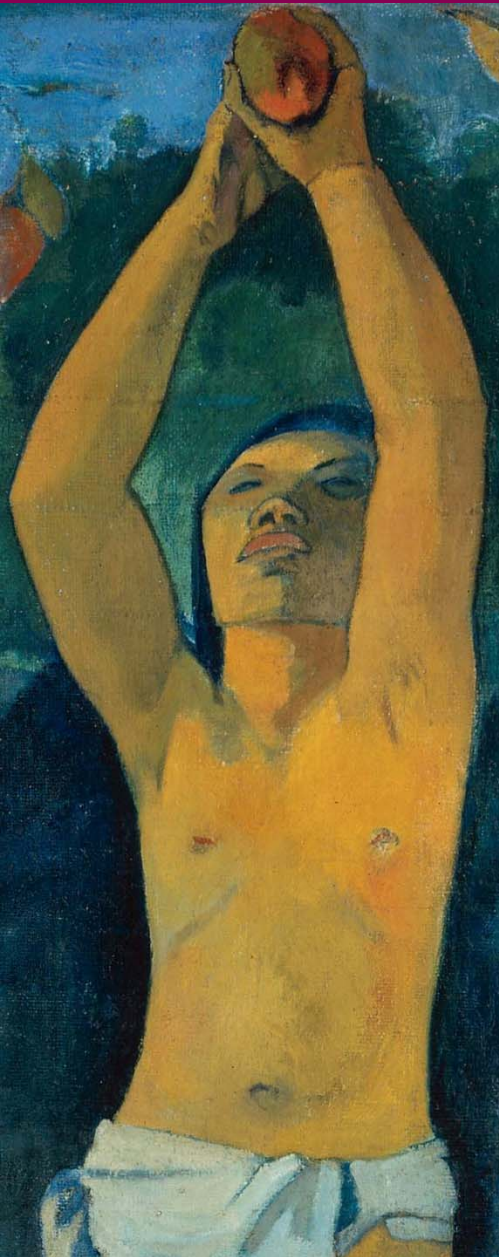
Journal	BMC Medical Education
University	Jagiellonian University Kraków (Poland)
Participants	226
Setting	Extension of BLS course lecture (1st year medicine)
Comparison	Gr. B: VP voluntary access Gr. A: Control (just lecture + book)
Outcomes	<ul style="list-style-type: none">• MCQ knowledge test (60 items)• BLS skills test (Cardiff Test)
Platform	CASUS® (Linear; Web)
Content/ Duration	6 cases (unlimited time: spaced activation) BLS with AED
Collaboration	Flipped classroom (individual, home in preparation to face-to-face classes)

Results

- 54% entitled students used the system at least once
- Average 15 min on each VP
- Most active time (9-10pm)
- Knowledge test
 - intention-to-treat comparison
 - 45.8 (control) vs 47.4 (VP);
 - $p = 0.01$; $ES = 0.44$
- Significant better skills performance at ($p < 0.05$)
 - Opening the airway
 - Check for signal of circulation
 - Knows when to stop BLS

Kononowicz A.A., Krawczyk P., Cebula G., Dembkowska M., Drab E., Fraczek B., Stachon A.J., Andres J.: *Effects of introducing a voluntary virtual patient module to a basic life support with an automated external defibrillator course: a randomised trial.*, BMC Med Educ, 12(1), 2012, 41

Do Virtual Patients really work?



- First systematic review with meta-analysis
 - Cook DA, Erwin PJ, Triola MM. Computerized virtual patients in health professions education: a systematic review and meta-analysis. *Academic Medicine* 2010;**85**(10):1589–602.
- Conclusions from the review:
 - Virtual patients are associated with substantial knowledge, clinical reasoning and skills gains in comparison to non-intervention (pooled ES=0.80-0.94)
 - Virtual patients are associated with negligible differences in knowledge, clinical reasoning and skills with other active learning methods
 - No conclusions regarding the effectiveness of different virtual patient designs variations



- Goal: Series of Cochrane reviews on effectiveness of e-Learning
 - Knowledge, Skills, Attitudes, Satisfaction, Cost, Patient Outcomes
- Partners
 - NTU Lee Kong Chian School of Medicine, Singapore
 - Imperial College, London
 - Karolinska Institutet, Stockholm
- Assumptions (selection)
 - Include RCT and cluster RCTs only
 - Include all health allied profession both pre- and post-graduate
 - Exclude comparison to non-intervention
 - Special interest in evidence for middle and low-income countries
- Protocols - examples
 - M-Learning
 - Virtual reality environments
 - **Virtual patients**
 - Kononowicz AA, Woodham L, Georg C, Edelbring S, Stathakarou N, Davies D, Masiello I, Saxena N, Tudor-Car L, Car J, Zary N: *Virtual patients simulations for health professional education (Protocol)*. Cochrane Database of Systematic Reviews 2016; 5:CD012194.

Virtual patients in radiology (design)

	Maleck M. et al. 2001	Mahnken AH. et al. 2011
Journal	Radiographics	European Journal of Radiology
University	LMU Munich (Germany)	RWTH Aachen (Germany)
Participants	192 (3 year medicine)	96 (4 year medicine)
Setting	Extension of radiology lecture (45min/week) and textbook	Extension of radiology internship
Comparison	Gr. A: VP with interactive elements Gr. B: non-interactive e-cases Gr. C: Paper cases Gr. D: Control (just lecture + book)	Gr. B: VP voluntary access Gr. C: VP mandatory access Gr. A: Control (just internship)
Outcomes	<ul style="list-style-type: none"> • MCQ knowledge test (14 items) • Image interpretation (4 freetext) • Student Satisfaction (35 items) 	<ul style="list-style-type: none"> • MCQ knowledge test (10 items) • Usage parameters
Platform	CASUS® (Linear; @Apple Macintosh)	CASUS® (Linear; Web-based)
Content/ Duration	10 cases (2 sessions each 2h) Chest radiographs; Bone imaging	10 cases (unlimited time avrg: 100-115 min) Img procedures: X-ray, CT, MRI, Ultrasound, Neuroradiology, Paediatric radiology
Collaboration	2-3	Self-directed (in-hospital computers & home)


CASUS 2001 and 2016

Card Editor

X-ray shadow Radiographic examination ? Help

Radiographic Examination

In seeking a definite diagnosis you demand an X-ray examination of the chest in posterior-anterior and lateral projection. Because of the reduced general condition of the patient you only got the P-A picture. Ms. Doe was too weak for standing more than one minute.



Type in your list of findings.

- shadow
- mediastinal shift
- infiltrates
- compensatory hyperinflation

Expert Evaluate

Maleck M. et al. 2001

eVIP case repository, 2016

43-letnia pacjentka z rakiem piersi i uczuciem duszności

Guest Help

Jump to: Card Top Question Answer

4 of 9 Cards

- 1: Przedstawienie Pacjentki
- 2: Badanie fizykalne
- 3: Procedury diagnozowania
- 4: Badanie RTG

Navigation


Aby pomóc w ustaleniu diagnozy, zleasz RTG klatki piersiowej w projekcji PA, i bocznej. Pani Kamińska była zbyt słaba, by stać dłużej niż minutę i w związku z tym otrzymałaś tylko zdjęcie w projekcji PA.

Question

Napisz, co widzisz na zdjęciu obok. Wpisz swoją odpowiedź w wolne pole poniżej.

Non-evaluated freetext

Type in your answer in the textfield.



RTG Pani Kamińskiej

Submit

Expert

Virtual patients in radiology (outcomes)

Maleck M. et al. 2001

	Pre/Post change (%)			Satisfaction [1-5]		
	n	MCQ Exam	Radiographs	Lecture	Textbook	Cases
VP interactive	47	+ 11.2*	+ 15.7*	3.3	2.5	3.2
VP non-interactive	38	+ 15.1*	+ 15.1*	2.9	3.1	3.5
Paper cases	42	+ 13.0*	+ 10.2*	2.7	2.3	3.7
Lecture+book only	65	+ 0.6	+ 8.5	3.5	2.8	-
		* p<0.05		All: 3.2	2.7	3.4

Mahnken AH. et al. 2011

	Pre/Post change (%)			Processed		
	n	MCQ Exam	Total time	Screens %	VPs [n of 10]	Passed [n of 10]
VP voluntary	32	13.2	114.3	63.4*	5.2*	3.3*
VP mandatory	32	15.4	100.5	74.0*	7.8*	5.6*
Internship only	32	8.5	-	-	-	-
		p = 0.56	p = 0.59		* p<0.01	

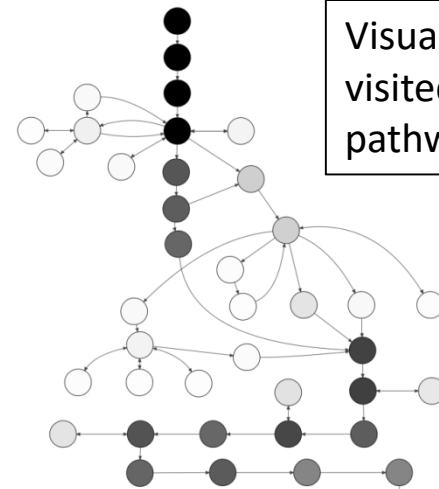
Methodological limitations:

- High variability of results
- Assignment to the three study groups was performed consecutively

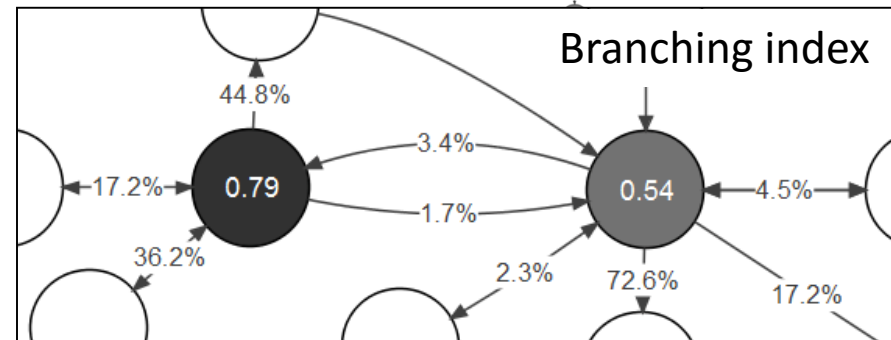
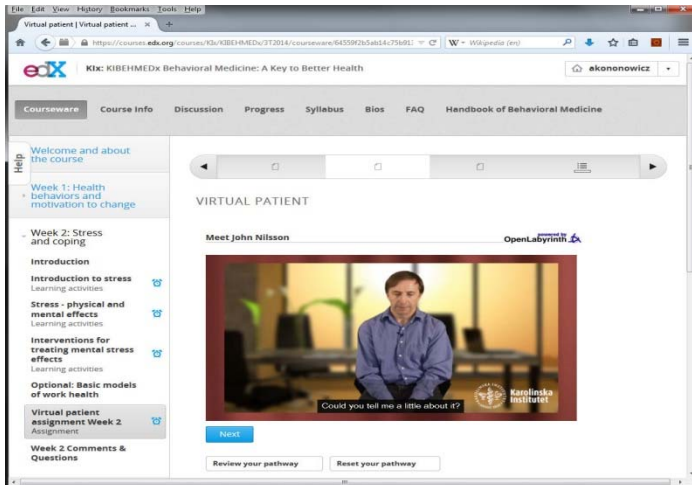
VP design studies

Author	Design	Conclusions (significant difference?)
Bearman 2001	narrative vs problem-solving structure	Narrative group better than problem-solving in communication skills after one week but three weeks later no difference
Dankbaar 2016	E-cases (Text-based VPs) vs Games-based VPs	No difference in clinical and communication competences
Davids 2014	VP vs VP with usability improvements	No difference in knowledge recall and transfer
Dickerson 2006	Recorded speech vs synthesized speech	No differences in the overall impression, speech intelligibility, and task performance
Harris 2013	VP with worked vs unworked approach	No difference
Mahnken 2011	Self-determined vs mandatory use	No difference
Maier 2013	VP space activated vs VP bolus activated	No difference
Maleck 2001	VP vs non-interactive VP	No difference (in knowledge)
Tolsgaard 2016	Constructing VP vs solving VPs	No difference in learning effects, 50% more time needed for constructing VP

- Virtual patients in MOOCs
 - Karolinska Institutet joined edX in 2013
 - KIBEHMEDX course: **9 Sep – 21 Oct 2014**
 - registered participants: **19,236**
 - completed VP assignment: **2,317**
 - Open Labyrinth 3.1 virtual patient system
 - Hosted on the cloud infrastructure of VPH Share project



Visual analytics:
visited nodes;
pathways detection



Kononowicz AA, Berman AH, Stathakarou N, McGrath C, Bartyński T, Nowakowski P, Malawski M, Zary N Virtual Patients in a Behavioral Medicine MOOC: A Case-based Analysis of Technical Capacity and User Navigation Pathways, JMIR Medical Education 2015; 1(2):e8

Where are we going?

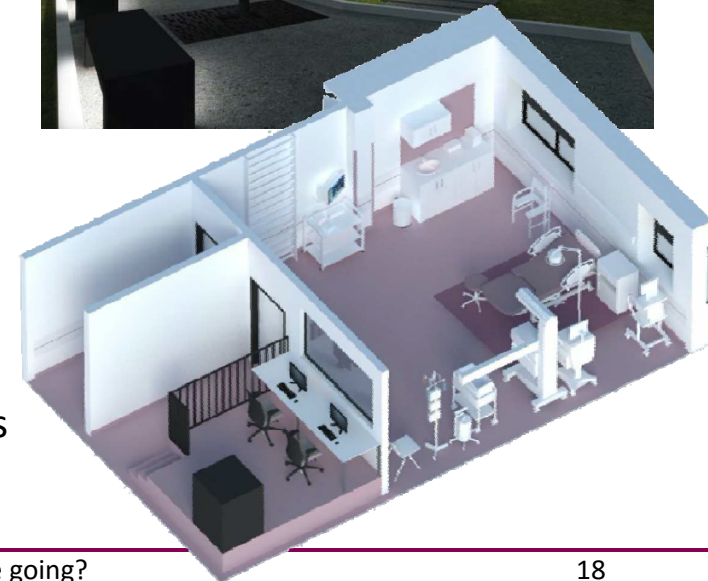
- Ellaway et al. 2009 - the „practica continua” framework
 - need to rethink the binary divide between virtual and real-world learning – need for integrated continua of simulation
 - „the learner starts with simple models and tasks, and then works through increasing complexity and integration of simulation modalities”

Ellaway RH, Kneebone R, Lachapelle K, Topps D. Practica continua: Connecting and combining simulation modalities for integrated teaching, learning and assessment. Med Teach 2009 Aug;31(8):725-731.

- Scenarios to use virtual patients in mixed-mode
 - Outcome of introductory virtual patient simulations influences initial configuration of successive simulations
 - Follow-up discussions and rehearsal after high-fidelity simulation events in on-line communities around virtual patients
- New opportunities for mix-mode simulations with virtual patients
 - Integration standards (xAPI)
 - Recognized need for interprofessional education
 - New hardware developments (mixed-reality smartglasses)
 - Development of medical simulation centres

Centre for Innovative Medical Education in Kraków

- „Dydaktyka, Innowacja, Rozwój”
 - A European Social Fund („POWER”) project
 - ~ 5 mln EUR for Jagiellonian (2016-2023)
 - Higher quality of medical education through development of innovative simulation-based teaching methods
 - Adaptation and equipment of existing rooms to the needs of the simulation centre
 - simulated: operating room, emergency rooms (3), intensive care rooms (4), control rooms (7), delivery room, ambulance, ALS & BLS rooms (6+2), clinical & surgical rooms, OSCE & standardized patient (SP) rooms (20)
 - Resources for instructors
 - High fidelity simulation scenarios, OSCE checklists, SP scenarios, physical examination checklists, **adaptation of existing and development of new virtual patient cases (40 cases)**, summer school competition scenarios
 - Teach-the-trainer courses



In summary



- Virtual patients
 - are not a new development
 - are heterogeneous in design and need adaptation
 - have in average small effects in comparison to other active learning interventions

but

- Virtual patients
 - have unquantified advantages
 - flexibility, scalability, safety, analytical potential
 - are a valuable extension of the curricula
 - can be combined with other forms of simulation



Děkuji !



Are there any questions?

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