

# AI inom klinisk utbildning: exempel och erfarenheter från generativ AI för virtuella patientmöten



**Karolinska  
Institutet**



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- Presentation
- Introduktion
  - Virtuella patientfall med AI + socialrobotik
    1. Våra erfarenheter
    2. Virtuella mottagningen – T6 läkarprogrammet
    3. Utvärdering och forskning
    4. Resultat
    5. AI-genererad återkoppling
- Sammanfattning och diskussion



# Presentation



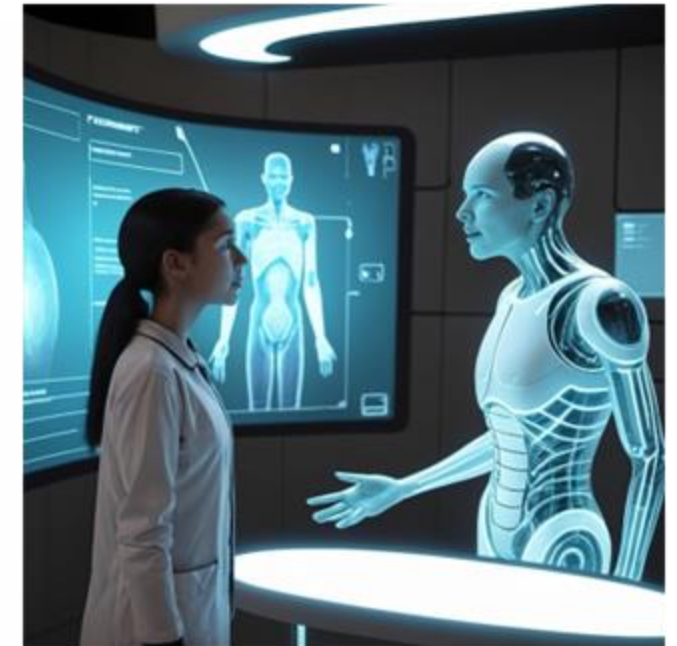
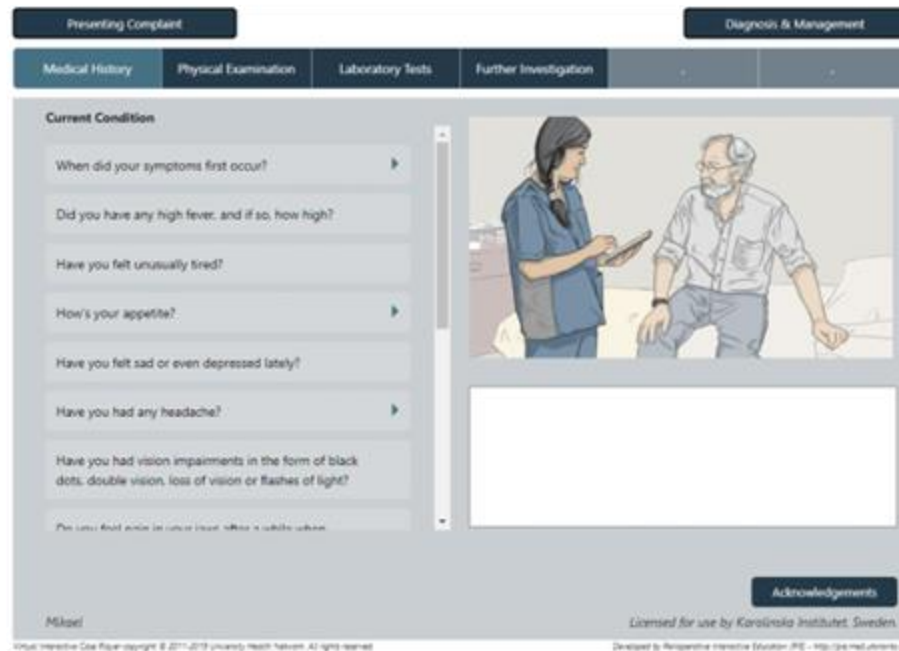
Alexander Borg



- Den största delen av verksamhetsförlagd utbildning sker på sjukhus
- Alla studenter får en unik utbildning
- Motsvarar det alltid alla lärandemål?

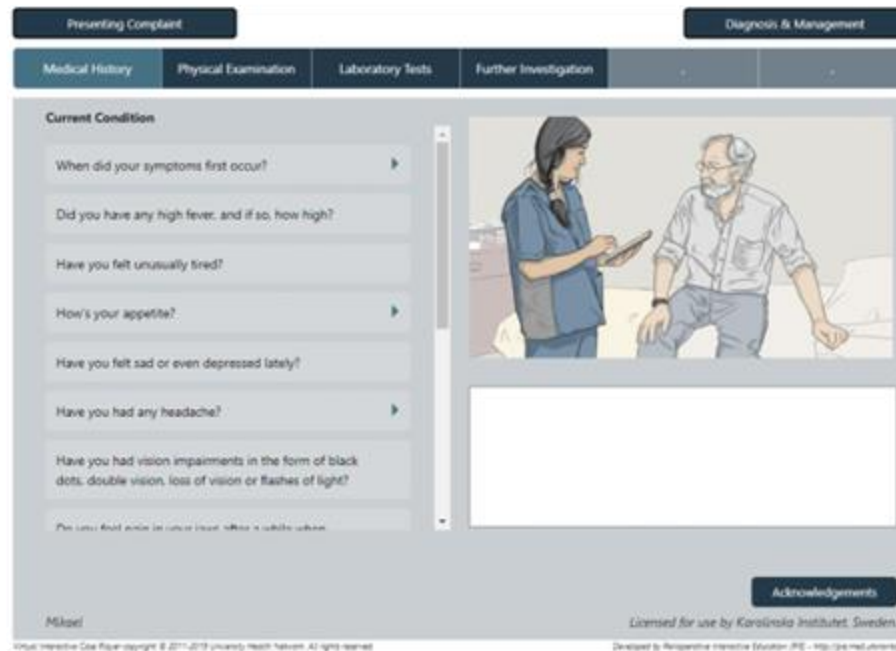


# Virtuella patienter



- Som ett stöd att uppnå lärandemål och exponeras för relevanta patientfall finns virtuella patienter (VP)
- Datorbaserade simuleringar av kliniska situationer

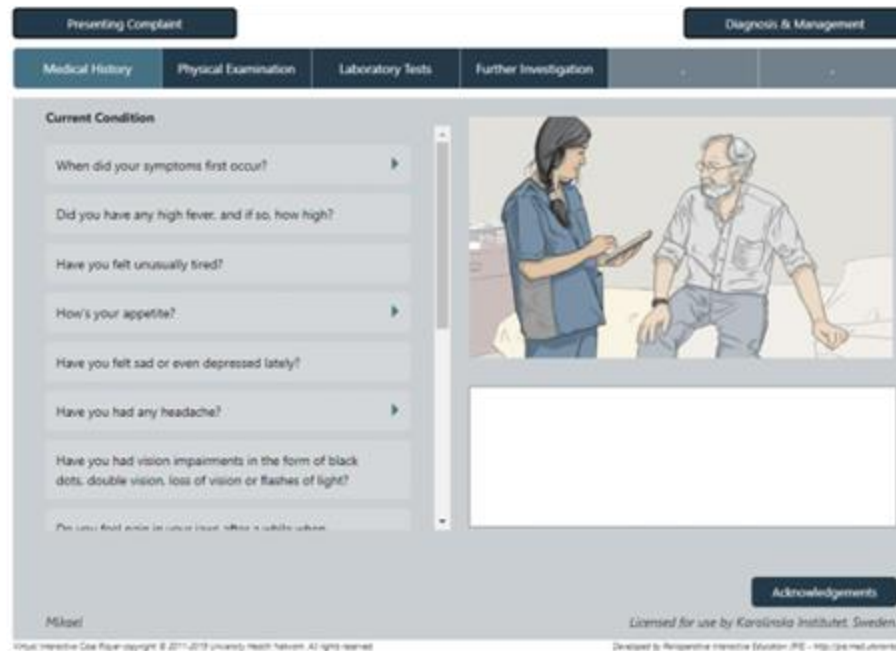
# Virtuella patienter



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+Representativa fall

# Virtuella patienter



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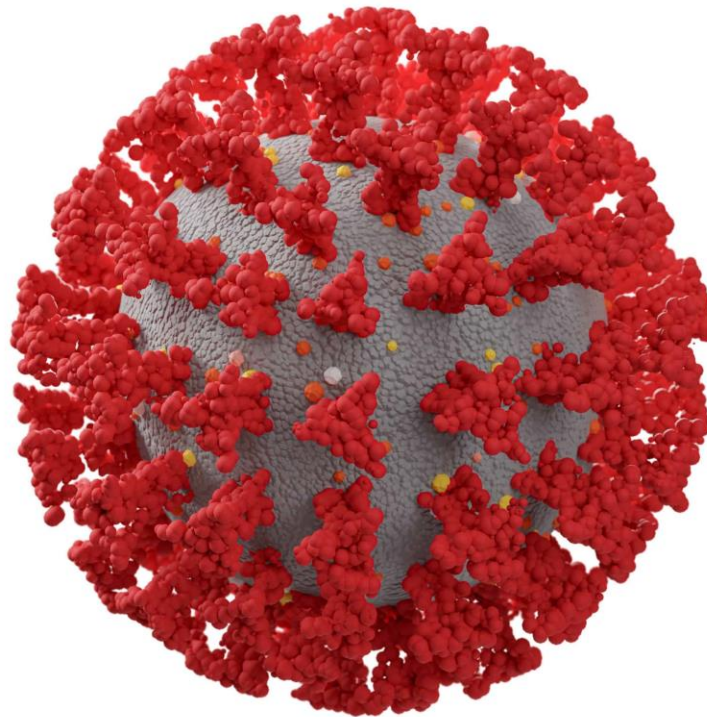
- Datorbaserade simuleringar av kliniska situationer

+Specifika lärandemål  
+Representativa fall

**Varför är det viktigt?**



**Varför är det viktigt?**



- Utmaningar att möta och undersöka patienter
- Behov av bra komplement om VFU inte kan tillgodose lärandemål



- Utmaningar att möta och undersöka patienter
- Behov av bra komplement om VFU inte kan tillgodose lärandemål
- **Virtuella patienter**



# Datorbaserade VP

Tyko



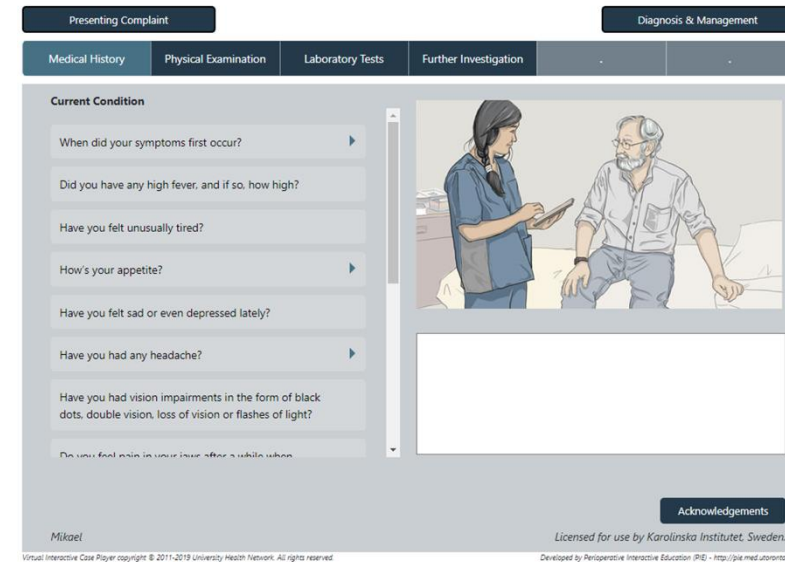
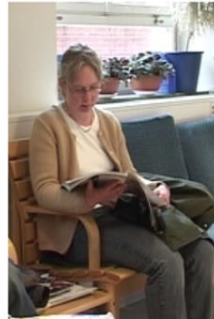
Lisa



Carl



Hedda



Presenting Complaint

Diagnosis & Management

Medical History Physical Examination Laboratory Tests Further Investigation

Current Condition

When did your symptoms first occur?

Did you have any high fever, and if so, how high?

Have you felt unusually tired?

How's your appetite?

Have you felt sad or even depressed lately?

Have you had any headache?

Have you had vision impairments in the form of black dots, double vision, loss of vision or flashes of light?

Do you feel pain in your knee after a while when...

Acknowledgements

Mikael

Licensed for use by Karolinska Institutet, Sweden.

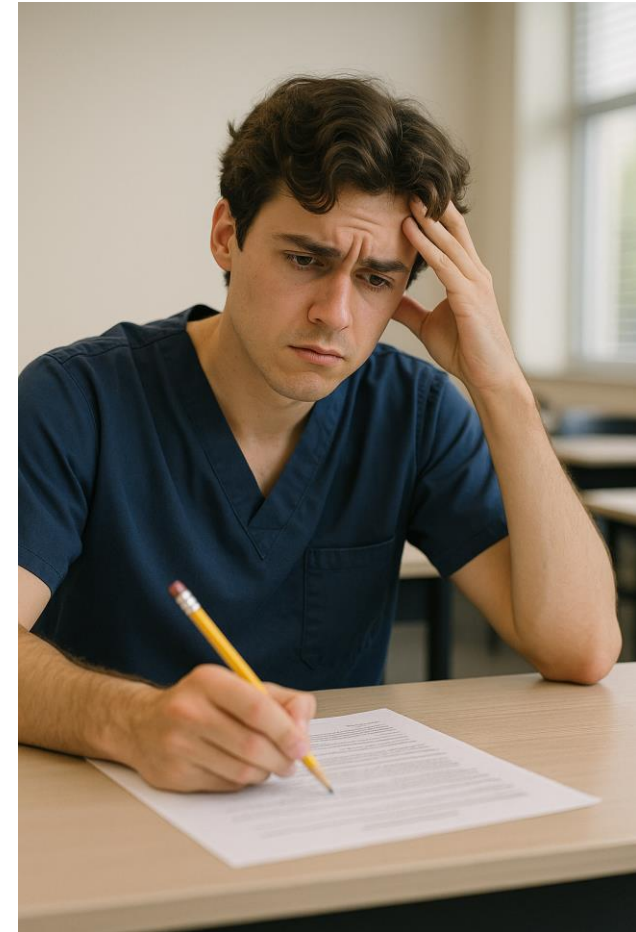
Virtual Interactive Case Player copyright © 2011-2019 University Health Network. All rights reserved.

Developed by Perioperative Interactive Education (PIE) - <http://pie.med.utoronto.ca>

- Traditionella datorbaserade fall är ofta semilinjära:
  - Samma början (fallpresentation) och avslut (preliminärdiagnostik och handläggning)
  - Fritt utforskande däremellan (anamnes, kliniska undersökningar, provtagning, bilddiagnostik, konsultation)
- ReumaCase
- Virtual Interactive Case System (VIC)

# Studentperspektivet

- **Vad tycker studenter?**
- Bra för att träna på kliniskt resonemang
- Saknar autenticitet som från riktiga patientmöten



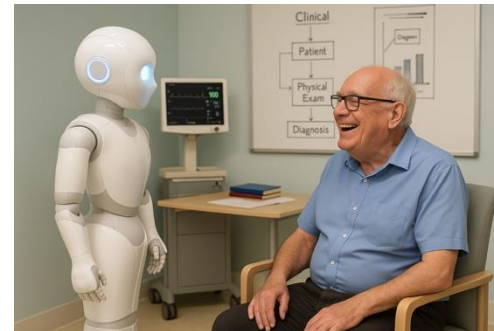
# Är robotar autentiska?

- Sociala robotar
- Människa-robot-interaktioner
  - Tal
  - Ansiktsuttryck
  - Gester
- Olika användningsområden



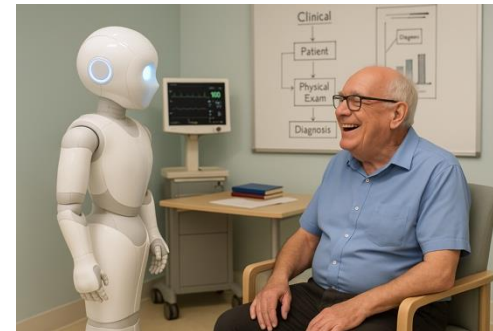
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# Är robotar autentiska?

- Sociala robotar
- Människa-robot-interaktioner
  - Tal
  - Ansiktsuttryck
  - Gester
- Olika användningsområden
- Utmaningar: fri dialog



- 2022



- 2022



- 2022



- 2022
- Artificiell intelligens (AI)
- Naturlig språkbehandling (Large Language Model; LLM)
- Nya sätt att skapa virtuella patienter?
- Mer autentiskt?



- Har ni positiva eller negativa erfarenheter av AI?
- Kan ni tänka er fördelar med AI inom utbildning?
- Kan ni tänka er nackdelar med AI inom utbildning?



# Introduktion

- Utvecklingen av stora språkmodeller (LLMs) möjliggör sofistikerade och avancerade dialogsystem.
- Olika tänkbara sätt att implementera
- Preliminära studier av VP-simulering med hjälp av AI har påbörjats men är jämfört med konventionella metoder för VP relativt outforskat.



*Att utveckla en ny AI-baserad social robotisk plattform  
för VP-simuleringar inom medicinsk utbildning, och  
undersöka dess förmåga att träna kliniskt resonemang  
och empatiskt beteende jämfört med en konventionell  
datorbaserad VP-plattform*



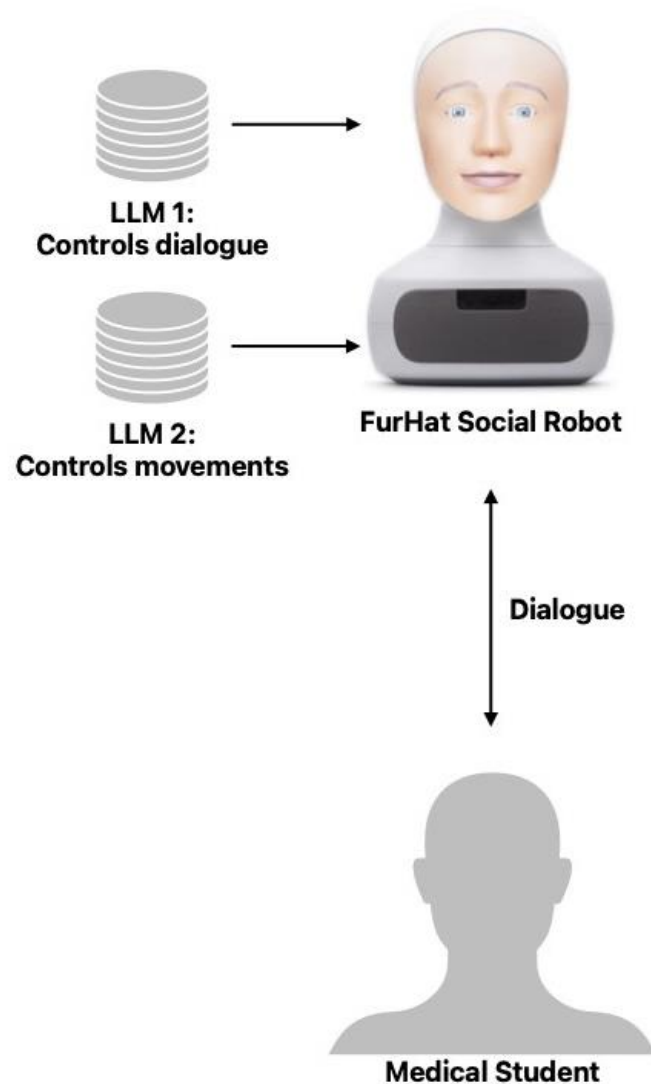
# Vad gjorde vi?



**Social AI-enhanced robotic interface**

**SARI**





Mikael is about to meet his physician for the first time. Mikael is a 68-year-old man who made an appointment a few days back. Apart from the age and sex of the patient, the only information the physician has is that Mikael has sought care because of “ache in the body”.

**The following is some information about Mikael’s condition [shortened]:**

- He has always been healthy and has not felt any pain similar to that he is seeking for now.
- Sometimes, he experiences back pain, but it has never been present for that long and it has not had the same character.
- In Mikael’s medical charts, it is stated that his blood lipids are above normal.
- Mikael has been advised to eat healthier to avoid developing diabetes and lower his blood lipids.
- Mikael has had a stable blood pressure since he has been on anti-hypertensive treatment.

**The following is a dialogue between Mikael and his physician:**

- Mikael: Hi doctor.
- Physician: Hello Mikael, my name is Morgan.
- Mikael: Nice to meet you, Morgan. Thanks for seeing me.
- Physician: Of course! Could you describe why you are here today?

**Write the next line that Mikael would say.**

- Nya läkarprogrammet



- Alla studenter termin 6 obligatorisk undervisning inom reumatologi
- ~140–160 studenter per termin under totalt 6 veckor
- **Behov: Tillgodose lärandemål för samtliga studenter**



- Nya läkarprogrammet



- Alla studenter termin 6 obligatorisk undervisning inom reumatologi
- ~150–160 studenter per termin under totalt 6 veckor
- **Lösning: Virtuella mottagningen**



- 20–25 studenter per vecka

- VFU

- Teori

- Virtuella patienter

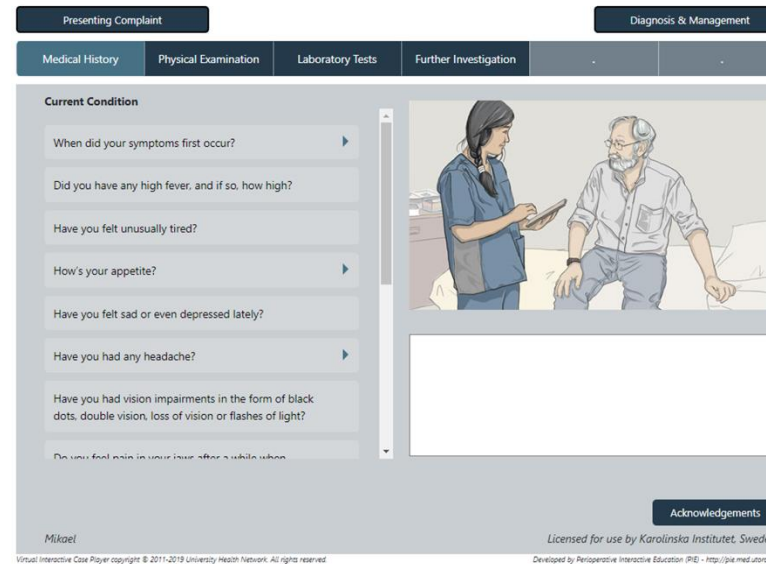


- 10–12 studenter per dag vid den virtuella mottagningen



# Virtuella mottagningen

## ➤ VIC och SARI



- Totalt 10 fall; 4 unika i vardera plattform; 1 är identiskt
  - Hälften börjar med SARI och hälften med VIC
  - Parvis eller grupper om 3 görs totalt 9 unika fall
  - Fall avslutas genom att studenter ställer preliminär diagnos föreslår åtgärdsplan
- Seminarium efter varje avslutat fall i storgrupp för diskussion och frågor.

- Kontinuerligt
- Kvalitativt
  - Kliniskt resonemang
  - Empati

## Introduction

- Presentation.
- Purpose of the interview: “explore perceptions and experiences from the usage of virtual patient cases through an AI-driven social robot as compared with a conventional semi-linear computer-based platform, for the training of clinical reasoning skills”.
- Tell about the number of interviews and recruitment.
- Contact information, neutrality, and pseudonymity – personal information will be saved on locked servers and coded during analysis. Reported in aggregated level.
- Informed consent form.

## Background

- Can you tell me a little bit about your background? Which semester are you attending at the medical programme at this moment and what clinical rotation or course are you attending right now?

## Virtual patient cases

- Where were you located when you did the cases? What were your perceptions and thoughts going into this activity? Did you prepare for the activity in any way?
- Did you feel like you got the time that you needed to perform the educational activity? Would you have liked more time or less time?
- How “close” did you feel towards the patient? Did you feel like the physician attending the patient? What are your thoughts regarding the patient encounter?
- What skills did you feel like you got to practice during these virtual patient cases?
- Can virtual patient cases be a complement to meeting real-life patients in the clinic? (quality of the patient encounter)
- Can you please elaborate what the word clinical reasoning means to you?
- Is there any other instance, or anything else you can think of, where virtual patient simulations can be of benefit if implemented? (A test? Examination? Learning through failure? Etc...)

## Comparison of the platforms:

- Could you please describe your experience using the AI-driven social robotic platform for virtual patient simulations? What aspects of the platform stood out to you in terms of facilitating clinical reasoning skill development?



# Kliniskt resonemang

- Skattningskalor kliniskt resonemang indelade i 7 teman:
  1. Autenticitet i patientmötet (graderat 1–5)
  2. Professionellt förhållningssätt (graderat 1–5)
  3. Coaching under konsultation (graderat 1–5)
  4. Lärandeeffekten av konsultationen (graderat 1–5)
  5. Sammanfattande bedömning av fallet (graderat 1–5)
  6. Särskilda styrkor med fallet/plattformen (kortsvar)
  7. Särskilda svagheter med fallet/plattformen (kortsvar)
- Totalt 14 frågor/påståenden där de första 12 motsvarar tema 1–5. 1 poäng motsvarar "strong disagreement" och 5 poäng motsvarar "strong agreement".
- Tema 6 och 7 utvärderades med korta svar i fritext.



# Utvärdering

- Kvantitativt
  - Kliniskt resonemang
  - Empati

**Authenticity of patient encounter and the consultation**

While working on this case, I felt I had to make the same decisions a clinician would make in real life.

| Social robot                                                                                                                                                                                                              | Computer-based platform                                                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <input type="radio"/> Strongly agree<br><input type="radio"/> Agree<br><input type="radio"/> Neutral<br><input type="radio"/> Disagree<br><input type="radio"/> Strongly disagree<br><input type="radio"/> Not applicable | <input type="radio"/> Strongly agree<br><input type="radio"/> Agree<br><input type="radio"/> Neutral<br><input type="radio"/> Disagree<br><input type="radio"/> Strongly disagree<br><input type="radio"/> Not applicable |
| <a href="#">reset</a>                                                                                                                                                                                                     | <a href="#">reset</a>                                                                                                                                                                                                     |

Please indicate briefly the reason(s) for your response to the question above (optional)

[Expand](#)

While working on this case, I felt I were the clinician caring for this patient

| Social robot                                                                                                                                                                                                              | Computer-based platform                                                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <input type="radio"/> Strongly agree<br><input type="radio"/> Agree<br><input type="radio"/> Neutral<br><input type="radio"/> Disagree<br><input type="radio"/> Strongly disagree<br><input type="radio"/> Not applicable | <input type="radio"/> Strongly agree<br><input type="radio"/> Agree<br><input type="radio"/> Neutral<br><input type="radio"/> Disagree<br><input type="radio"/> Strongly disagree<br><input type="radio"/> Not applicable |
| <a href="#">reset</a>                                                                                                                                                                                                     | <a href="#">reset</a>                                                                                                                                                                                                     |

Please indicate briefly the reason(s) for your response to the question above (optional)

[Expand](#)



Rheumatology International (2024) 44:3041–3051  
<https://doi.org/10.1007/s00296-024-05731-0>

## OBSERVATIONAL RESEARCH



# Enhancing clinical reasoning skills for medical students: a qualitative comparison of LLM-powered social robotic versus computer-based virtual patients within rheumatology

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1. Autenticitet
2. Implementering
3. Styrkor & svagheter



- Ökad inlevelse och realism med robot
  - ansiktsuttryck, fri formulering och direkt kommunikation

*Det var en direkt kontakt med roboten. Att ha en riktig röst gör mycket.  
Det kändes väldigt likt ett riktigt patientbesök.*



- Positivt med samarbete i små grupper
  - Aktiv diskussion

*Det var bra att göra fallen med två eller tre [studenter] som satt gemensamt, så man kunde diskutera som man gör på kliniken.*



- Emellanåt mekanisk dialog, något statiskt jämfört med riktiga patienter
- Bra möjlighet att träffa representativa patienter

*När man pratade med roboten så behövde man säga sammanhängande meningar, [...] ibland, om du pausade och tänkte i mitten av en mening blev du avbruten med att den började sitt svar. Det kändes som ett hinder.*



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JOURNAL OF MEDICAL INTERNET RESEARCH

Borg et al

Original Paper

## Virtual Patient Simulations Using Social Robotics Combined With Large Language Models for Clinical Reasoning Training in Medical Education: Mixed Methods Study

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Alexander Borg<sup>1</sup>, MD; Carina Georg<sup>2</sup>, PhD; Benjamin Jobs<sup>1</sup>; Viking Huss<sup>3</sup>, MD; Kristin Waldenlind<sup>3</sup>, MD, PhD; Mini Ruiz<sup>4</sup>, MD, PhD; Samuel Edelbring<sup>5,6</sup>, PhD; Gabriel Skantze<sup>7</sup>, PhD; Ioannis Parodis<sup>1,8</sup>, MD, PhD

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<sup>3</sup>Division of Clinical Epidemiology, Department of Medicine Solna, Karolinska Institutet, Karolinska University Hospital, Stockholm, Sweden

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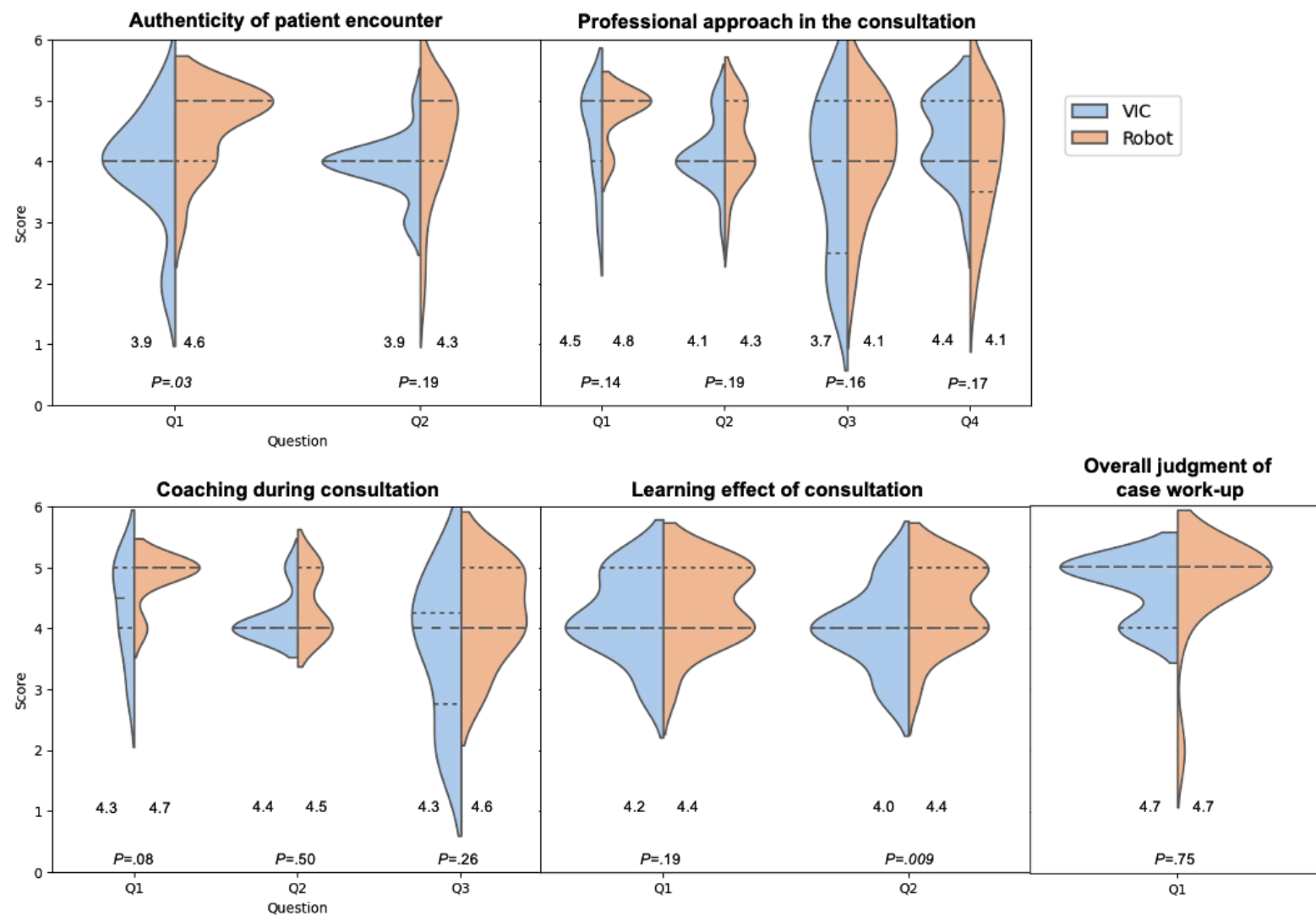
<sup>6</sup>School of Education, Culture and Communication, Mälardalen University, Västerås, Sweden

<sup>7</sup>Division of Speech Music and Hearing, Royal Institute of Technology, Stockholm, Sweden

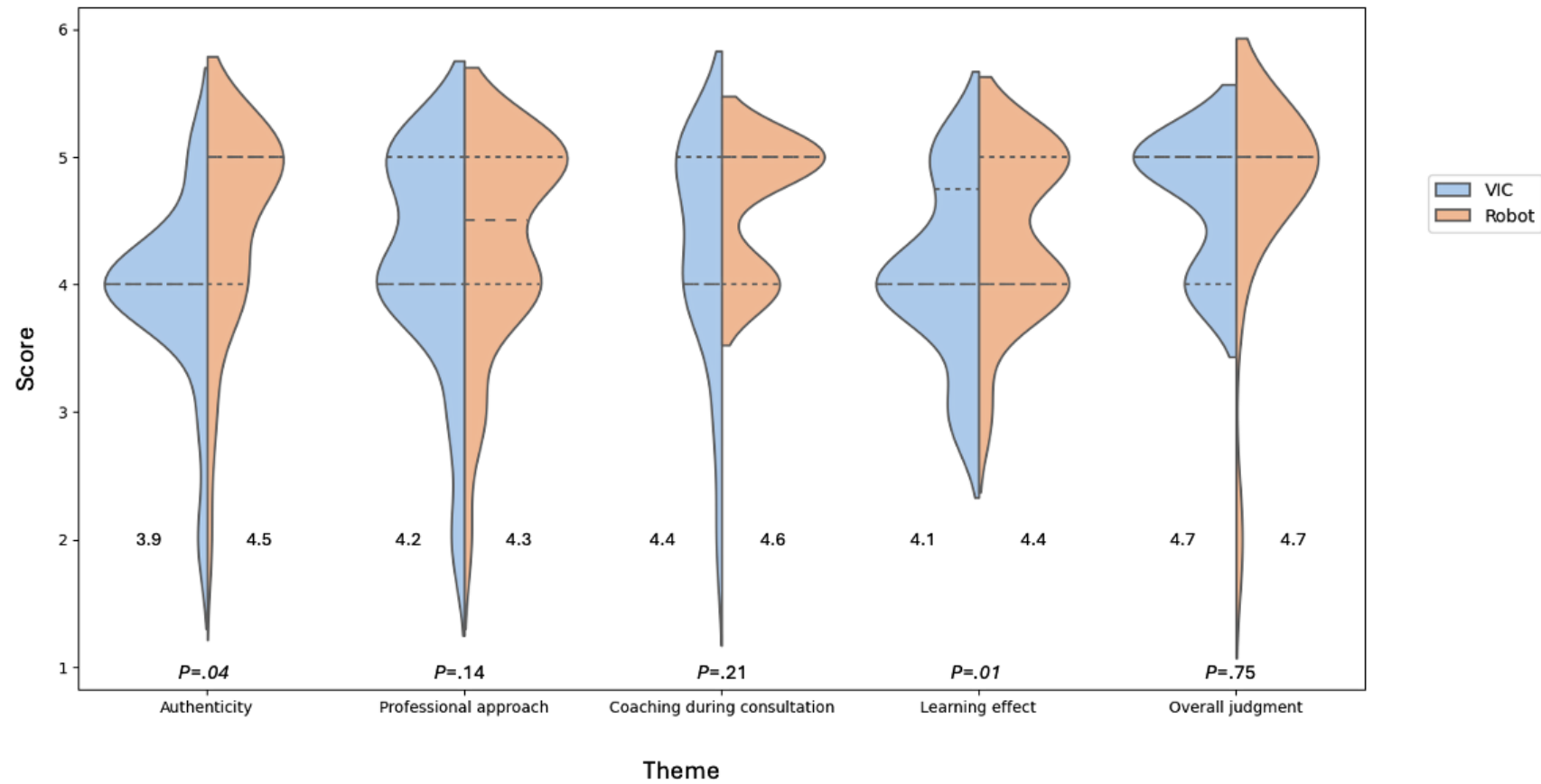
<sup>8</sup>Department of Rheumatology, Faculty of Medicine and Health, Örebro University and Örebro University Hospital, Örebro, Sweden



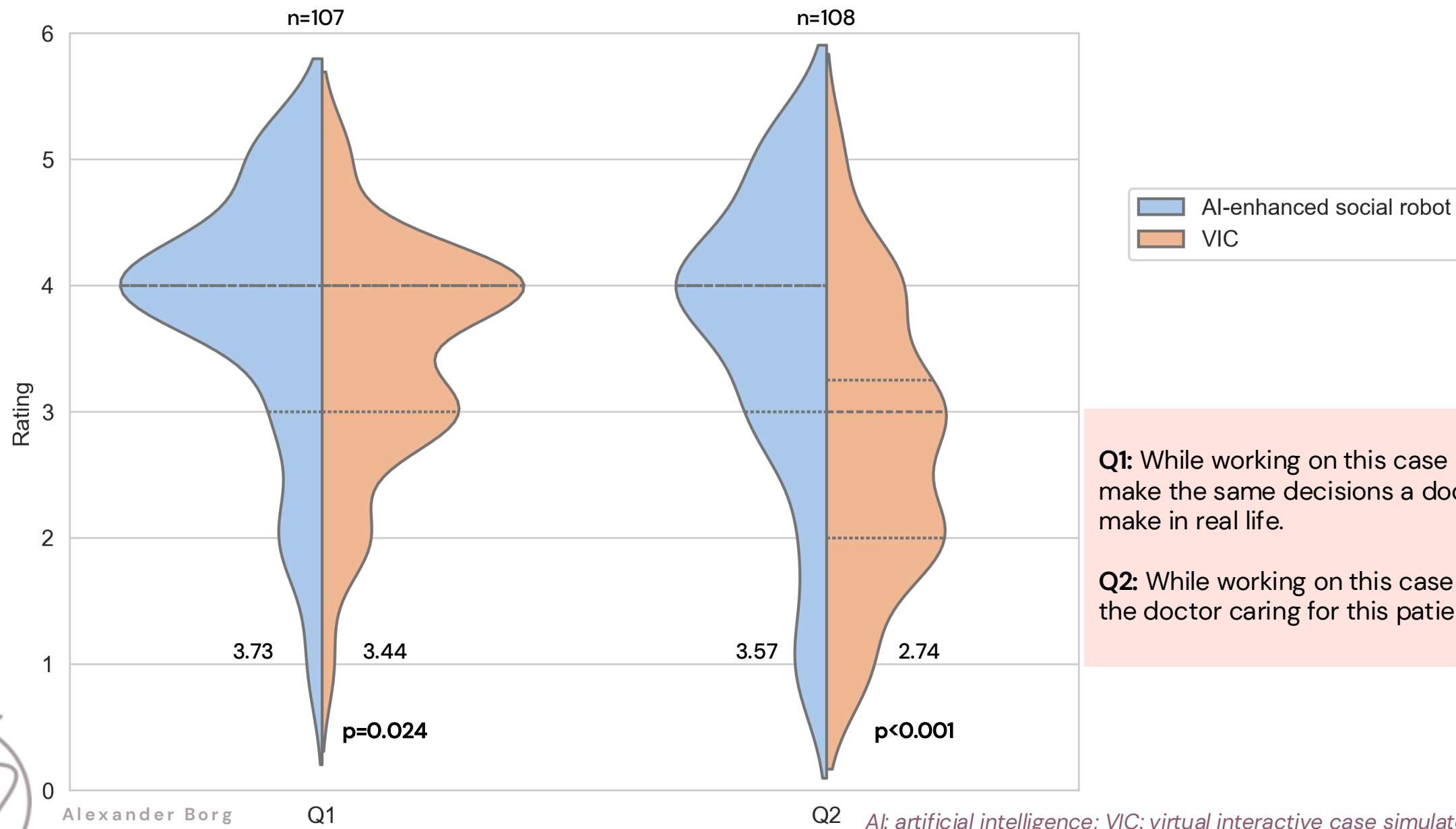
N = 15



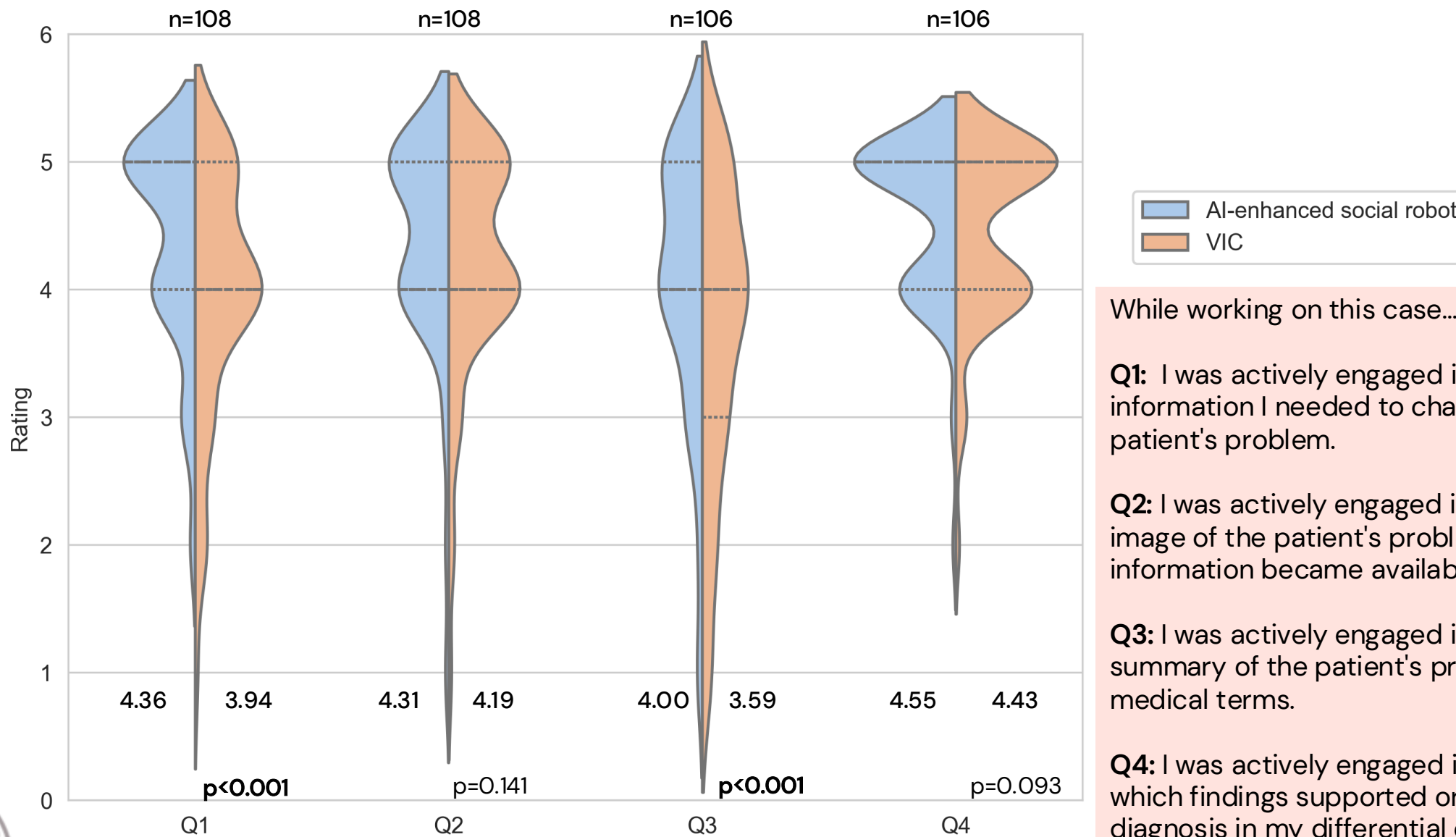
N = 15



# Preliminära resultat: authenticity



# Preliminära resultat: professional approach



While working on this case...

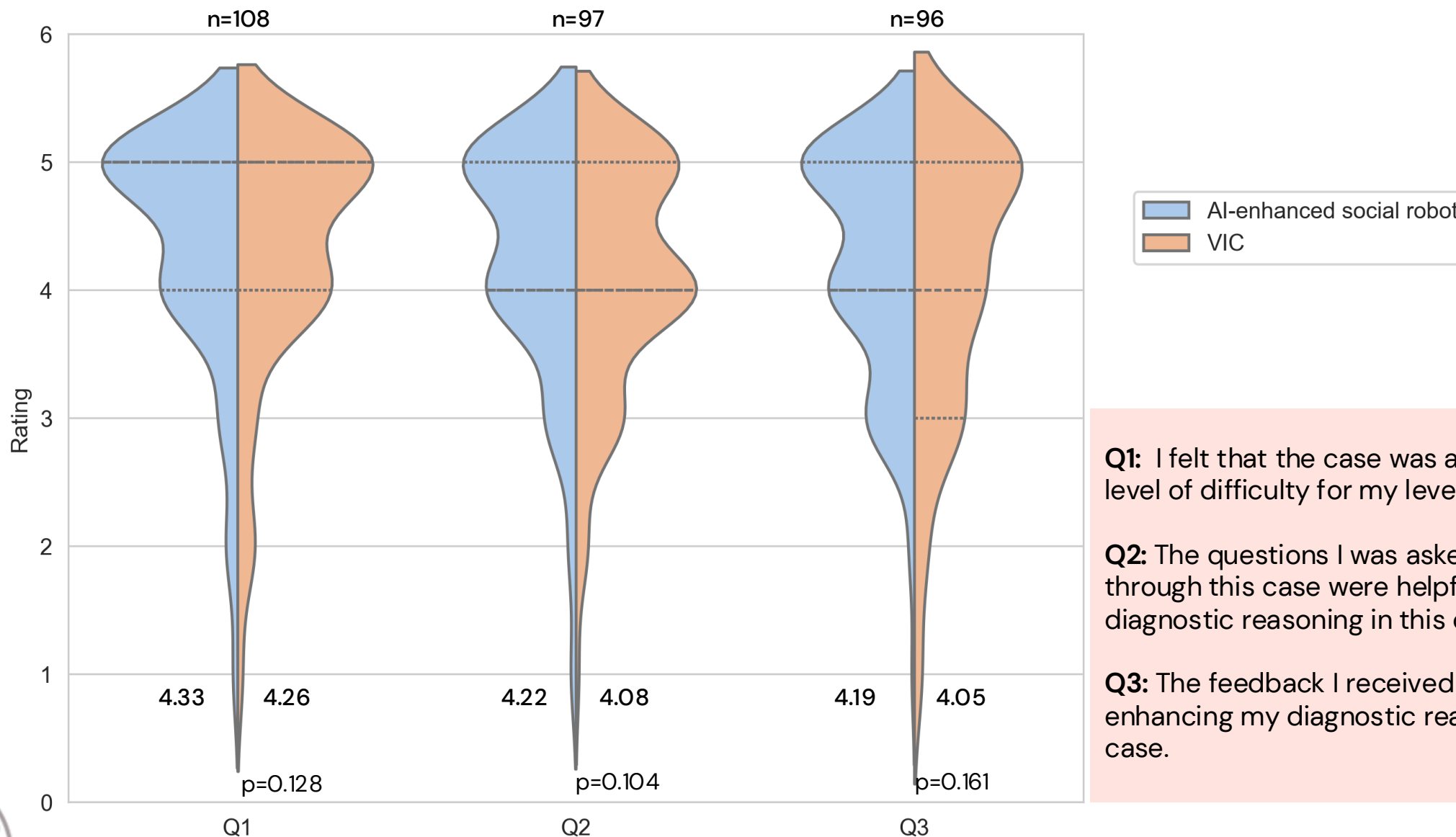
**Q1:** I was actively engaged in gathering the information I needed to characterise the patient's problem.

**Q2:** I was actively engaged in revising my initial image of the patient's problem as new information became available.

**Q3:** I was actively engaged in creating a short summary of the patient's problem using medical terms.

**Q4:** I was actively engaged in thinking about which findings supported or refuted each diagnosis in my differential diagnosis.

# Preliminära resultat: coaching during consultation

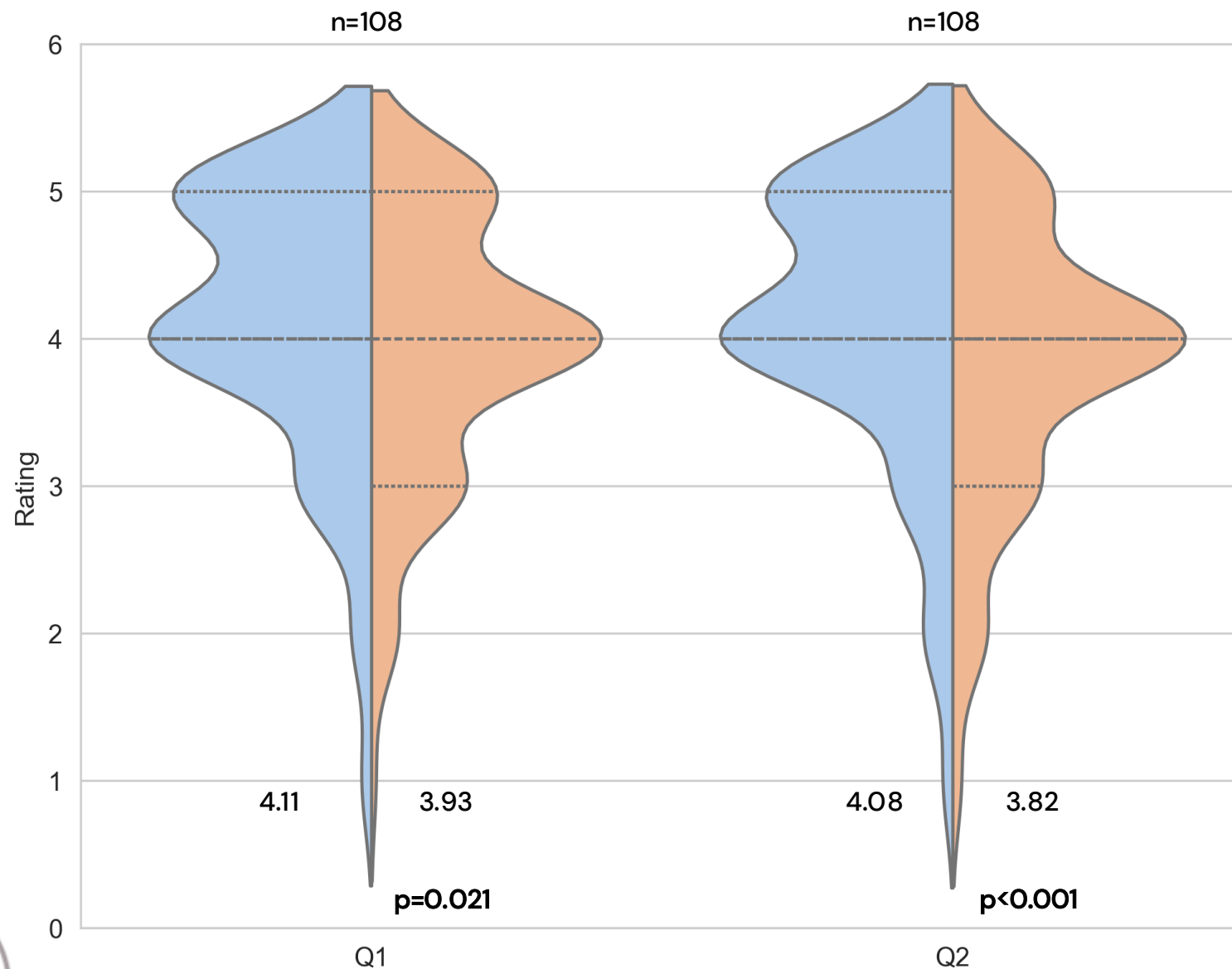


**Q1:** I felt that the case was at the appropriate level of difficulty for my level of training.

**Q2:** The questions I was asked while working through this case were helpful in enhancing my diagnostic reasoning in this case.

**Q3:** The feedback I received was helpful in enhancing my diagnostic reasoning in this case.

# Preliminära resultat: learning effect

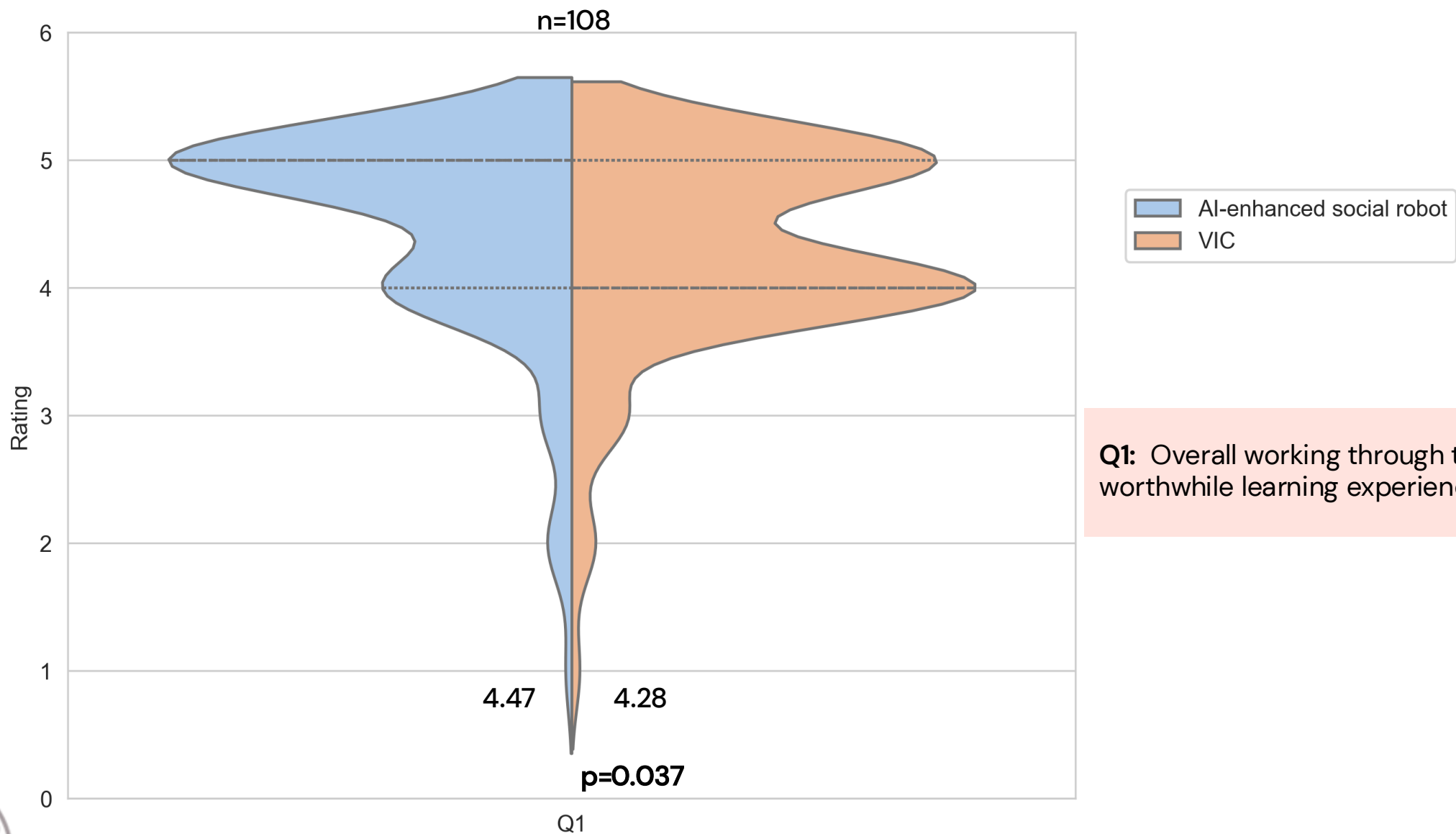


After completing this case...

**Q1:** I feel better prepared to confirm a diagnosis and exclude differential diagnoses in a real-life patient with this complaint.

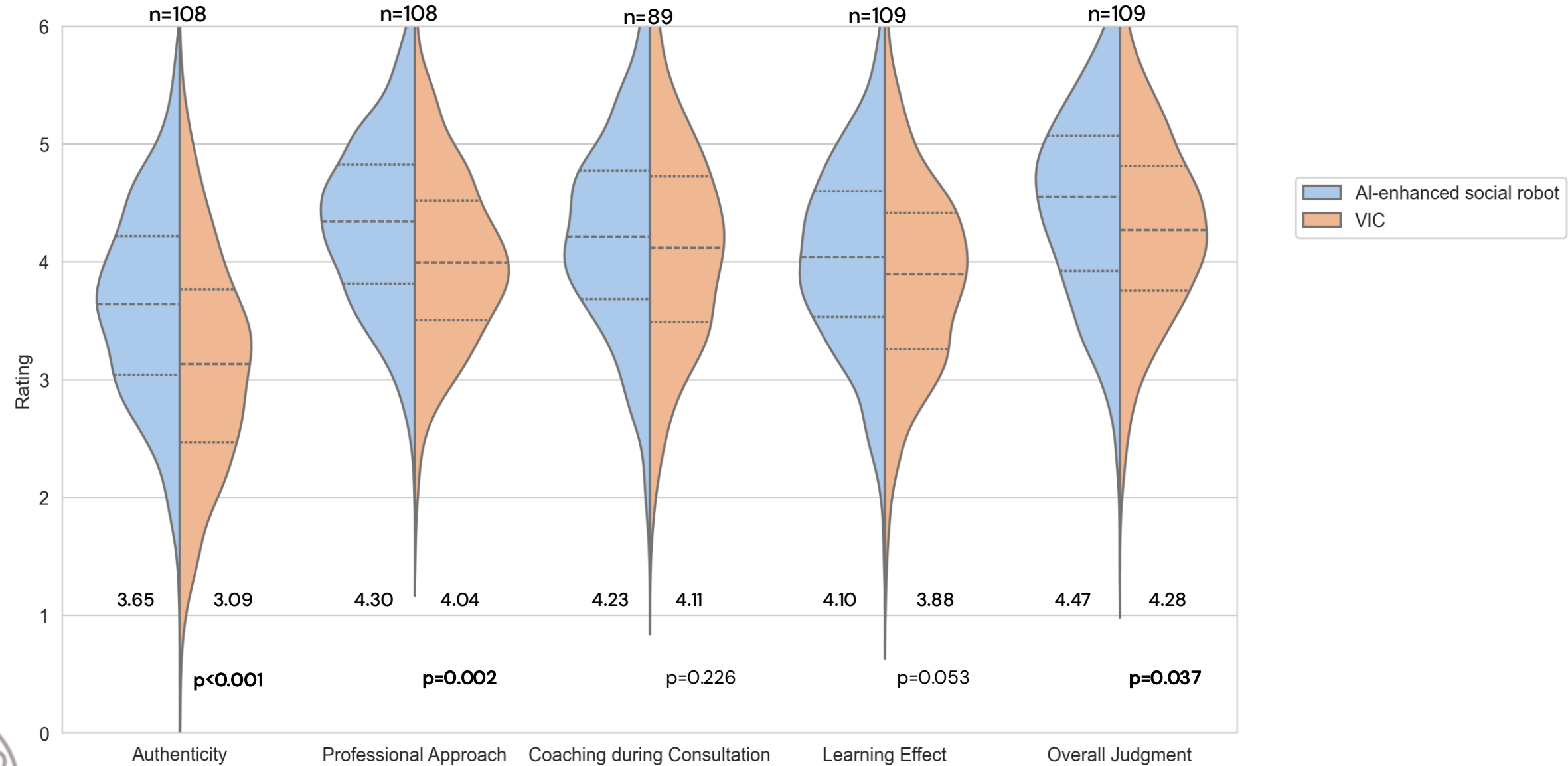
**Q2:** I feel better prepared to care for a real-life patient with this complaint.

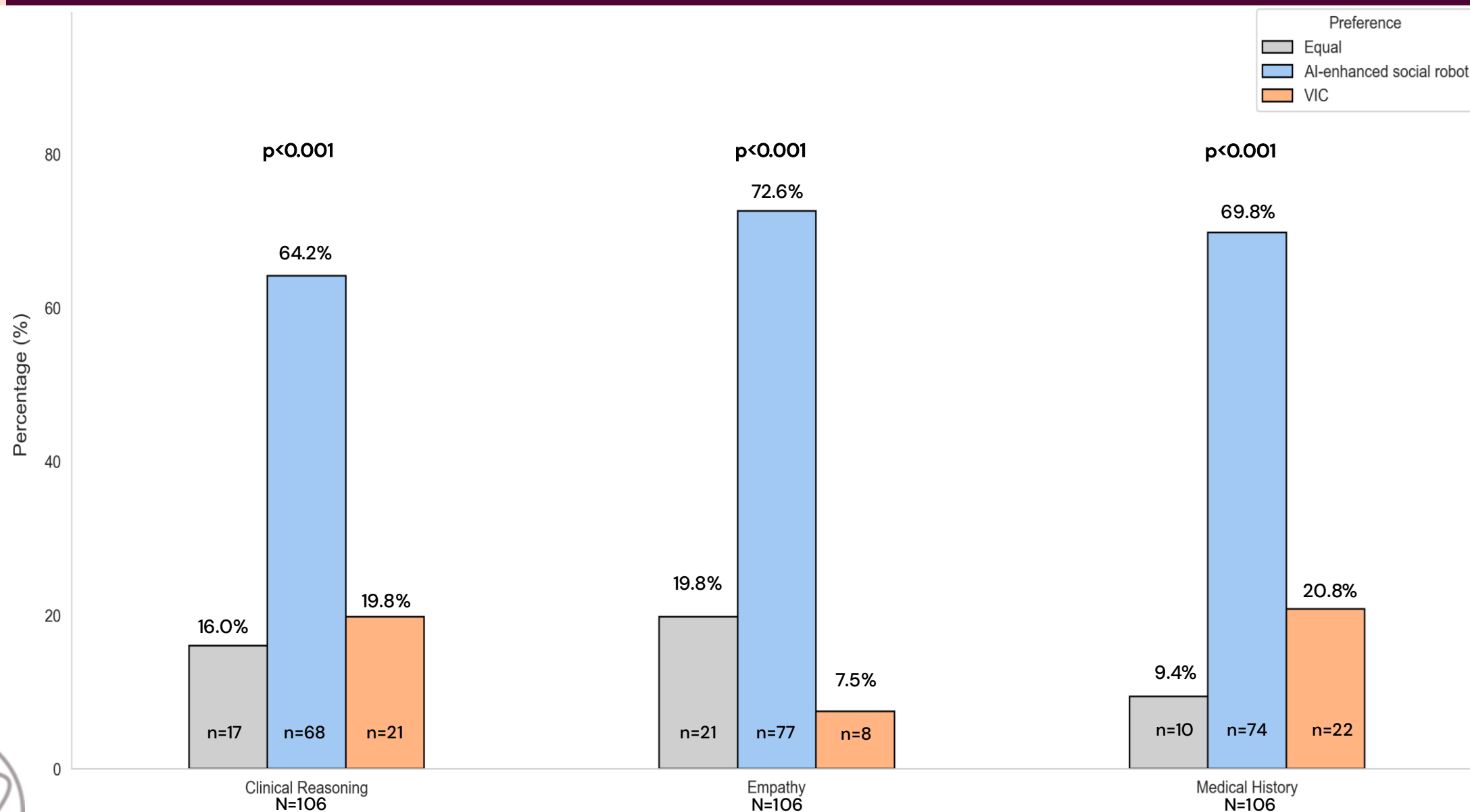
# Preliminära resultat: overall judgment



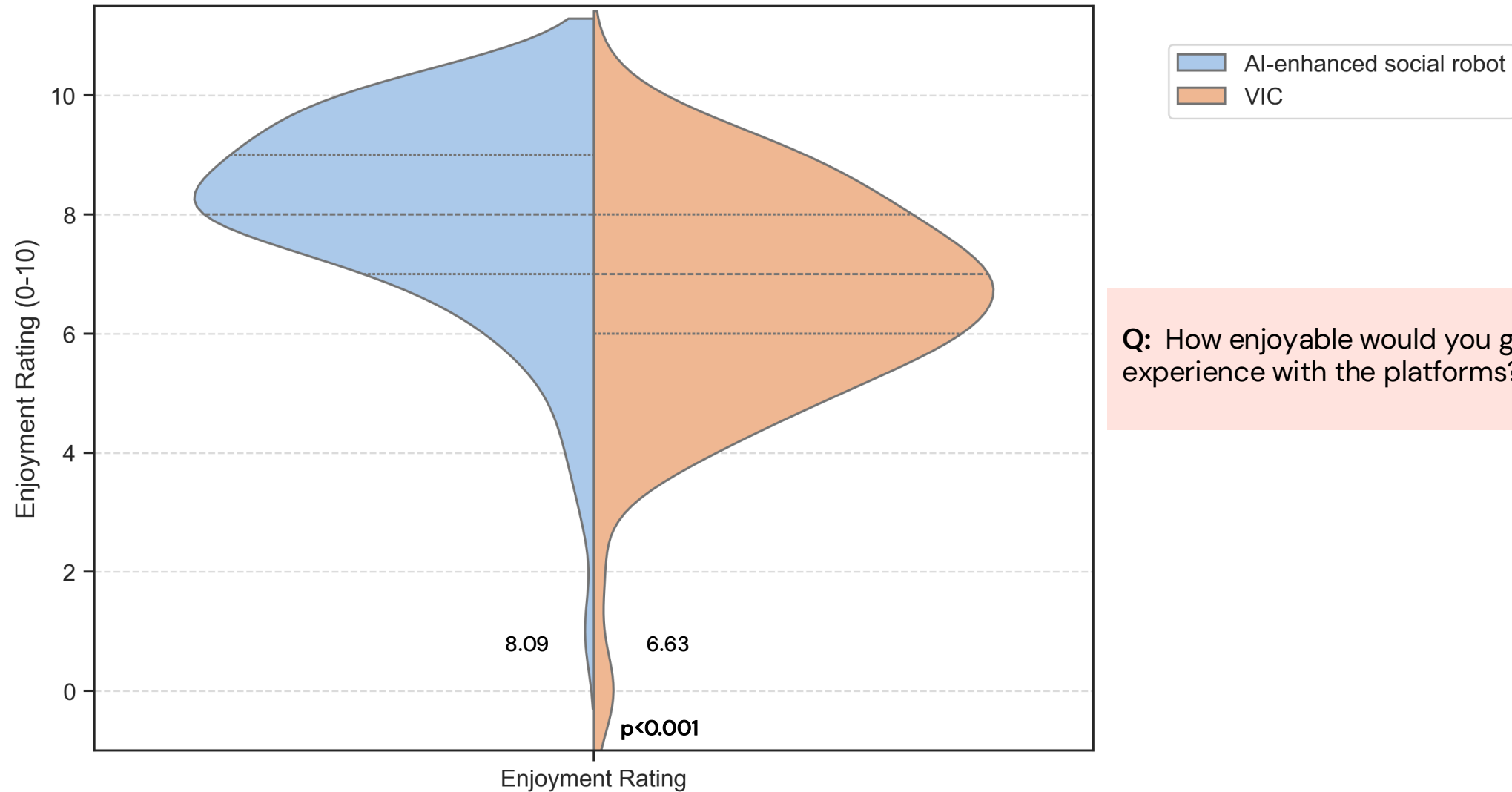
**Q1:** Overall working through this case was a worthwhile learning experience.

# Summerade resultat



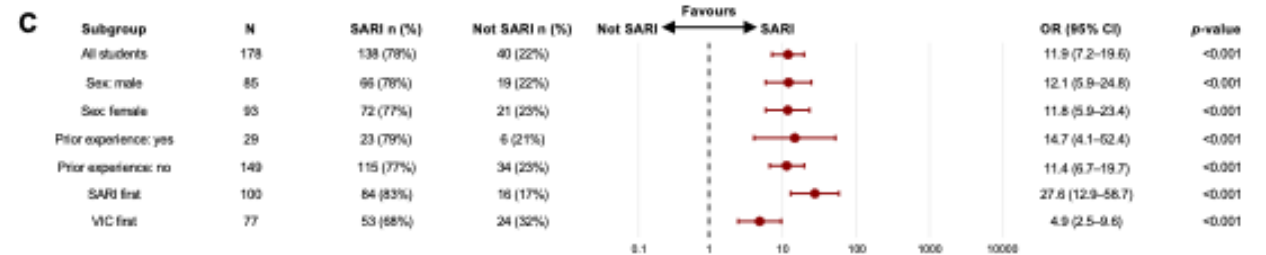
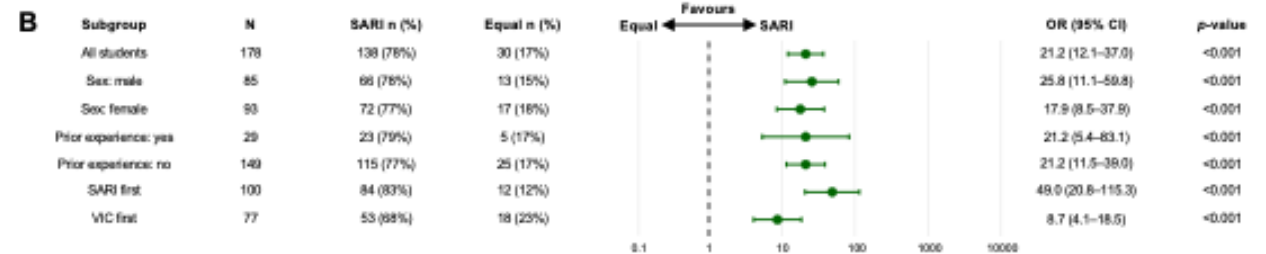
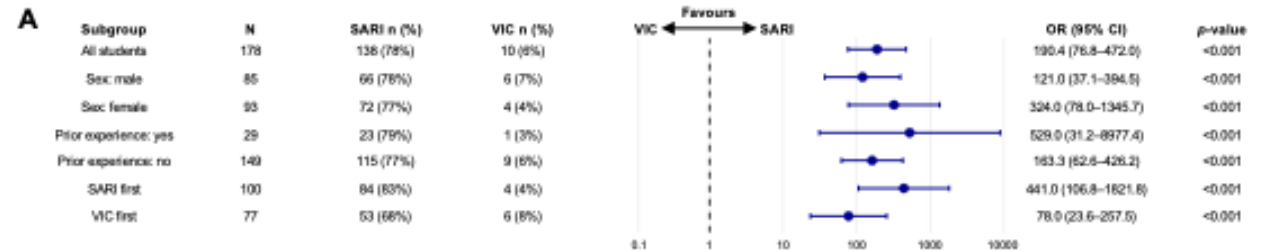


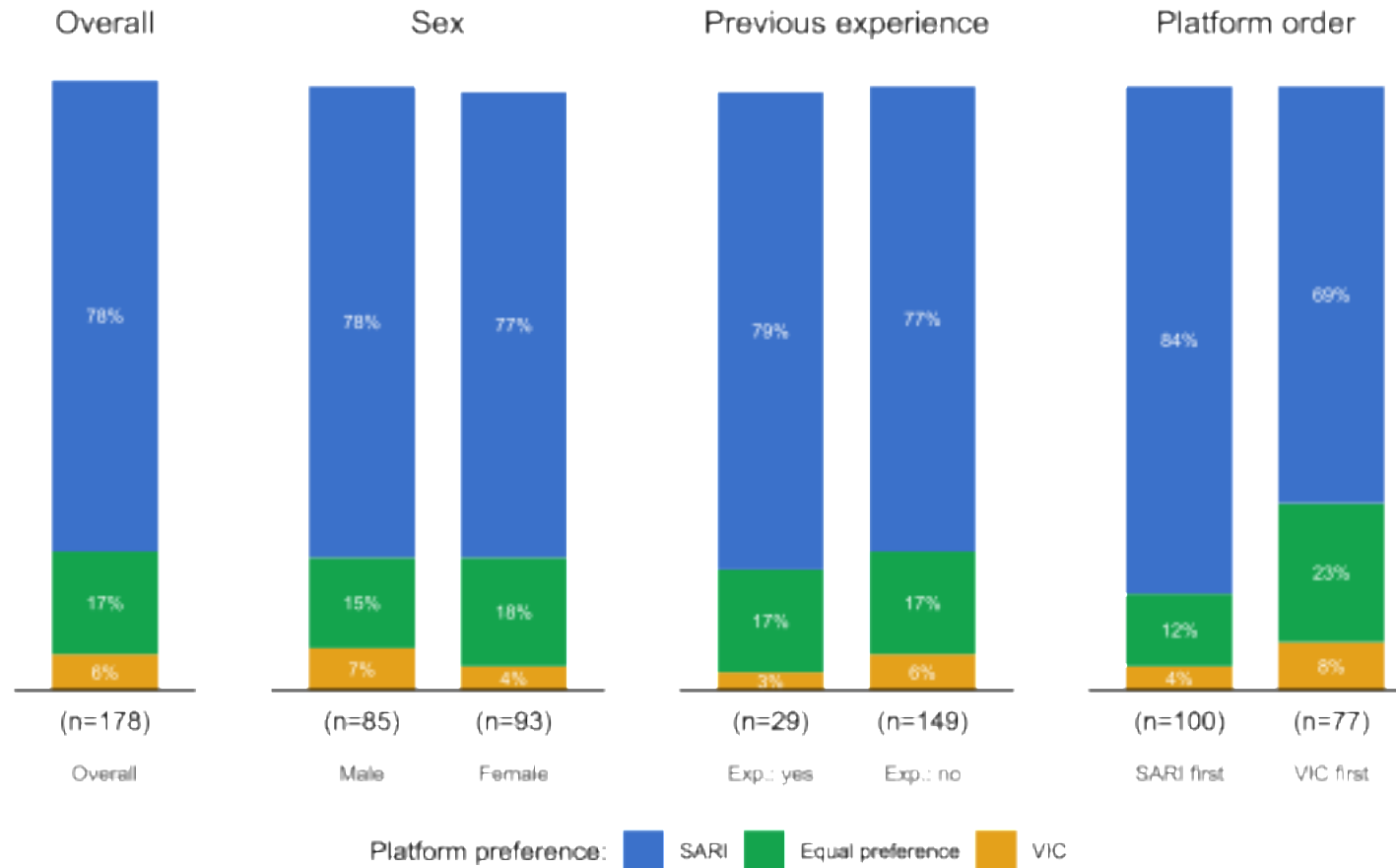
Platform Enjoyment Ratings



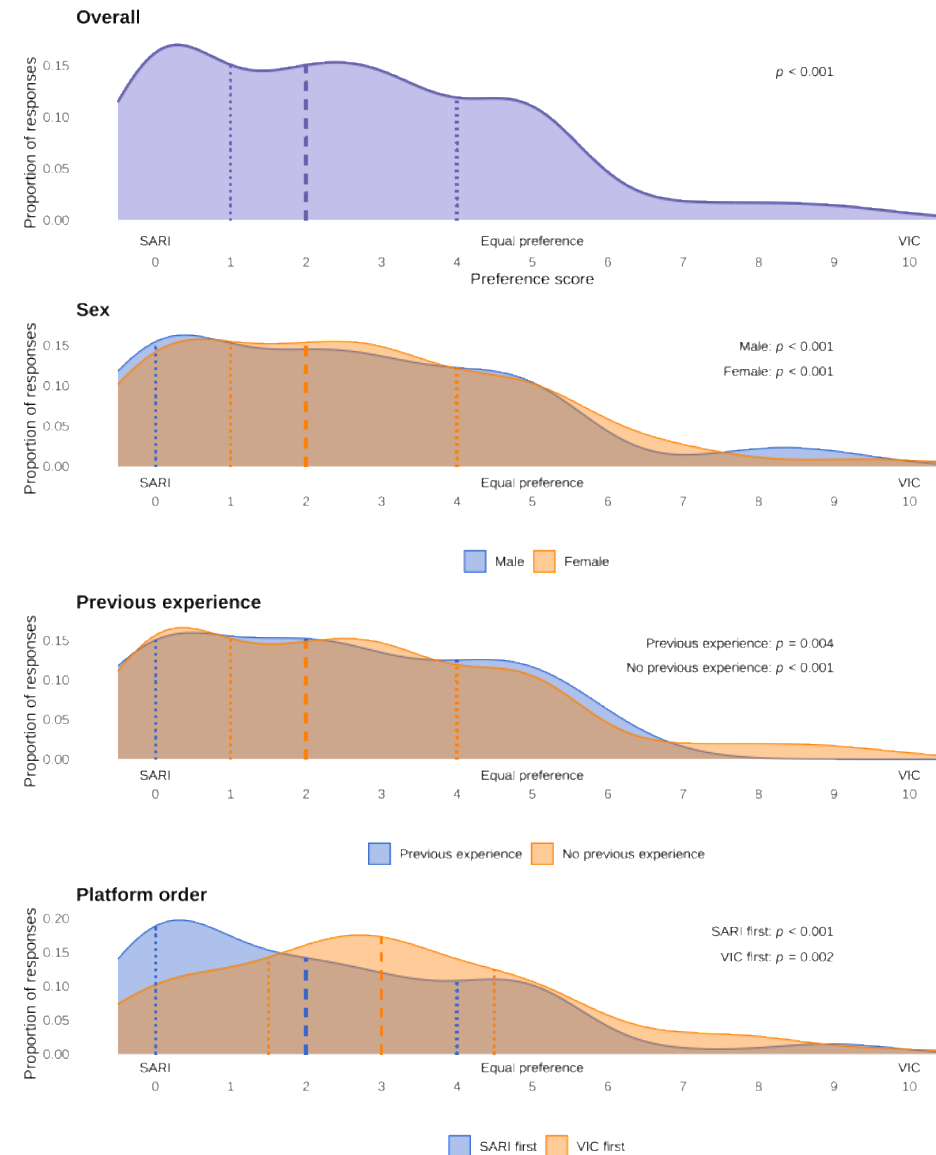
Q: How enjoyable would you grade your total experience with the platforms?

- Överlag, vilken av plattformarna föredrar du i relation till empati?
- SARI
- VIC
- Föredrar båda likvärdigt

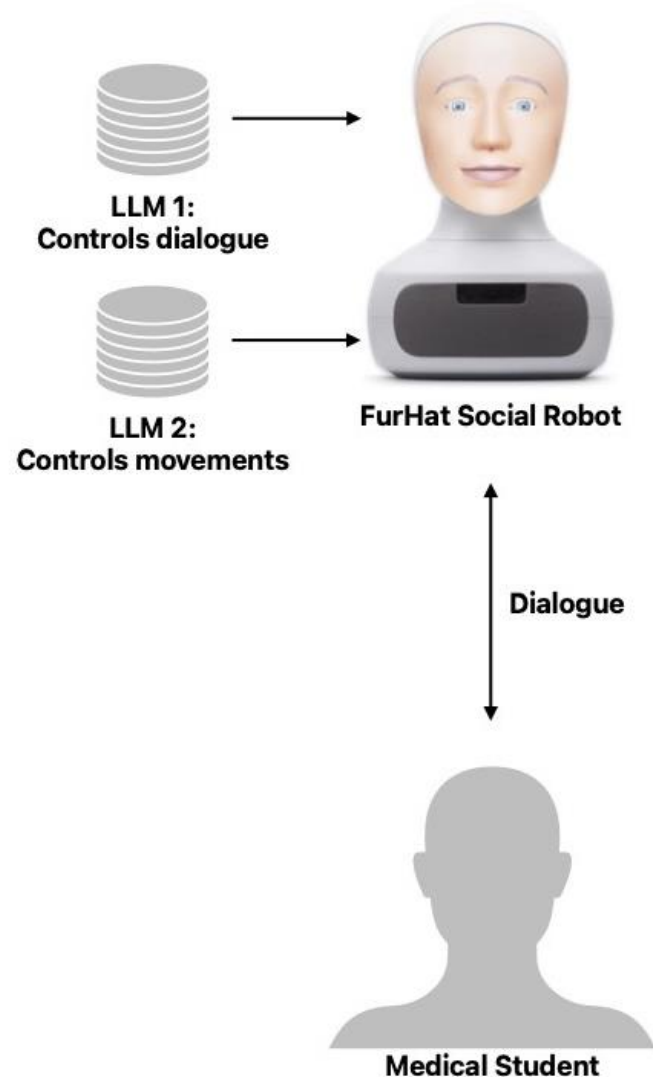




- Visuell analog skala
- På en skala mellan 0–10, där
  - 0= full preferens för SARI
  - 10= full preferens för VIC



# AI-generated feedback



0:00 / 15:17

Good day, doctor. I've been having problems with my swelling hands, and loss of strength. It has been gradually become worse and now it's entirely unbearable.

okay when did it started

It started a few months back with swelling in my left hand, but then I started experiencing loss of strength and mobility in both my hands, and now it's getting harder to move around as well.

anything else besides the weakness and symptoms in the hands

Yes, I have also been experiencing difficulties with walking and rising from a sitting position. I've been losing weight rapidly, and my appetite has decreased due to difficulty swallowing.

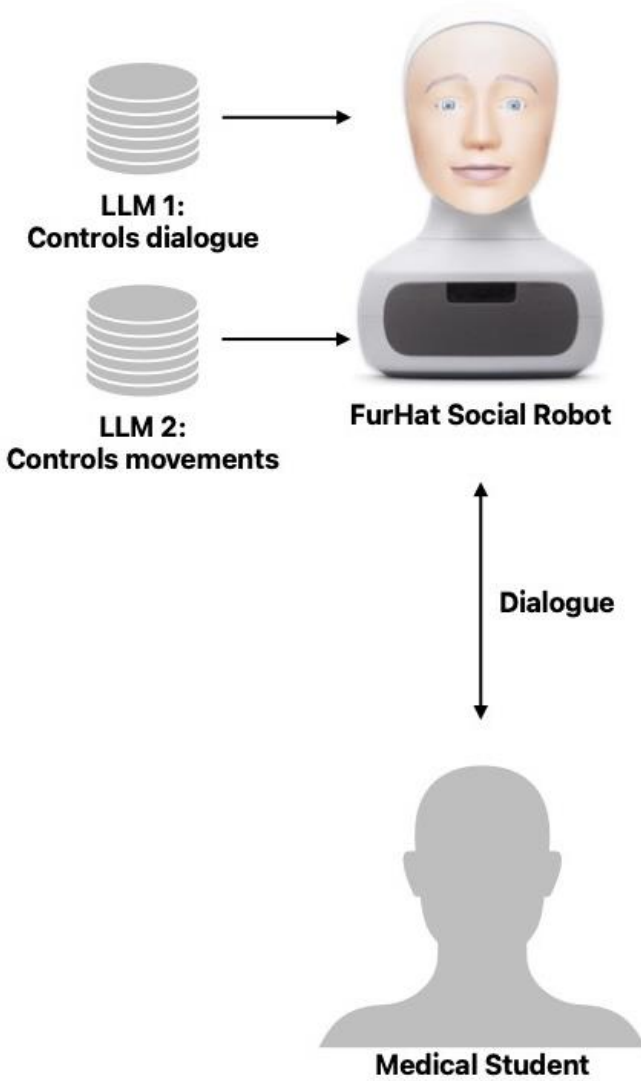
okay so do you feel also weakness in your um legs

Yes, I have also been experiencing difficulties to walk in stairs and carrying heavier objects.

but it started first in the hands

Yes, that's correct. The symptoms started with swelling in my left hand without any redness or tenderness.

# AI-genererad feedback

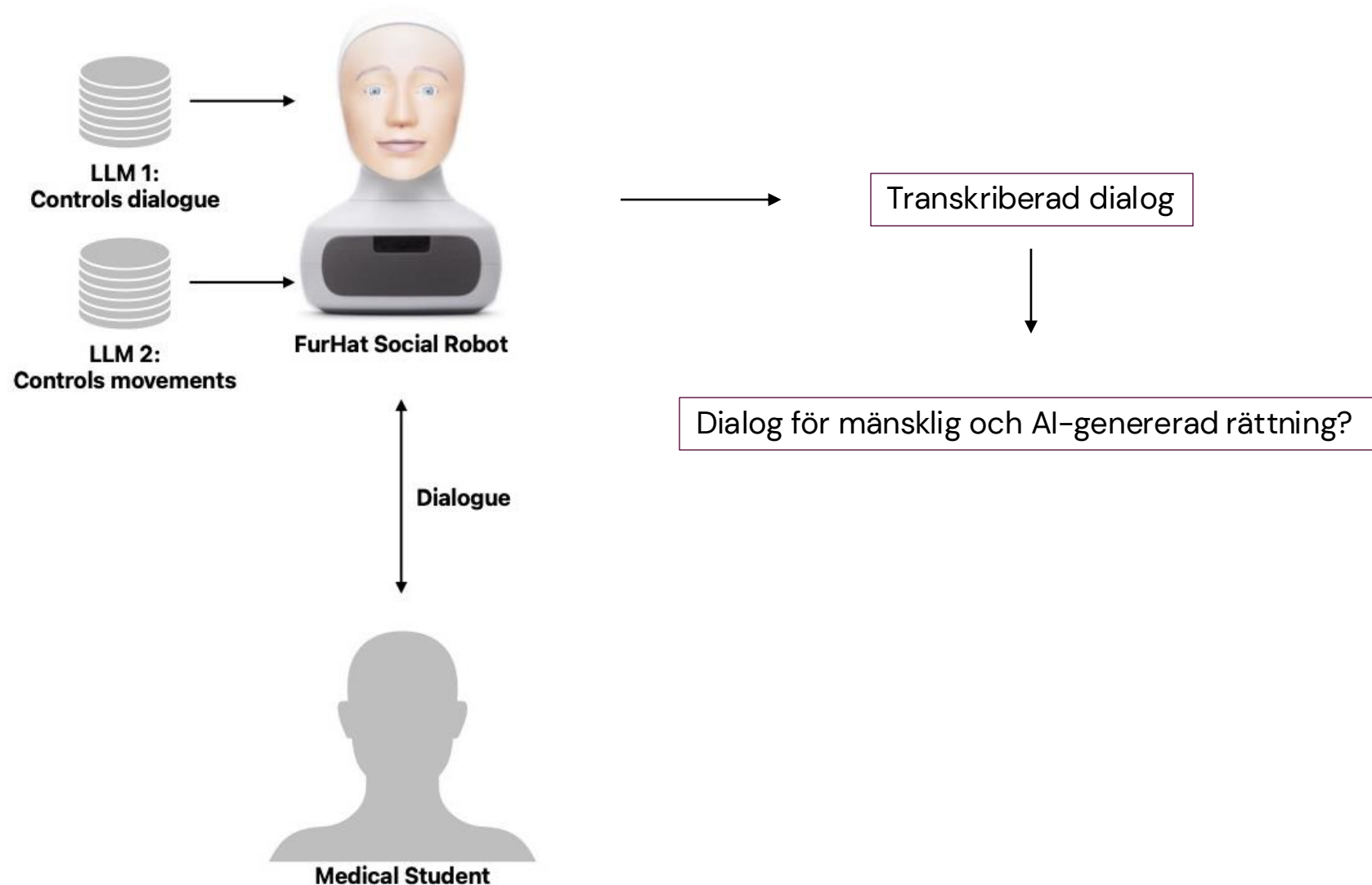


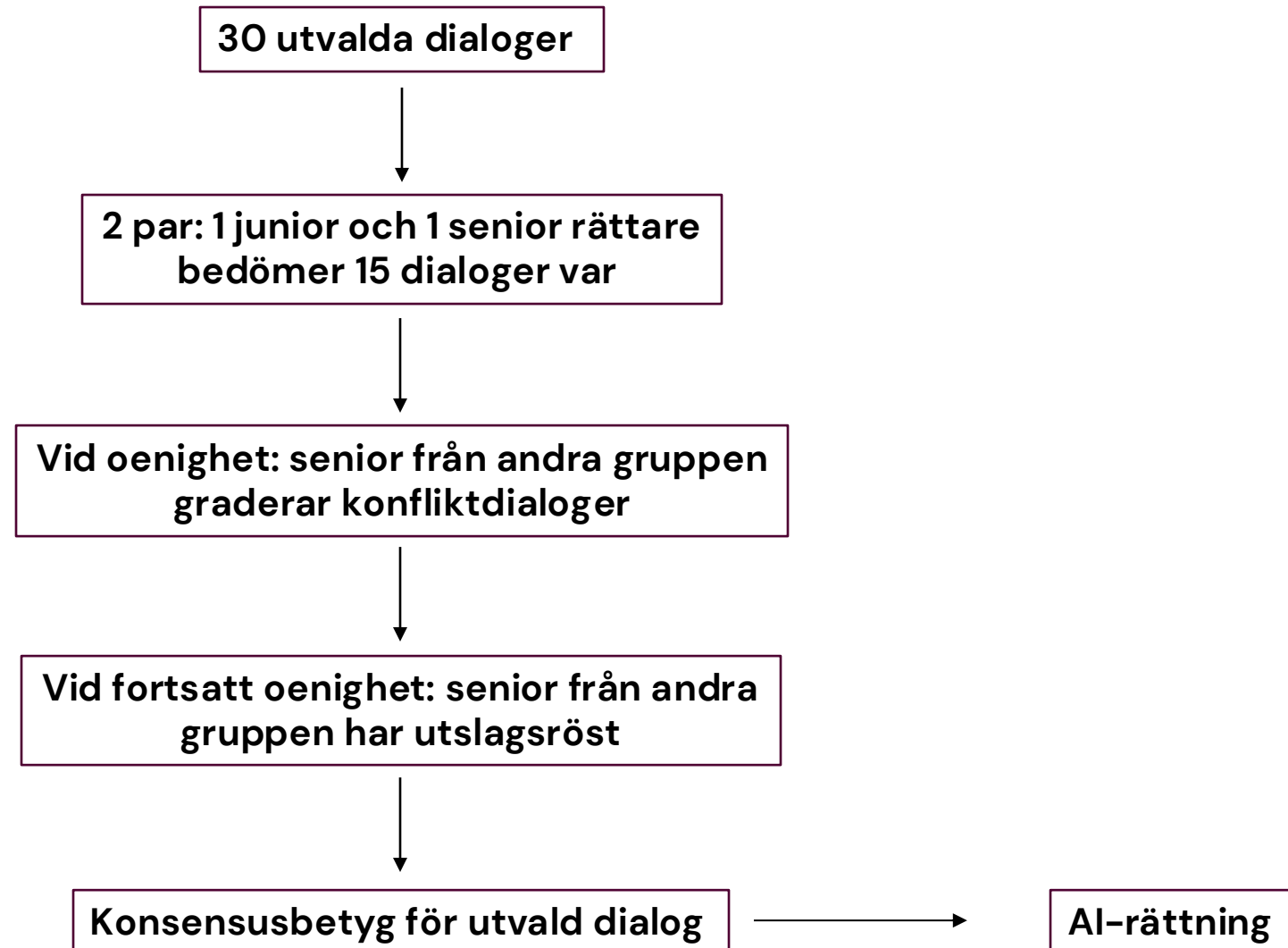
## Formativ OSCE – axial spondylit med centralt och perifert engagemang

| Kommunikation vid start 3p                                                                                                                                                                                                                                                          | Ej alls | Delvis | Fullständigt |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------|--------------|
| Startar med öppna frågor och bereder patienten talutrymme för sin berättelse<br>Startar ej med öppna frågor 0p<br>Startar med öppna frågor men avbryter i förtid 0,5p<br>Startar med öppna frågor och förstår använda dessa i tillämpliga situationer 1p                            |         |        |              |
| Klargör vad patienten själv tänker kring symtom, om pat är bekymrad/orolig för något samt vad patienten vill få ut av besöket<br>Klargör ej 0p<br>Efterhör delvis 0,5p<br>Efterforskar och bereder adekvat utrymme för pat.s tankar kring symtom, ev oro ev önskemål med besöket 1p |         |        |              |
| Sammanfattar tillämpligt och avvägt för att säkerställa informationsöverföring och bekräfta patienten<br>Sammanfattar ej 0p<br>Sammanfattar till viss del 0,25p<br>Sammanfattar vid lämpliga tillfällen i nyanserad dialog med patienten 0,5p                                       |         |        |              |
| Generell anamnes 3,5 p                                                                                                                                                                                                                                                              | Ej alls | Delvis | Fullständigt |
| Tidigare/Nuvarande sjukdomar<br>Efterfrågar ej 0p<br>Efterfrågar delvis 0,5p<br>Efterfrågar fullt 1p                                                                                                                                                                                |         |        |              |
| Efterhör avseende livsstilsvanor (rökning, alkohol, fysisk aktivitet)<br>Efterfrågar ej 0p<br>Efterfrågar delvis 0,5p<br>Efterfrågar fullt 1p                                                                                                                                       |         |        |              |
| Aktuell medicinering och allergier<br>Efterfrågar ej 0p<br>Efterfrågar delvis 0,5p<br>Efterfrågar fullt 1p                                                                                                                                                                          |         |        |              |
| Efterfrågar om ärlighet<br>Efterfrågar ej 0p<br>Efterfrågar 0,5p                                                                                                                                                                                                                    |         |        |              |
| Riktad anamnes 1,5p                                                                                                                                                                                                                                                                 | Ej alls | Delvis | Fullständigt |
| Efterhör avseende ryggsmärta (karakter, lokalisation)<br>Efterhör ej 0p<br>Efterhör delvis 0,25p<br>Efterhör fullt 0,5p                                                                                                                                                             |         |        |              |
| Efterhör avseende extraartikulära manifestationer (uveit, entesit, GI, etc)<br>Efterhör ej 0p<br>Efterhör en typ av extraartikulär manifestation 0,25p<br>Efterhör nyanserat om minst 2 olika former 0,5p                                                                           |         |        |              |
| Efterhör angående morgonstelhet<br>Efterfrågar ej 0p<br>Efterfrågar men penetrerar ej ytterligare 0,25p<br>Efterfrågar och fördjupar med tidsaspekt, förbättrande/försämrande faktorer 0,5p                                                                                         |         |        |              |
| Diagnostik och åtgärder 1,5p                                                                                                                                                                                                                                                        | Ej alls | Delvis | Fullständigt |
| Diagnostiskt<br>Lyckas ej sammanfatta få fram information eller misstankar om ledsjukdom 0p<br>Lyckas få fram enbart perifert engagemang utifrån anamnes 0,25<br>Lyckas få fram både axiellt och perifert engagemang utifrån anamnes 0,5p                                           |         |        |              |
| Behandling<br>Rekommenderar ingen/felaktig behandling 0p<br>Rekommenderar rimligt behandlingsförslag utifrån diagnosmisstanke 0,5p                                                                                                                                                  |         |        |              |
| Ytterligare undersökning (röntgen, blodprover)<br>Nämner ej 0p<br>Penetrerar delvis 0,25p<br>Ger fullständiga och lämpliga utredningsförslag 0,5p                                                                                                                                   |         |        |              |
| Kommunikation vid avslut 0,5 p                                                                                                                                                                                                                                                      | Ej alls | Delvis | Fullständigt |
| Förvisar sig att pat är införstådd och ger utrymme för kompletterande frågor<br>Berör ej detta 0p<br>Berör till viss del 0,25p<br>Berör adekvat 0,5p                                                                                                                                |         |        |              |

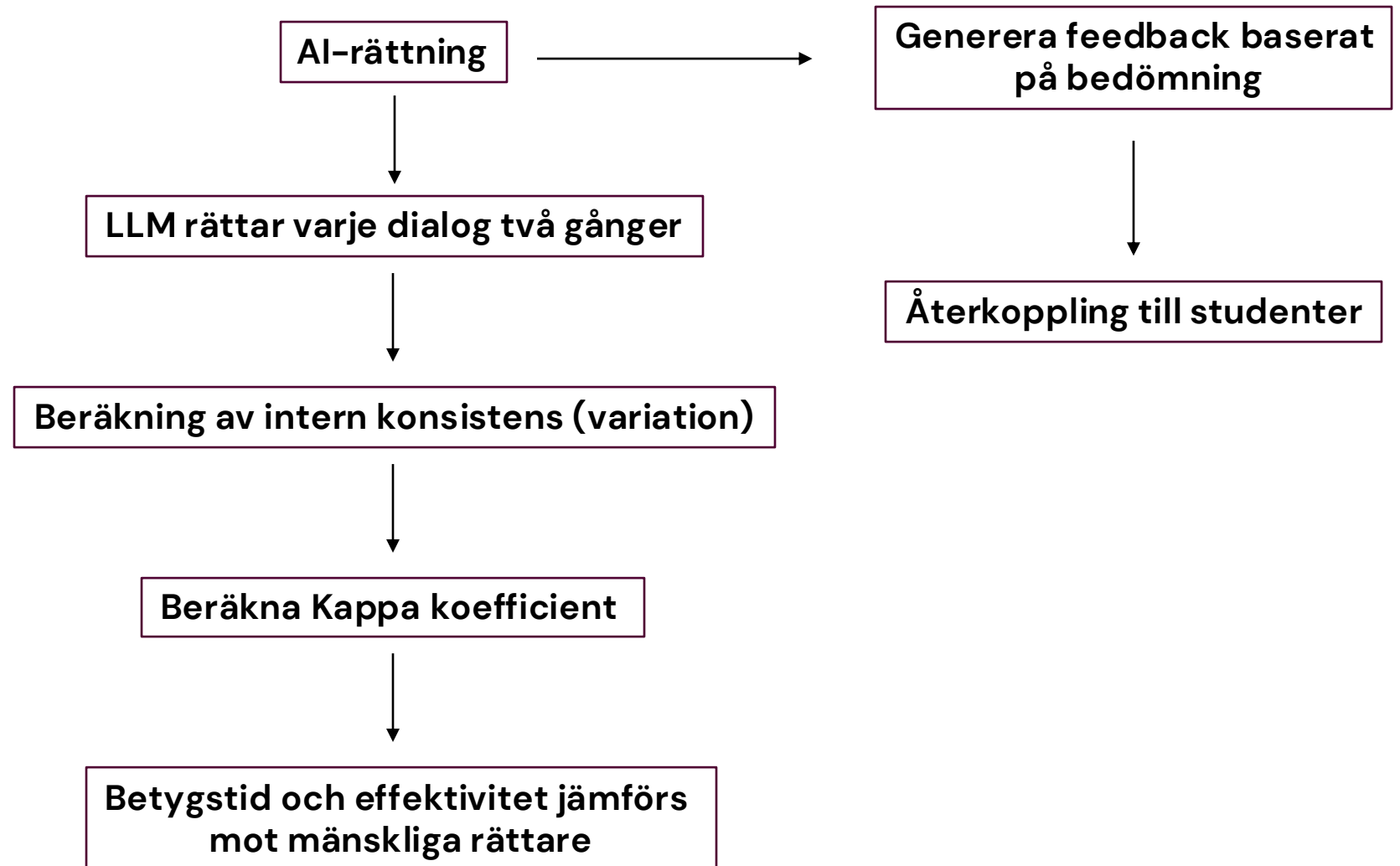


# AI-genererad feedback





# AI-genererad feedback



# AI-generated feedback

Hanna W61: user/2024-05-08 13-24-26

▶ 0:00 / 15:17



Good day, doctor. I've been having problems with my swelling hands, and loss of strength. It has been gradually become worse and now it's entirely unbearable.

okay when did it started

It started a few months back with swelling in my left hand, but then I started experiencing loss of strength and mobility in both my hands, and now it's getting harder to move around as well.

anything else besides the weakness and symptoms in the hands

Yes, I have also been experiencing difficulties with walking and rising from a sitting position. I've been losing weight rapidly, and my appetite has decreased due to difficulty swallowing.

okay so do you feel also weakness in your um legs

Yes, I have also been experiencing difficulties to walk in stairs and carrying heavier objects.

but it started first in the hands

Yes, that's correct. The symptoms started with swelling in my left hand without any redness or tenderness.

and since when is a more generalized or also on the legs

I would say it started becoming more generalized about a month after my symptoms first started, and now it's

## Feedback

### • Open-Ended and Exploratory Questions:

You primarily used closed-ended questions at the beginning, such as "when did it started" and "anything else besides the weakness and symptoms in the hands," which limits the patient's ability to freely express their situation in their own words. Starting with open-ended questions can offer more context on the patient's condition from their perspective. Additionally, you excelled in inviting the patient's thoughts on their symptoms by asking, "what do you think you have?" This question encourages the patient to share their own insights and concerns. Balancing both types of questions can improve your clinical interactions by creating a comprehensive understanding of the patient's experience.

### • Inquiry into Specific Concerns and History:

You effectively explored specific concerns by asking, "do you have a fear of dying?" which pertains directly to the patient's worries about their serious condition. This reflects sensitivity to the psychological impact of the symptoms. Furthermore, you appropriately gathered past medical history by asking, "do you have any other medical conditions?" understanding past health issues aids in forming a more accurate medical context, crucial for assessment and management. While you thoroughly addressed these areas, consider specifically asking what the patient hopes to achieve from the visit to align your approach with their expectations and goals.

### • Comprehensive Lifestyle and Family History Assessment:

Your efforts in gathering lifestyle information and family history are noteworthy. You asked relevant questions such as "do you smoke?" and "anyone in your family that had similar symptoms before," which are essential for understanding potential genetic and lifestyle factors influencing the condition. This thoroughness shows good clinical reasoning practice by identifying factors outside immediate symptoms that could contribute to the condition.

### • Detailed Symptoms and Daily Impact Evaluation:

You delved into the impact of symptoms on daily activities by questioning difficulties in "moving around" and "getting up from a chair." It is important as it provides insight into how the symptoms affect the patient's quality of life and could indicate the extent of the condition. However, while you recognized proximal muscle weakness, you might also differentiate



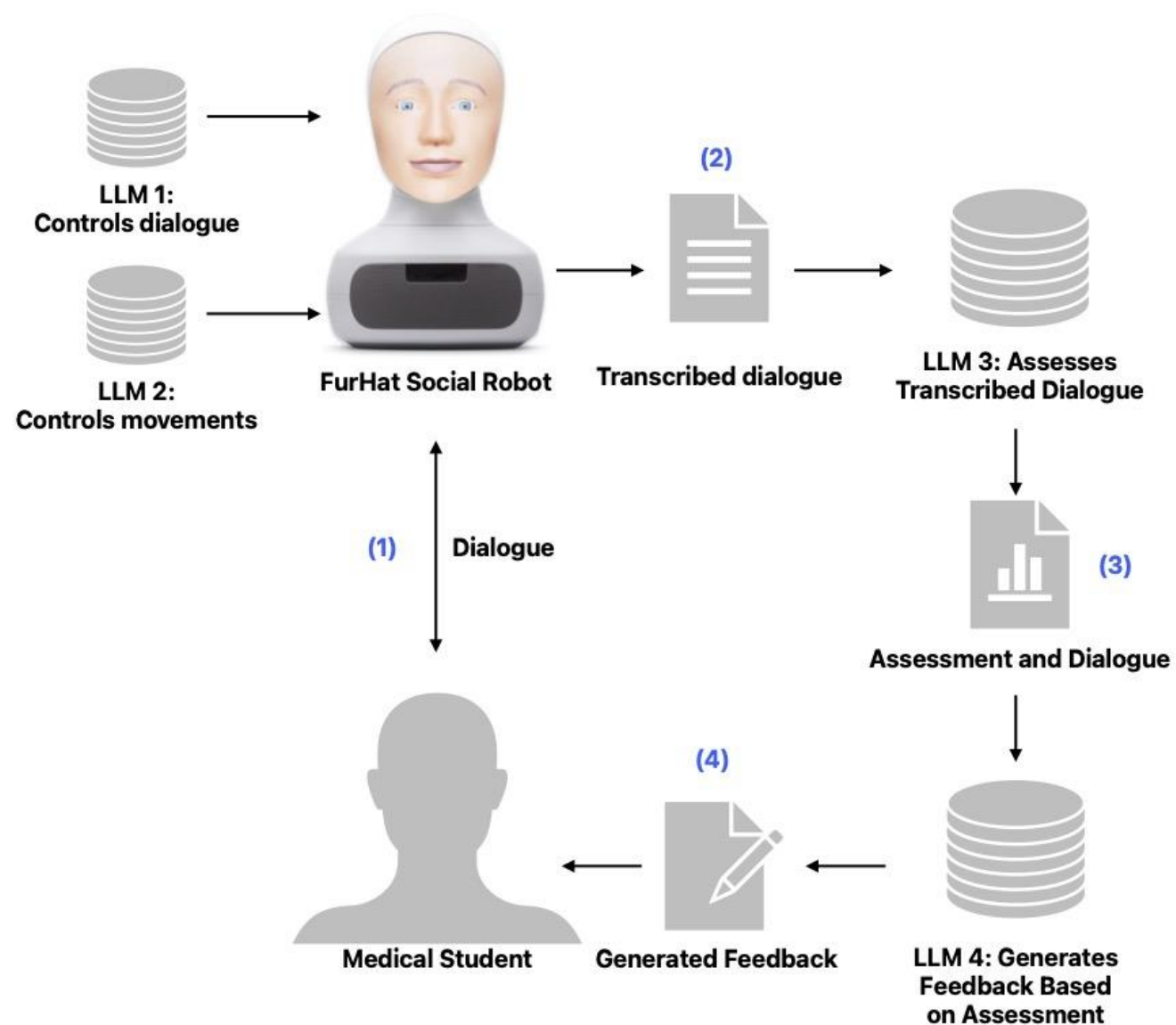
Overall, this feedback aims to refine your clinical practice, focusing both on your successes and areas for growth. Use open communication and thorough questioning to learn as much as possible about the patient's condition, and remember that the subtleties in patient language can guide diagnostic insights.

Re-run analysis

Download as Word



# AI-generated feedback



- Flera potentiella användningsområden av AI inom interaktiva virtuella patientfall
- Ett lovande komplement vid avsaknad av representativa patienter
- Uppskattad teknologi av studenter och medarbetare som bidrar med unika fördelar



# Erkännanden

## Handledare



## Mentor



Alexander Borg

## Forskningsgrupp



## Amanuenser

Cidem Gentline

Viking Huss

Fabricio Espinosa

Johannes Mofors

Anna Hugelius

## Läkarstudenter



Svenska  
Läkaresällskapet



NYCKEL  
FONDEN  
Forskning vid USÖ



**Karolinska  
Institutet**

**TACK**

# AI inom klinisk utbildning: exempel och erfarenheter från generativ AI för virtuella patientmöten



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