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Immersive Surgical Edu

Beyond the Classroom: Virtual Reality, Augmented Reality and Haptics for Enhanced Surgical Training and Education

Project Reference: 2023-1-NO01-KA220-HED-000160462

Results of the simulation evaluation of medical students at the Lithuanian University of Health Sciences.

Lithuanian University of Health sciences (LUHS)
15-16 October 2025, Kaunas, Lithuania

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VR SIMULIATION SCENARIOS

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The module of Basics of Surgery. Part of the practical and clinical skills. Topics of asepsis and antisepsis and behavior in the operating room. Familiarization with the operating room environment; rules of conduct and access; knowledge of dressing equipment, proper dressing; surgical hand preparation, behavior in the hand's preparation room.

Scenario No. I

The ImmersiveSurgical Edu VR and haptic simulation begins with the trainee approaching the operating room block. Initially, the trainee becomes familiar with the VR equipment and the operation of the haptic device, performing actions, and understanding the principles of operation. The trainee performs simple actions in a virtual environment. Once the trainee is ready, they begin learning activities by answering questions in virtual menus, selecting the necessary tools, and following the steps outlined in the virtual scenario steps algorithm (Algorithm No. 1) below.

The following is an algorithm of actions, tasks, and steps that, once completed, allows the trainee to enter the virtual operating room, where they continue learning activities according to the tasks of another scenario.

Education level: For students of the Faculty of Medicine from the third year.

Subject: Asepsis, antisepsis. Medical Asepsis. Infection Control.
Surgical Asepsis and Operating Room Preparation
Rules of conduct in the operating unit. Correct behavior in the operating room.
Selection of protective equipment. Surgical hand preparation.
Proper preparation for work in the operating room.

Format: Individual and group training or training with a mentor.
Learning mode; Training mode; Exam mode.

Duration: Approx. 4 hours practical skills in VR and Haptics formats.

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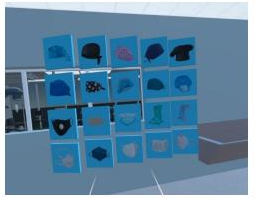
Introduction and simulation objectives:

The work of each representative of the medical staff is closely related to his specific duties, responsibilities, and functions within the clinic staff. Very important aspects in surgery are knowledge of the basics of asepsis and antiseptics, proper behavior in the patient treatment environment (ward, patient reception area, patient examination, and assessment area), operating room, in different rooms of the operating room (dressing room, hand preparation room, surgical operation area).

At this stage of the virtual lesson, students will learn the correct behavior, the basis of aseptic and antiseptic, the correct selection of tools in the changing environment of the operating room, in other rooms of the operating room.

Learning goals and student benefits:



- Develop 3D orientation and virtual solution management skills.
- Practice spatial orientation, coordination, and quick, rational thinking.
- Develop collaboration skills using virtual solutions and remote communication.

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- Develop aseptic and aseptic skills in the virtual environment, correct behavior in the virtual operating room environment without harming yourself and others.
- To learn how to correctly prepare hands and antiseptic in hand preparation room.
- Develop a rational, targeted selection of tools to avoid mistakes in a real situation.
- Develop reflective skills while working in a virtual operating room that matches the actual design of your educational institution's operating environment.
- Learn to navigate the abundance of medical tools without fear of getting lost while learning virtually.
- Develop and strengthen the "The mind in the body" principle in yourself.

Activity example:

For teachers:

- You can use the desired virtual questionnaire (test of questions) before the student enters the virtual operating room for the learner to absorb, learn, check theoretical knowledge on the topics of aseptic, antiseptic.
- Can use a confusing, evaluative database of virtual equipment (pajamas, pants, caps, masks, glasses, footwear, and others) of the dressing room, preparation for the operation room from the data of several existing medical equipment sets.
- You can set the mode execution (learn mode, training mode, exam mode).
- You can evaluate the student's learning progress, evaluate his process, errors in the performance of tasks, and time.
- You can use the desired virtual action plan (hand preparation actions) before the student enters the virtual hand preparation room so that the learner can learn the sequence of actions and correct behavior.
- You can use a hand preparation action test with real video from the available image database.

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VR SIMULIATION SCENARIOS

The module of Basics of Surgery. Part of the practical and clinical skills. Topics of asepsis and antisepsis and behavior in the operating room, surgery procedure. Work in the operating room. Antiseptic selection, preparation of the operating field, draping the operating field, palpation of the abscess site, evaluation, selection of the future incision site, marking, injection of anesthetic into the planned incision site, recognition, and selection of necessary surgical instruments, opening the abscess, irrigating the abscess cavity, wound dressing.

Scenario No. II

The student continues to perform virtual simulation tasks. One of the main tasks of the student is to properly prepare the operating field, choosing the appropriate antiseptic, select the necessary surgical instruments, evaluate the abscess site, perform palpation, evaluate and select the correct incision site, perform infiltration, local anesthesia of the incision site, open the abscess, irrigate its cavity and properly dress the wound. By mastering the control of virtual and haptic devices, student aims to perform all actions as accurately and correctly as possible according to the tasks listed below, the steps of the scenario.

Education level: For students of the Faculty of Medicine from the third year.

Subject: Asepsis, antisepsis. Medical and surgical asepsis. Infection Control.
Surgical Asepsis and Operating Room Preparation. Preparation of the operating field.
Selection of protective equipment.

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Local anesthesia in practice.
Selection and preparation of surgical instruments.
Evaluation of the surgical site. Evaluation of abscess localization.
Opening of the abscess. Wound dressing.
Rules of conduct in the operating unit. Correct behavior in the operating room.
Proper preparation for work in the operating room.

Format: Individual and group training or training with a mentor.
Learning mode; Training mode; Exam mode.

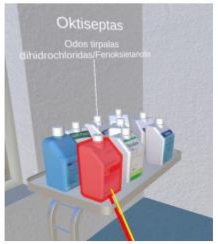
Duration: Approx. 4 hours practical skills in VR and Haptics formats.

Introduction and simulation objectives:

The work of each representative of the medical staff is closely related to his specific duties, responsibilities, and functions within the clinic staff. Very important aspects in surgery are knowledge of the basics of asepsis and antiseptics, proper behavior in the patient treatment environment (ward, patient reception area, patient examination, and assessment area), operating room, in different rooms of the operating room (dressing room, hand preparation room, surgical operation area).

At this stage of the virtual lesson, students will learn the correct behavior, the basis of aseptic and antiseptic, the correct selection of tools in the changing environment of the operating room, in other rooms of the operating room, the basics of surgical operations.

Learning goals and student benefits:



- Develop 3D orientation and virtual solution management skills.
- Practice spatial orientation, coordination, and quick, rational thinking.
- Develop collaboration skills using virtual solutions and remote communication.
- Develop aseptic and aseptic skills in the virtual environment, correct behavior in the virtual operating room environment without harming yourself and others.
- To learn how to correctly prepare hands and antiseptic in hand preparation room.

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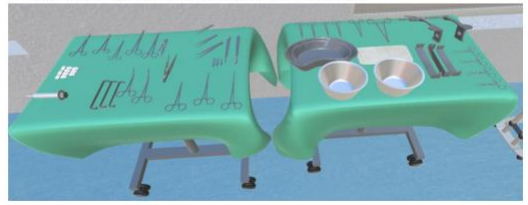
- Develop a rational, targeted selection of tools to avoid mistakes in a real situation.
- Develop reflective skills while working in a virtual operating room that matches the actual design of your educational institution's operating environment.
- Learn to navigate the abundance of medical tools without fear of getting lost while learning virtually.
- Develop and strengthen the "The mind in the body" principle in yourself.



Activity example:

For teachers:

- You can use the desired virtual questionnaire (test of questions) before the student enters the virtual operating room for the learner to absorb, learn, check theoretical knowledge on the topics of aseptic, antiseptic.
- Can use a confusing, evaluative database of virtual equipment (antiseptics, surgical instruments) operation room from the data of several existing medical equipment sets.
- You can set the mode execution (learn mode, training mode, exam mode).
- You can evaluate the student's learning progress, evaluate his process, errors in the performance of tasks, and time.
- You can use the desired virtual action plan (surgical operation) before the student enters the virtual operation room so that the learner can learn the sequence of actions and correct behavior.

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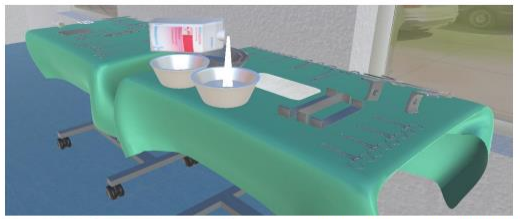
VR SIMULIATION SCENARIOS



- You can use videos of abscess assessment and opening procedures from an available image database.
- You can use wound dressing footage from a database of available videos.

For students:

- You will test your theoretical knowledge on aseptic and antiseptic issues by performing virtual tasks in the operating room.
- You will virtually get acquainted with the operating room environment, operating room equipment, sterile zones, instruments, and rules of conduct that exist in your educational institution.
- You will learn how to correctly choose the necessary means and instruments for preparing the operating room, properly change clothes, and prepare for the operation from the abundance of available equipment.
- You will learn how to properly prepare the operating room, assess the reason for which you plan to operate on the patient, plan surgical procedures, and perform the operation.
- You will learn how to properly prepare for each stage of work in the operating room.
- You will evaluate your learning process, progress, and mistakes. You will repeat the stages as they appear, correctly.

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Extension idea:

- Ask your students to discuss the results, observations, and impressions of the virtual experience and learning. To express an opinion about the correct option, behaved in the operating room, the danger.
- Immediately repeat the steps in the real operation. Rate the performance after the virtual tour experience.

Assessment and evaluation suggestions:

- Did your students correctly select virtual tools?
- Did your students navigate and behave appropriately in the virtual operating environment?
- Did your students correctly replicate the steps to perform the surgical operation?
- Were your students able to plan and execute the steps correctly?
- Did your students complete the tasks quickly enough to master the virtual learning solution?
- Did the preparation in the virtual environment help your student perform the tasks in a real situation and environment?
- Does your student feel safe and free when operating the virtual tools and performing the tasks virtually?

Guideline before and after the VR simulation lesson by scenario.

- Are your students properly prepared to perform tasks in a virtual and haptic environment?
- Are there students who cannot use virtual reality and haptic devices due to health ailments?

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Description and explanation of scenario tasks

Virtual simulation uses an instrument kit (Fig. 1). The trainee must recognize the instruments and choose the appropriate ones for performing the planned actions.

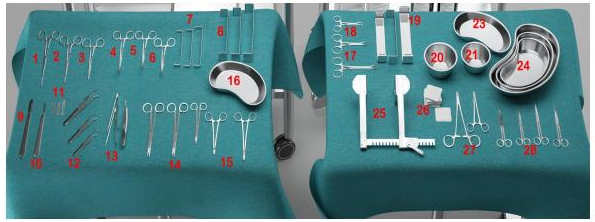

Fig. 1 Instrument kit used in virtual simulation.

PREPARATION OF THE OPERATING FIELD

The necessary instruments and supplies are selected from the instruments placed on the virtual simulation operating tables according to the list below.

1. Kidney-shaped bowl – suitable No. 16 suitable; 23; 24 not included in the task;
2. Straight clamp – suitable No. 1 most suitable; 2;3 not included in the task; or long forceps No. 13 not included in the task;
3. Round container with antiseptic - suitable No. 20; 21; a kidney-shaped bowl can be added; not included in the task;
4. Tampons – suitable No. 26 suitable;

These instruments are selected to prepare the operating field with the selected antiseptic. The selection of antiseptics is based on the list of antiseptics and other chemicals below, which contains solutions that are suitable and unsuitable for preparing the operating field. This stage aims to teach the trainee to recognize the necessary tools, choose the safest ones, and develop critical thinking in various clinical situations in the operating room. In the next step, the trainee must choose the correct instruments, antiseptic and wipe the operating field correctly, leaving no untreated areas of the planned manipulation site. The aim is to learn the skills of proper operating field preparation, asepsis, and antiseptics.

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Virtual simulation scenarios were evaluated by conducting a survey based on questionnaires:

SUS, NASA TLX, IPQ, WBLT and VRSQ questionnaires

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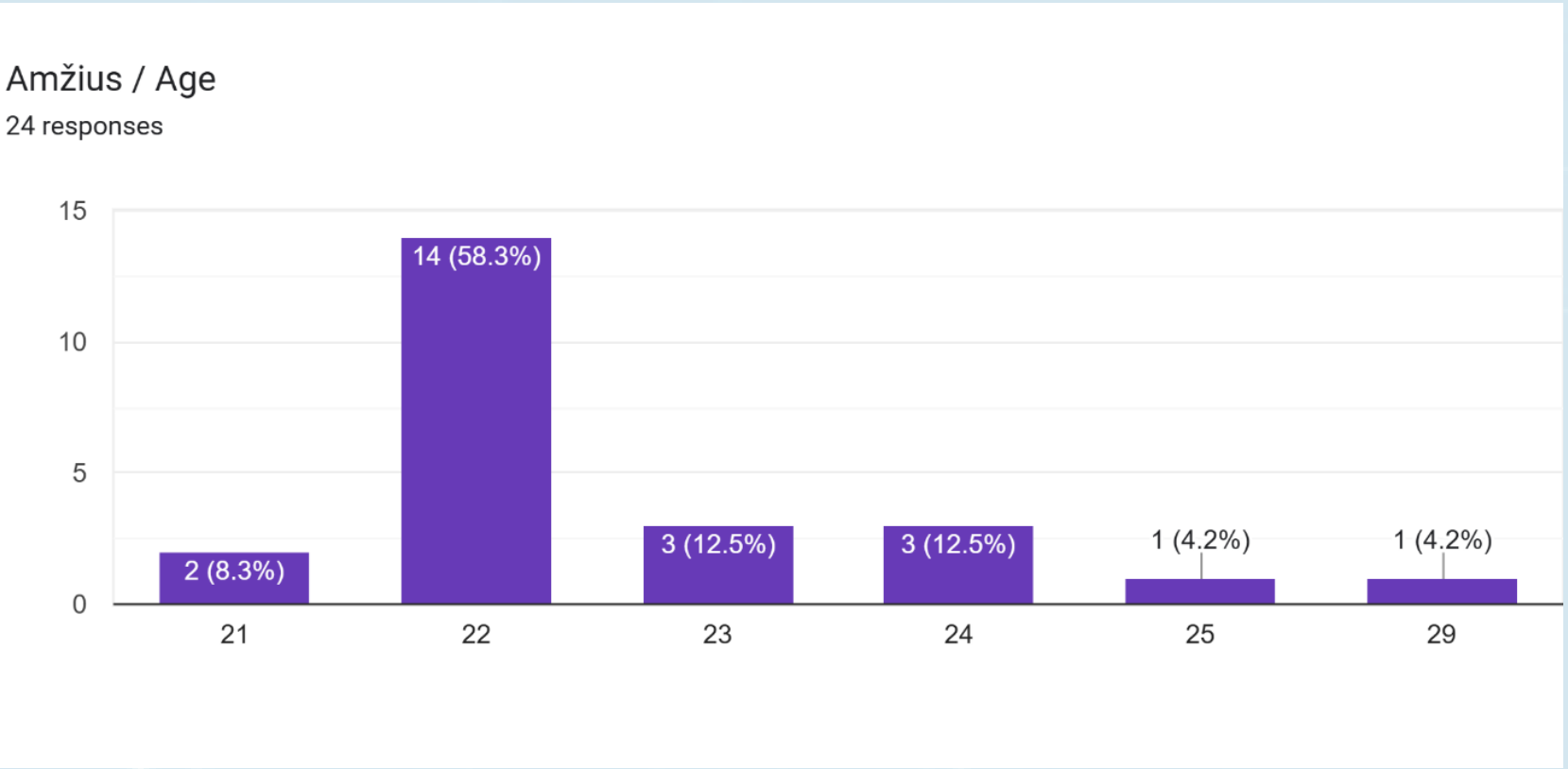

Moteris/Female – 20 (83,4%)

Vyrai/Male – 4 (16.6%)

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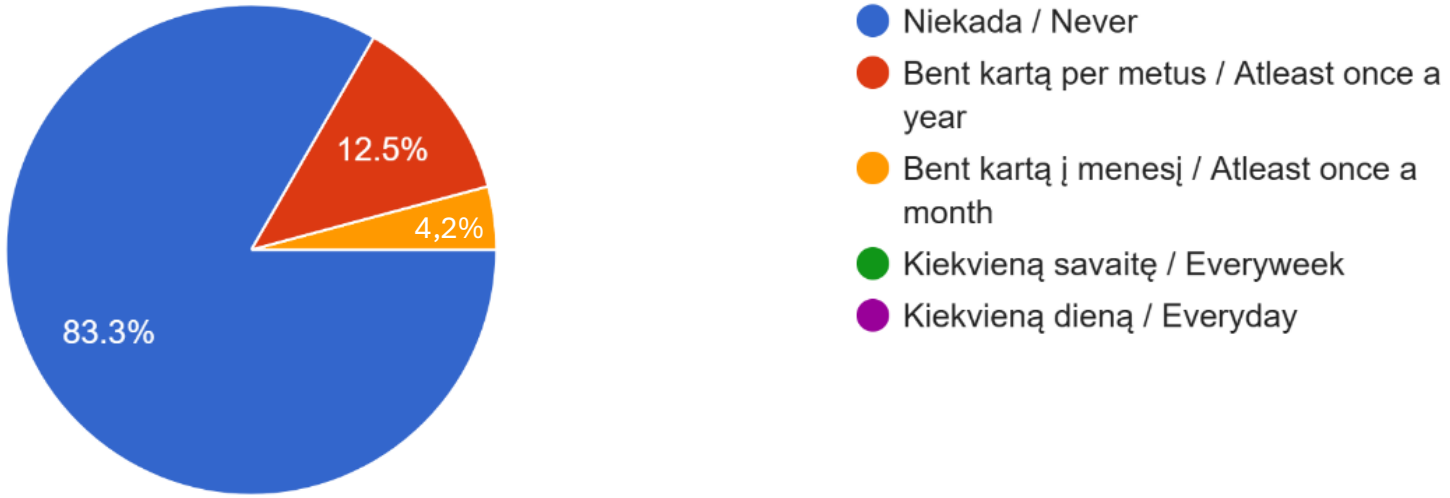
Kaip dažnai naudojate virtualiją realybę? / How often do you use virtual reality?

24 responses



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SUS klausimynas / SUS questionnaire

System usability scale (SUS) klausimynas yra skirtas įvertinti sistemos panaudojamumą.

System usability scale (SUS) is used to measure the general usability of a system.

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	1	2	3	4	5	
Visiškai nesutinku / Strongly disagree	○	○	○	○	○	Visiškai sutinku / Strongly agree

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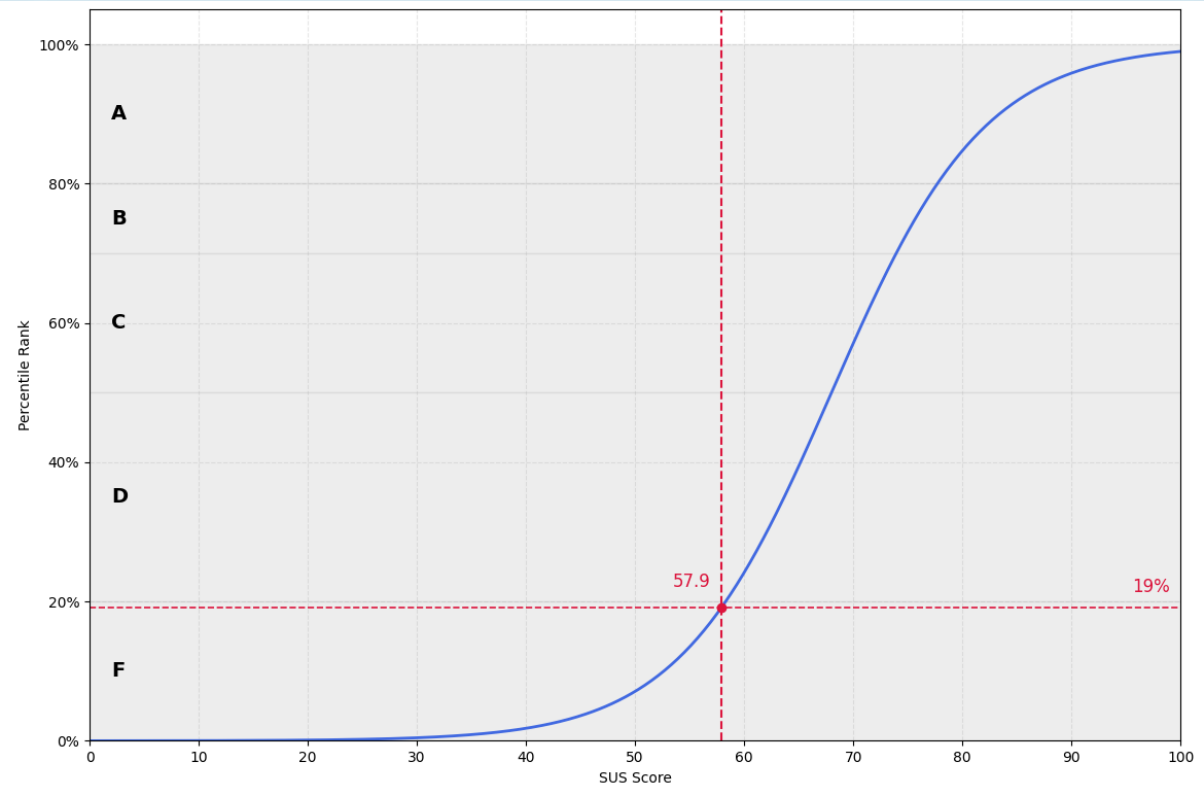

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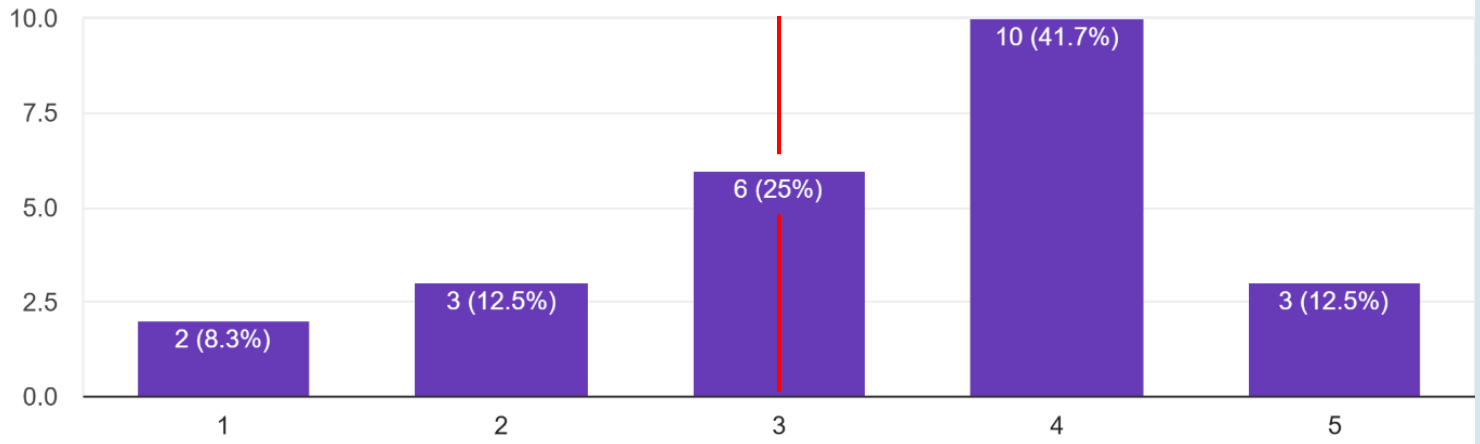
SUS klausimynas / SUS questionnaire

1. Manau, kad šia sistema norėčiau dažnai naudotis / I think that I would like to use this system frequently.

24 responses



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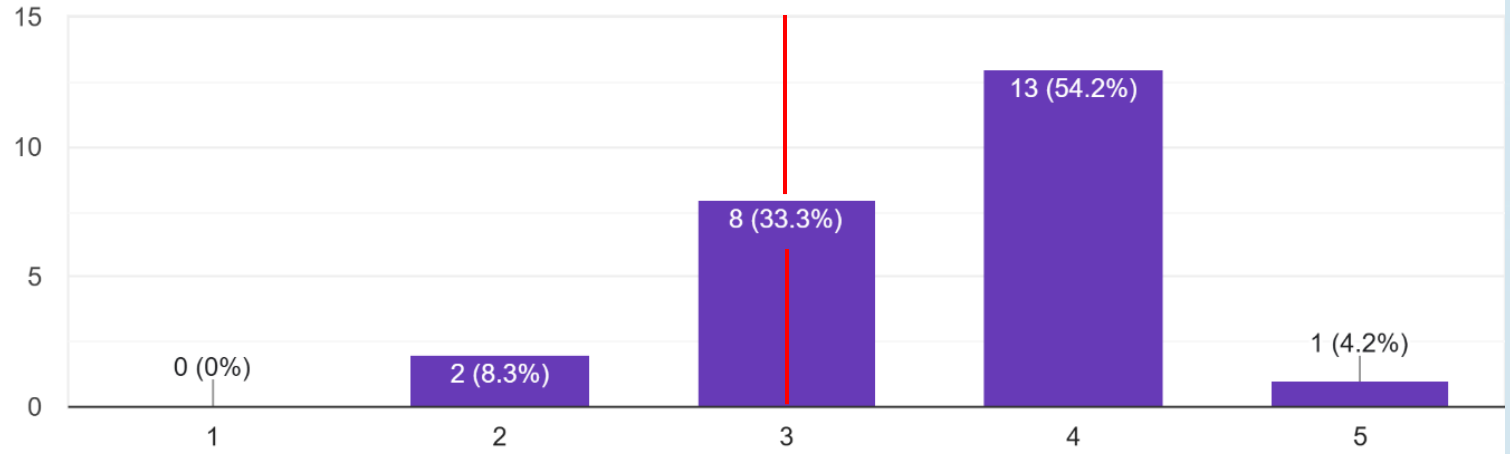
5. Man atrodo, kad įvairios sistemos funkcijos buvo gerai integruotos / I found the various functions in this system were well integrated.

24 responses



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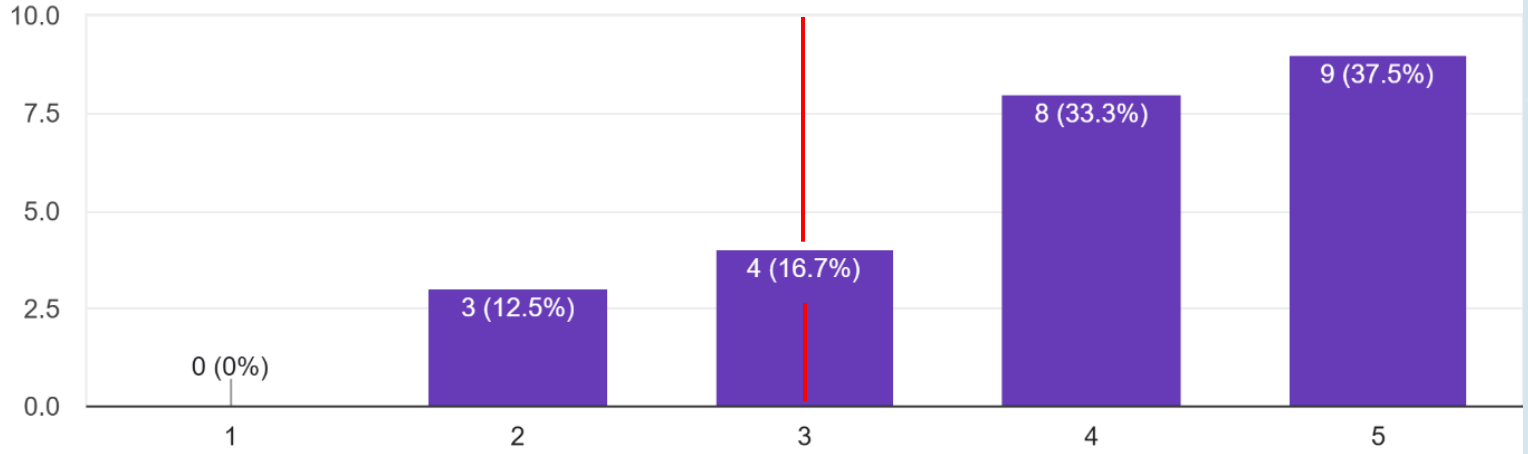
7. Įsivaiduoju, kad daugelis žmonių greitai išmoktų naudotis šia sistema / I would imagine that most people would learn to use this system very quickly.

24 responses



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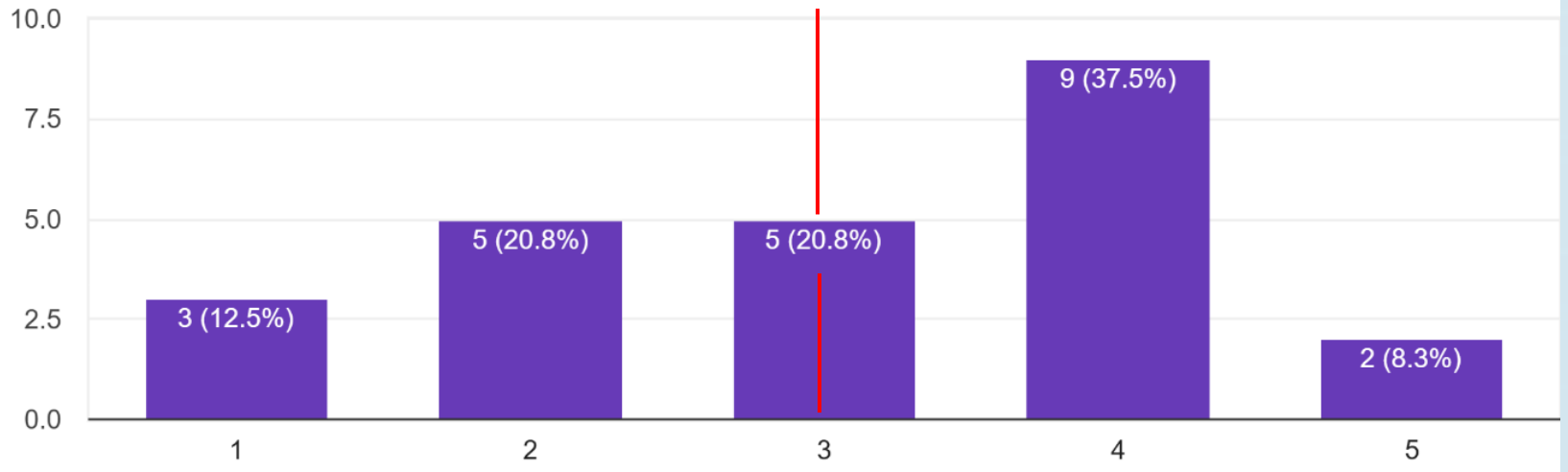
9. Aš jaučiausi užtikrintai naudojant šią sistemą / I felt very confident using the system.

24 responses



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NASA TLX klausimynas / NASA TLX questionnaire

NASA užduočių krūvio indeksas (NASA TLX) yra įrankis, skirtas subjektyviam protinio darbo krūvio (MWL) vertinimui matuoti ir atlikti.

The NASA task load index (NASA TLX) is a tool for measuring and conducting a subjective mental workload (MWL) assessment.

Low (0-9), medium (10-29), moderate (30-49), high (50-79), and very high (80-100)

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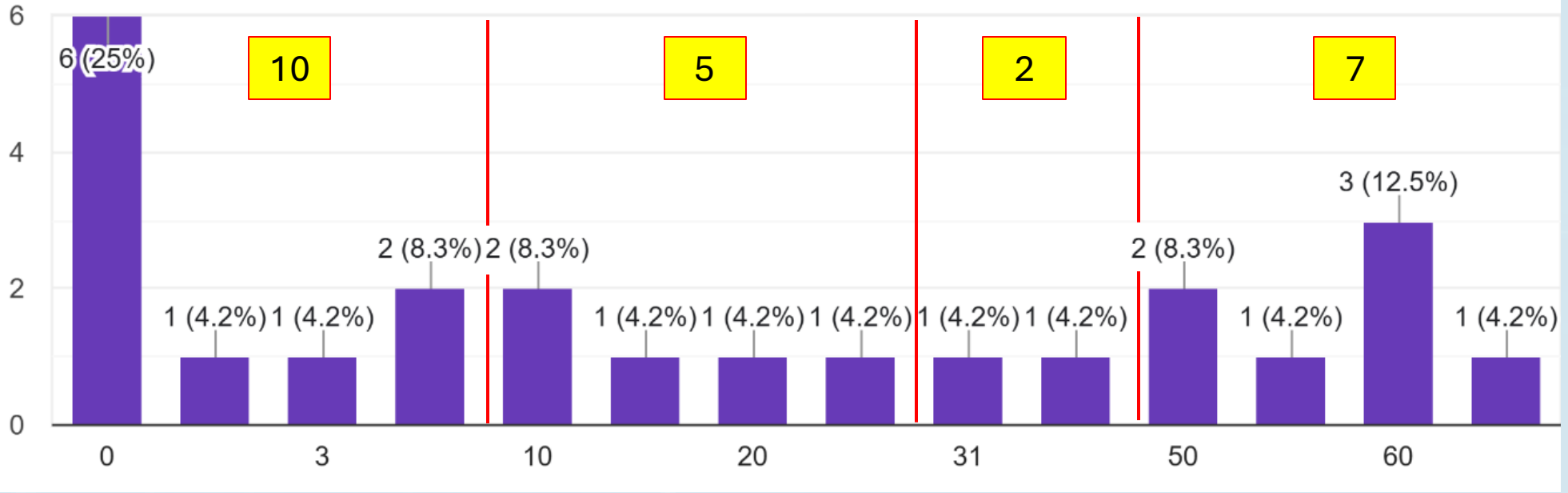
Protinis Poreikis | Kiek protiškai sudėtinga buvo užduotis?(0 - labai mažai, 100 - labai daug)
Mental Demand | How mentally demanding was the task?(0 - very low, 100 - very high)



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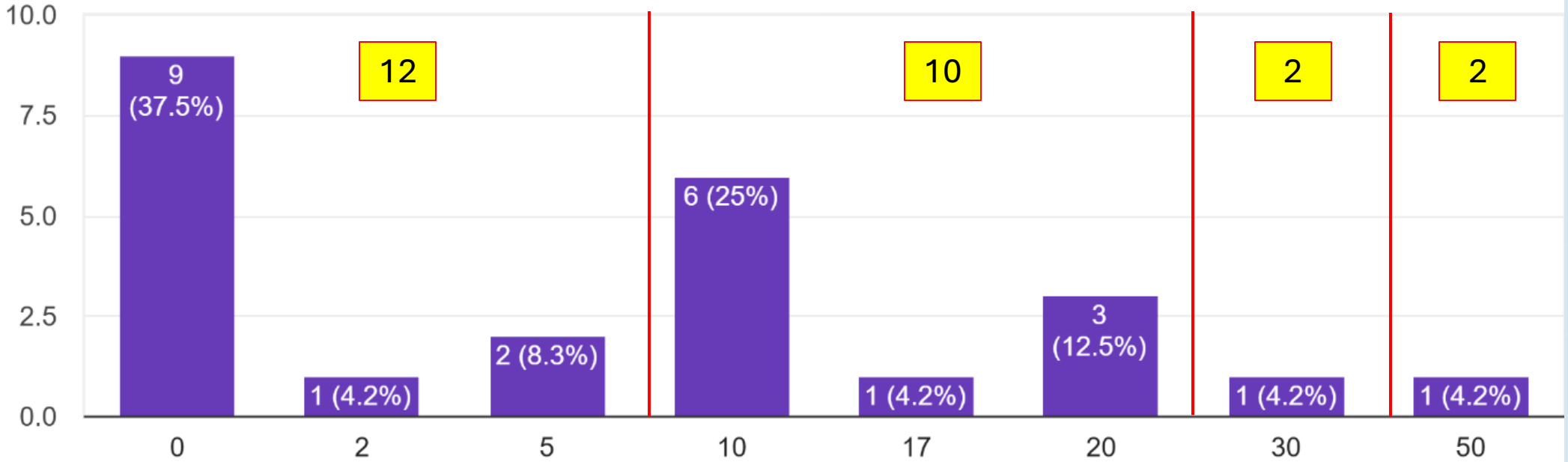
Fizinis Poreikis | Kiek fiziškai sudėtinga buvo užduotis? (0 - labai mažai, 100 - labai daug)
Physical Demand | How physically demanding was the task? (0 - very low, 100 - very high)



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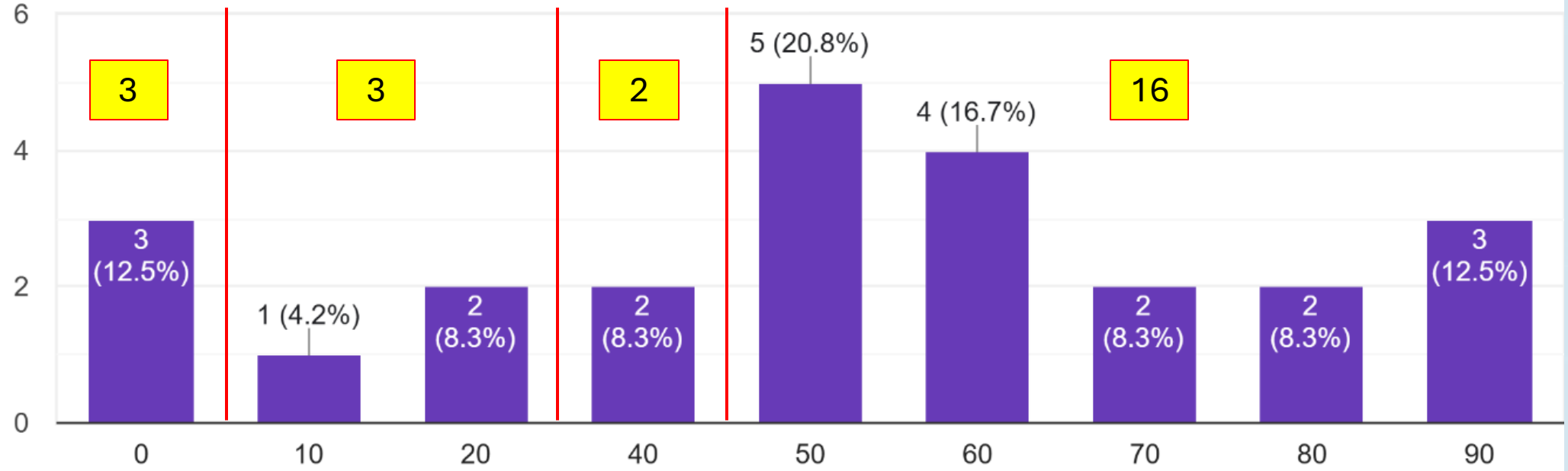
Atlikimas | Kaip jums sekėsi atlikti paskirtą užduotį? (0 - puikiai, 100 - nesėkmingai)
Performance | How successful were you in accomplishing whatyou were asked to do? (0 - perfect, 100 - failure)



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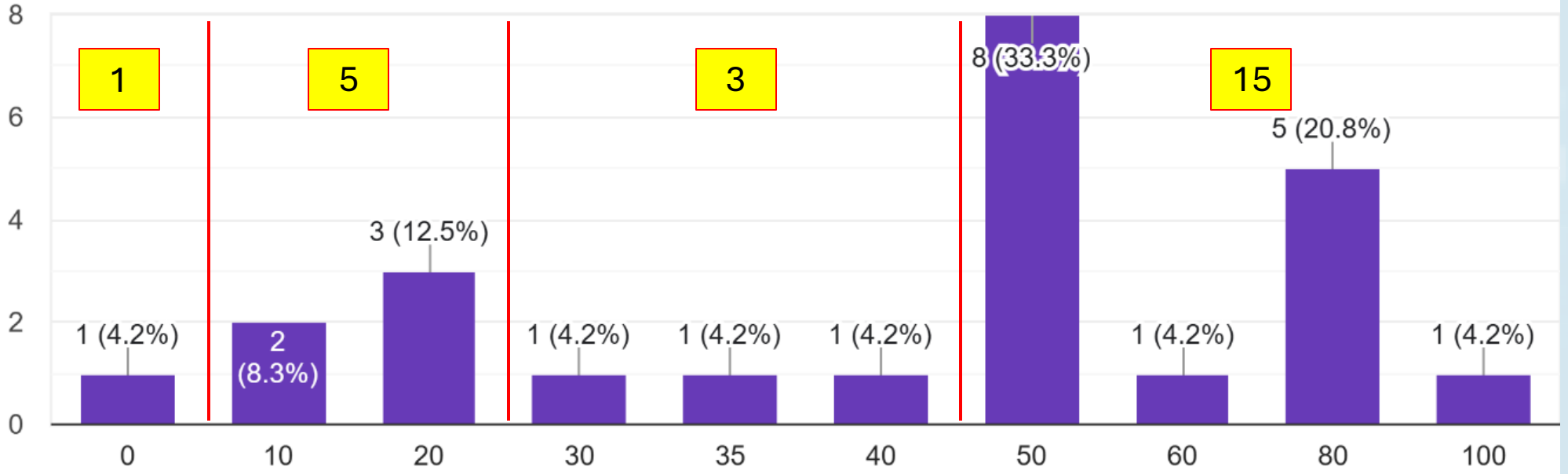
Pastangos | Kiek pastangų turėjote sutelkti, kad pasiektumėte savo užduoties atlikimo lygį?
(0 - labai mažai, 100 - labai daug)
Effort | How hard did you have to work to accomplish your level of performance?
(0 - very low, 100 - very high)



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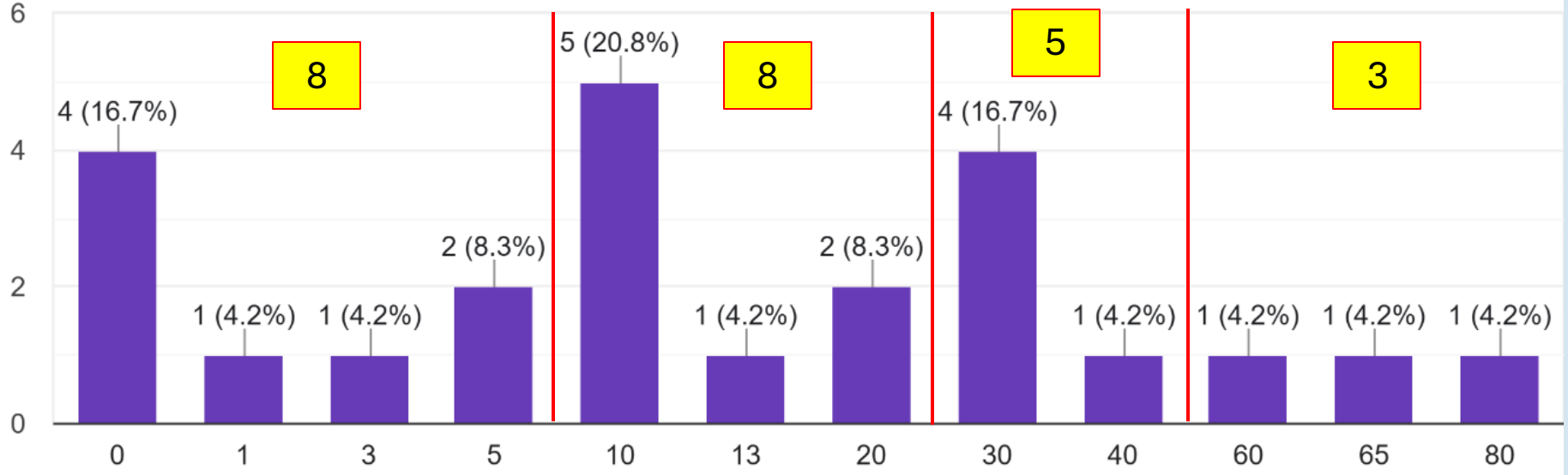
Nusivylimas | Kiek buvote savimi nepasitikintis, nenorus, susierzinęs ir stresuojantis užduoties atlikime? (0 - labai mažai, 100 - labai daug)

Frustration | How insecure, discouraged, irritated, stressed, and annoyed were you? (0 - very low, 100 - very high)



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IPQ klausimynas / IPQ questionnaire

„igroup“ presence questionnaire (IPQ) klausimynas yra skirtas „buvimo“ pojūčiui nustatyti naudojant VR programas.

"igroup" presence questionnaire (IPQ) is used to measure the feeling of presence when using VR applications.

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	1	2	3	4	5	6	7	
Visiškai ne / Not at all	○	○	○	○	○	○	○	Labai / Very much

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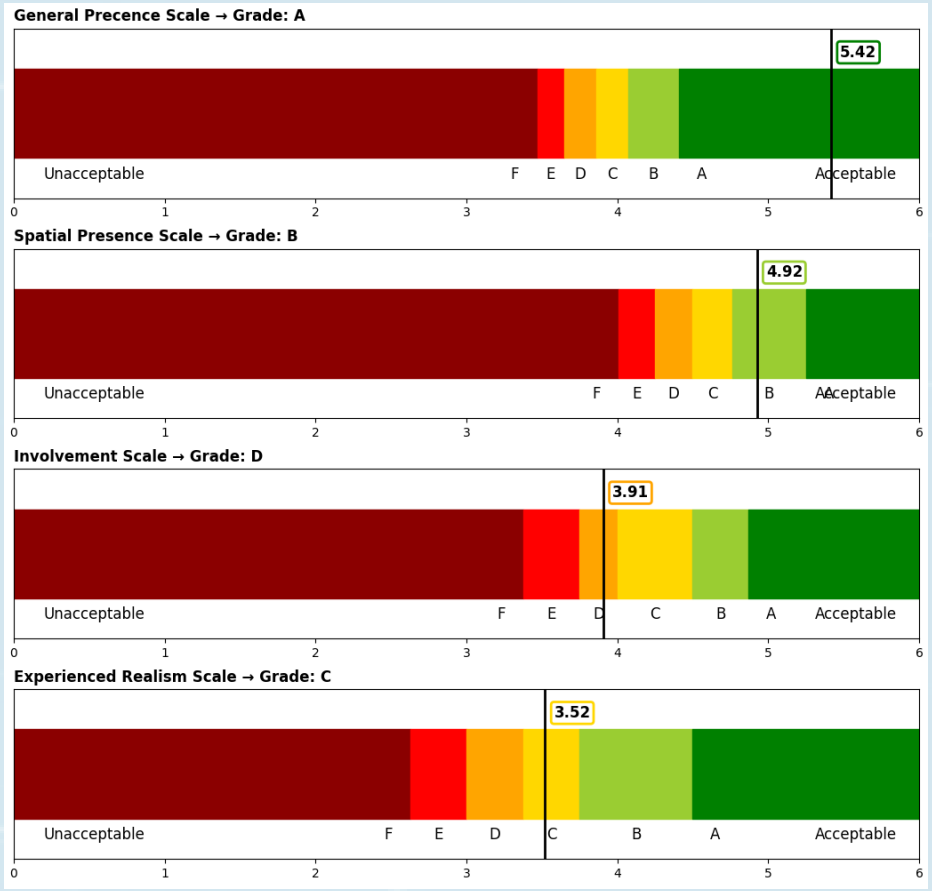

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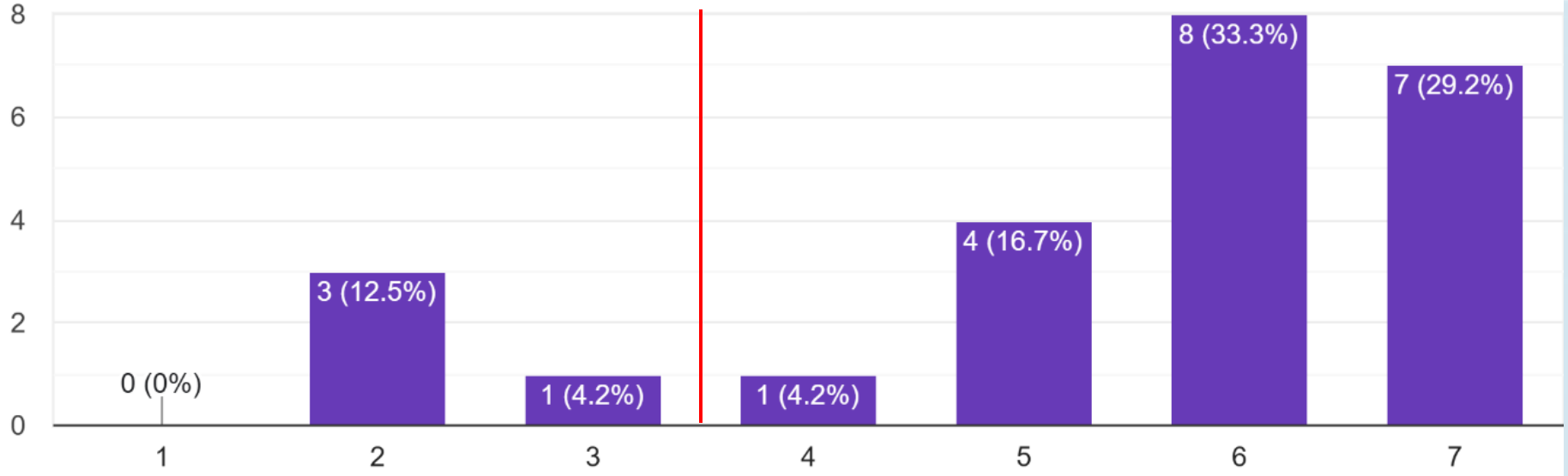
1. Jaučiausi lyg iš tikrųjų būčiau virtualioje aplinkoje / In the computer generated world I had a sense of "being there".



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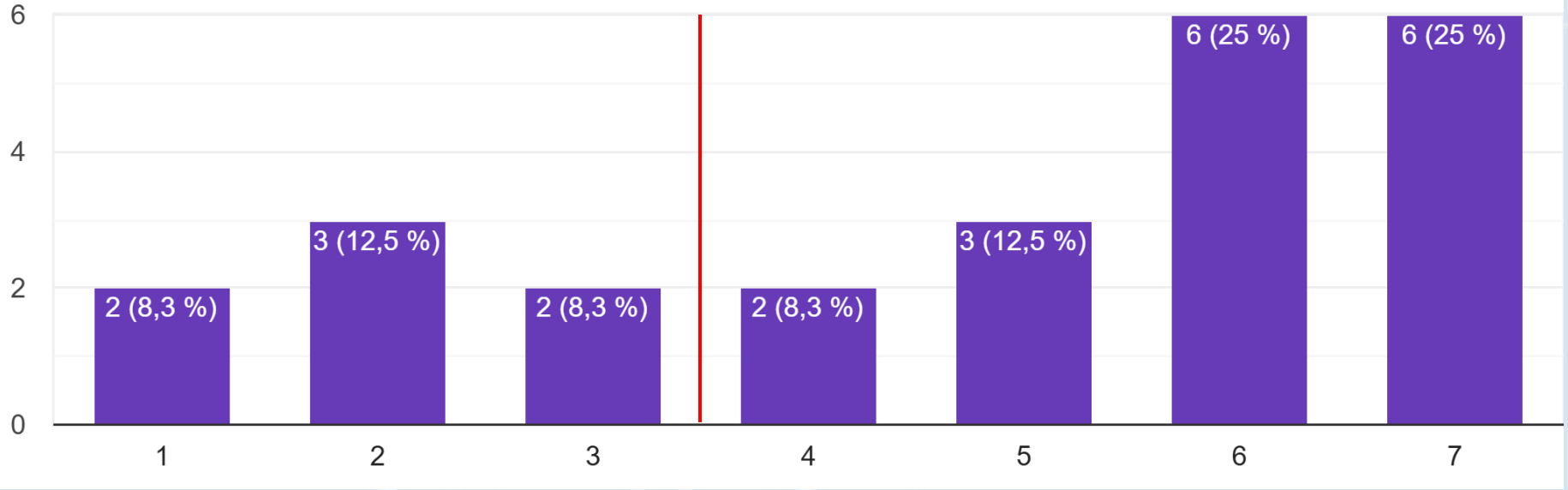
4. Nesijaučiau esanti/-is virtualiojoje aplinkoje / I did not feel present in the virtual space.



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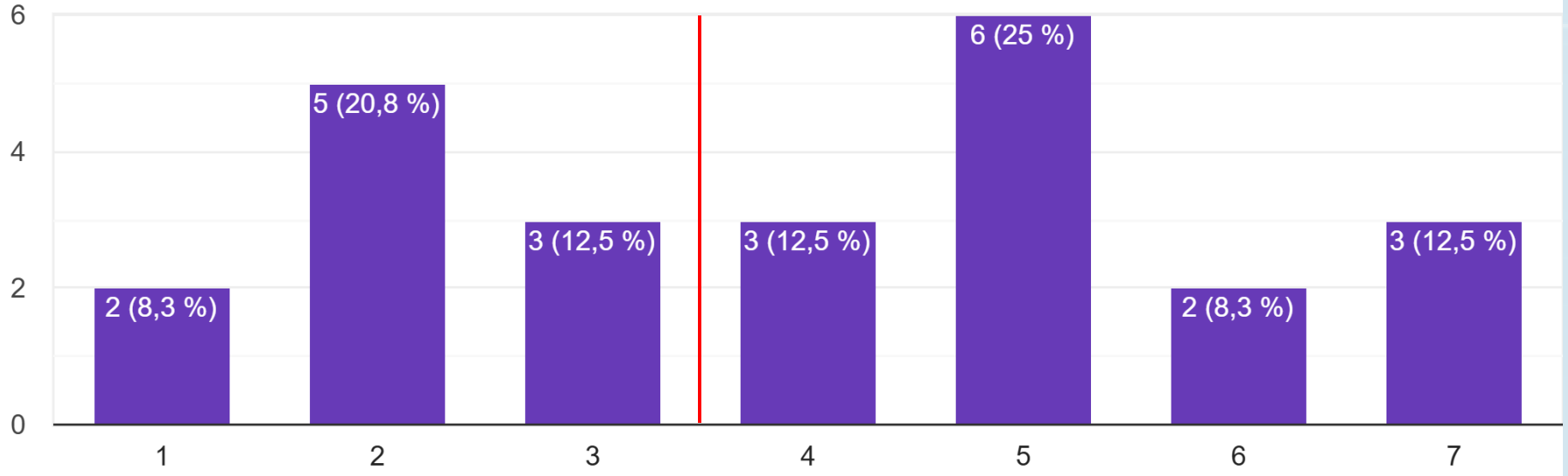
10. Mane visiškai įtraukė virtualusis pasaulis / I was completely captivated by the virtual world.



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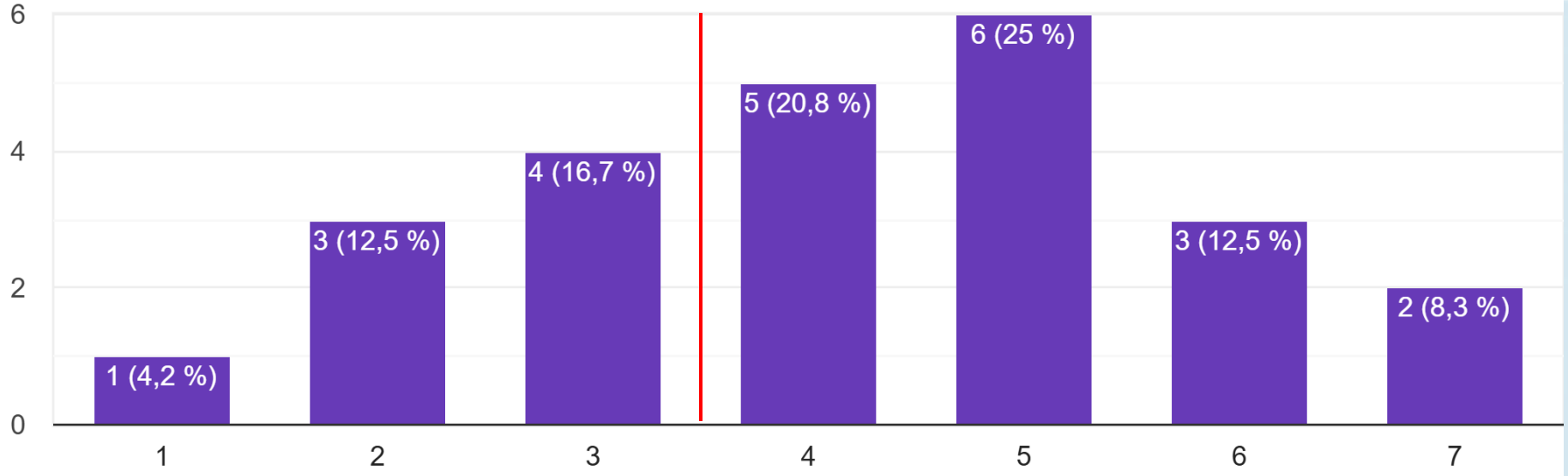
12. Kiek jūsų potyriai virtualiojoje aplinkoje atitiko jūsų tikro pasaulio potyrius? / How much did your experience in the virtual environment seem consistent with your real world experience?



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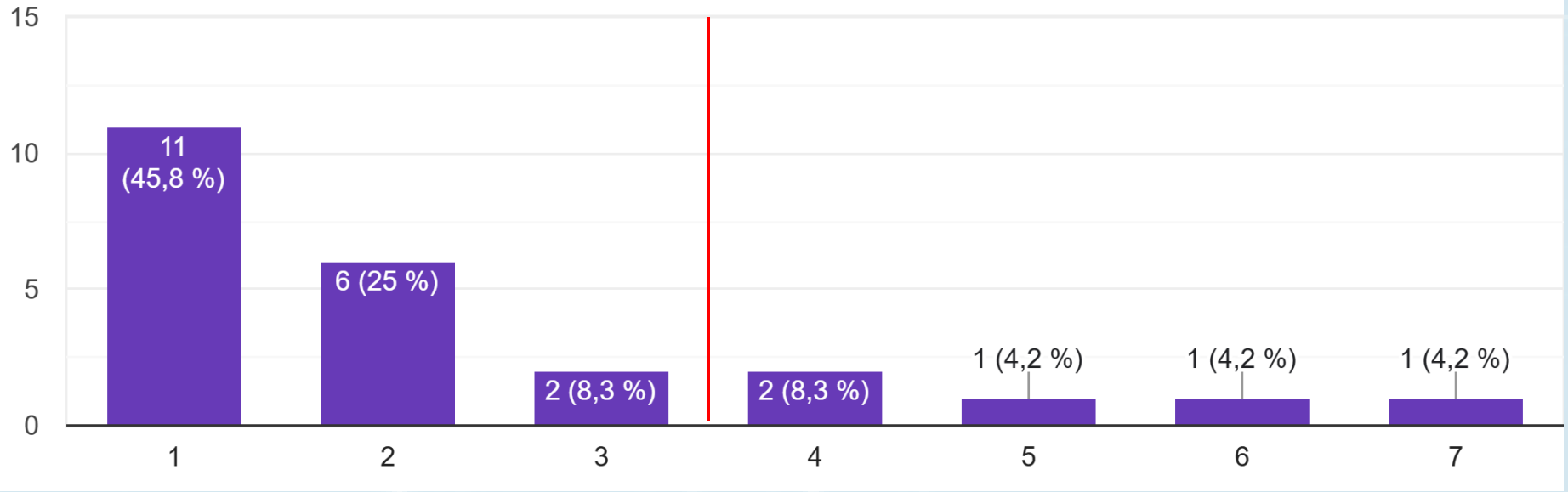
14. Virtualusis pasaulis atrodė realesnis nei tikrasis pasaulis / The virtual world seemed more realistic than the real world.



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WBLT klausimynas / WBLT questionnaire

Žiniatinklio mokymosi priemonės (ŽMP) dar vadinamos mokymosi objektais - yra interaktyvios priemonės, kurios padeda mokytis konkrečių sąvokų, stiprindamos, sustiprindamos ir (arba) nukreipdamos besimokančiųjų kognityvinius procesus.

The Web Based Learning Tools (WBLT) also known as learning objects, are interactive tools that support the learning of specific concepts by enhancing, amplifying, and/or guiding the cognitive processes of learners.

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	1	2	3	4	5	
Visiškai nesutinku / Strongly disagree	○	○	○	○	○	Visiškai sutinku / Strongly agree

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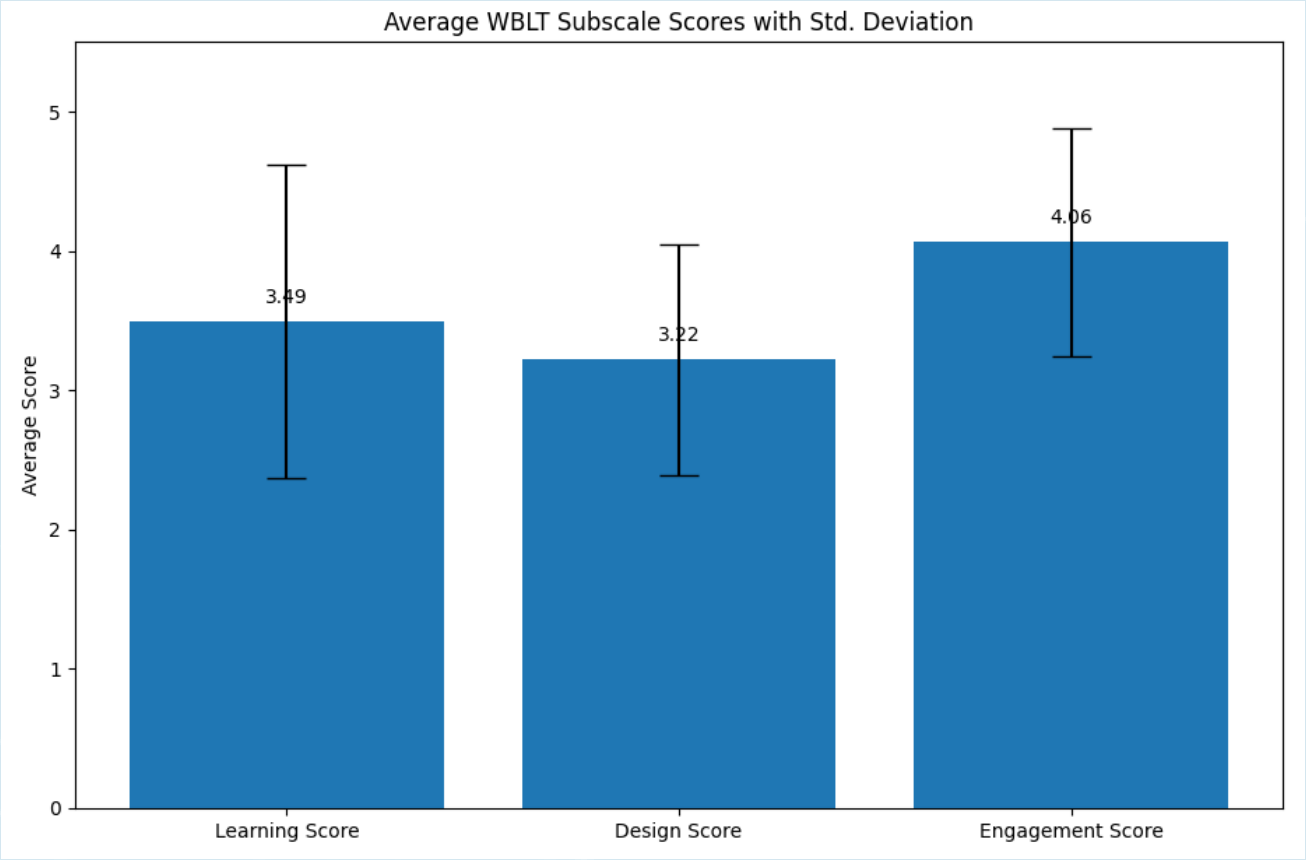

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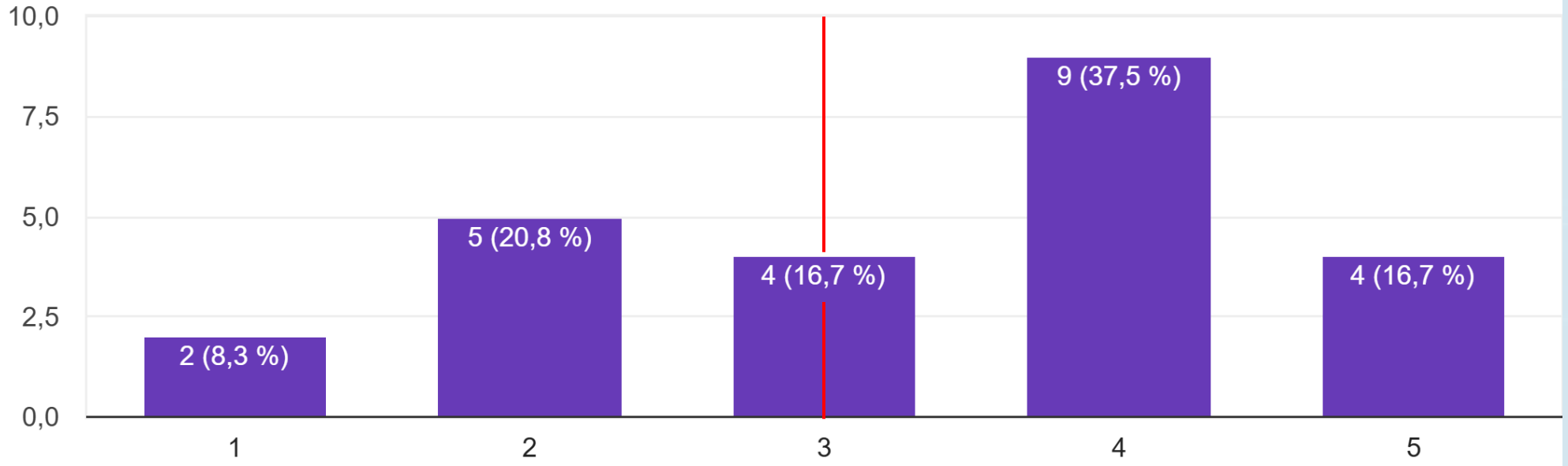
Mokymasis / Learning

1. Darbas su mokymosi objektu man padėjo mokytis / Working with the learning object helped me learn.



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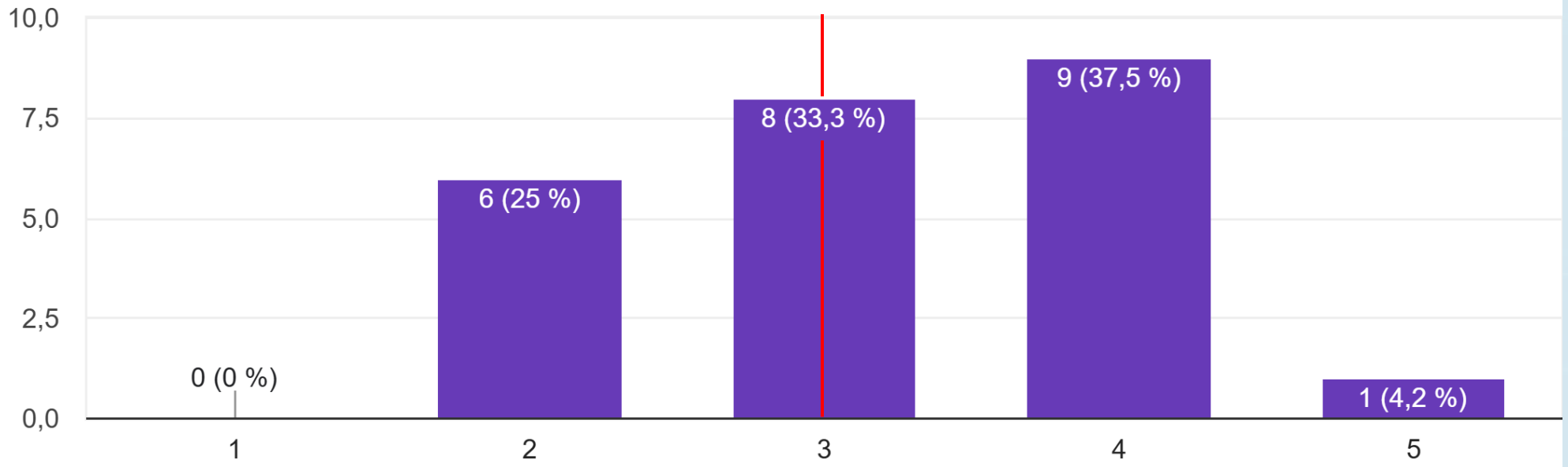
Projekto dizainas / Design

9. Mokymosi objektas buvo tinkamai parengtas / The learning object was well organized



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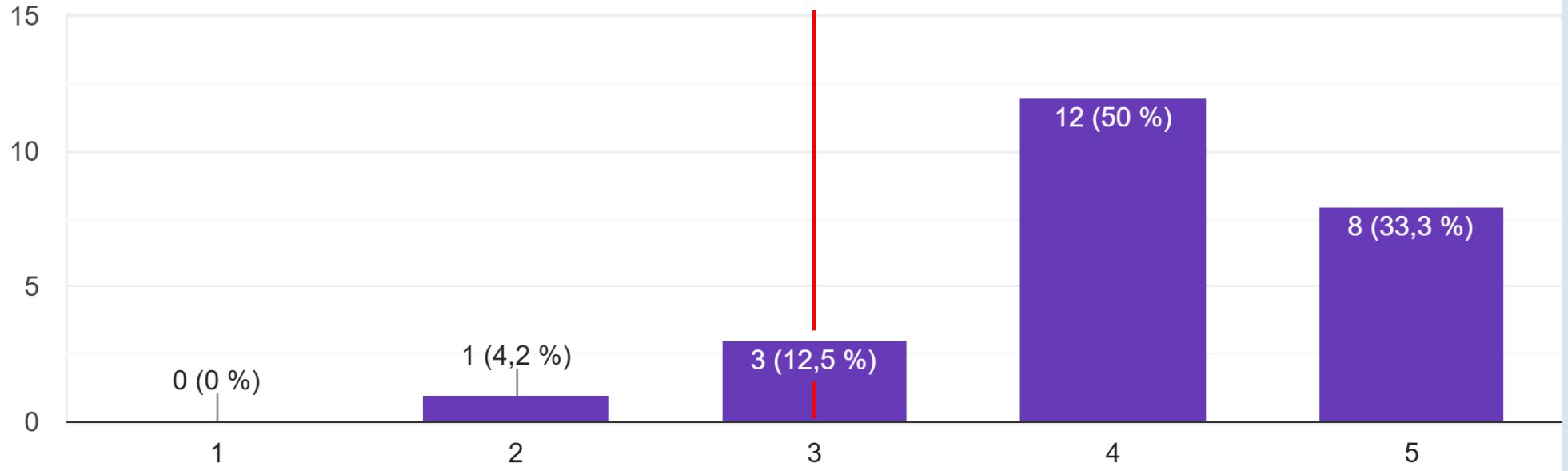
Įsitraukimas / Engagement

9. Mokymosi objektas buvo tinkamai parengtas / The learning object was well organized



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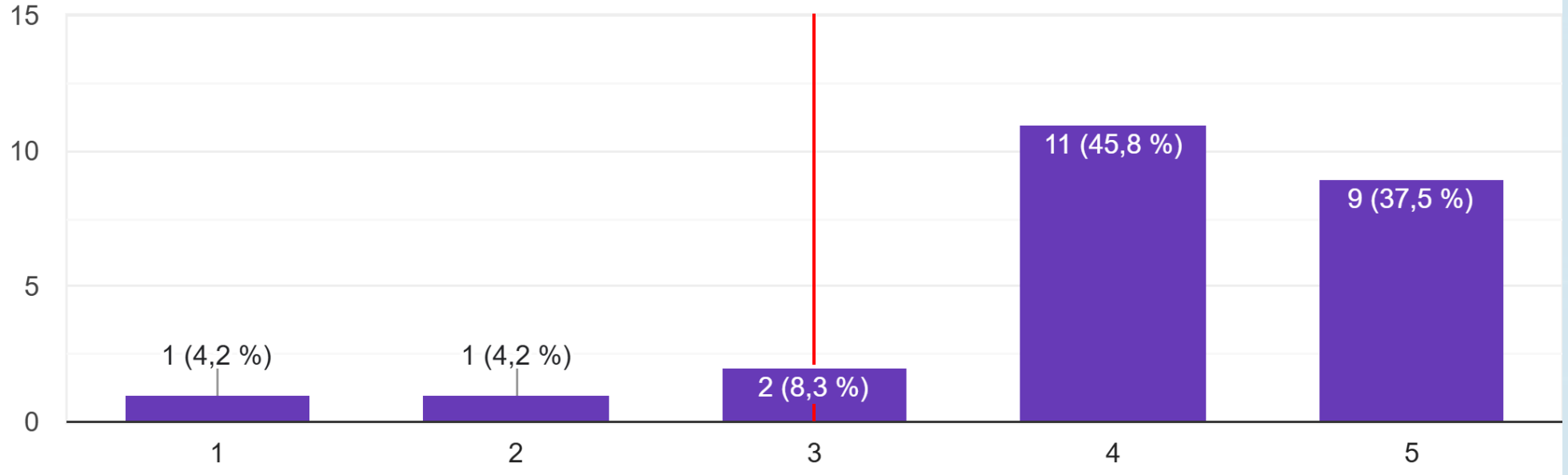
Įsitraukimas / Engagement

12. Su mokymosi objektu mokytis buvo įdomu / The learning object made learning fun



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Virtualios realybės “ligos” klausimynas (VRLK) / Virtual Reality Sickness Questionnaire (VRSQ).

Tai klausimynas, naudojamas įvertinti diskomfortą, akių įtampą ir dezorientaciją, kurią žmogus gali patirti naudodamasis virtualią realybę.

This is a questionnaire used to assess the discomfort, eye strain, and disorientation that a person may experience while using virtual reality.

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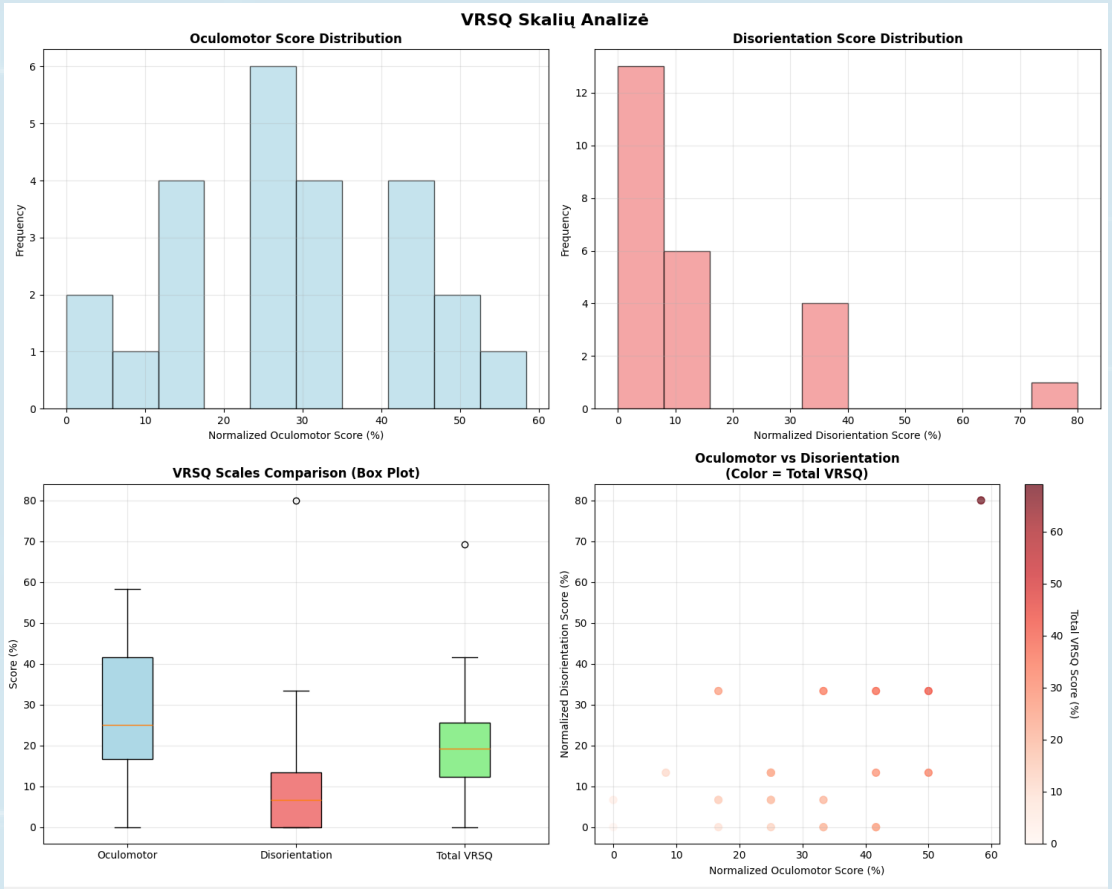

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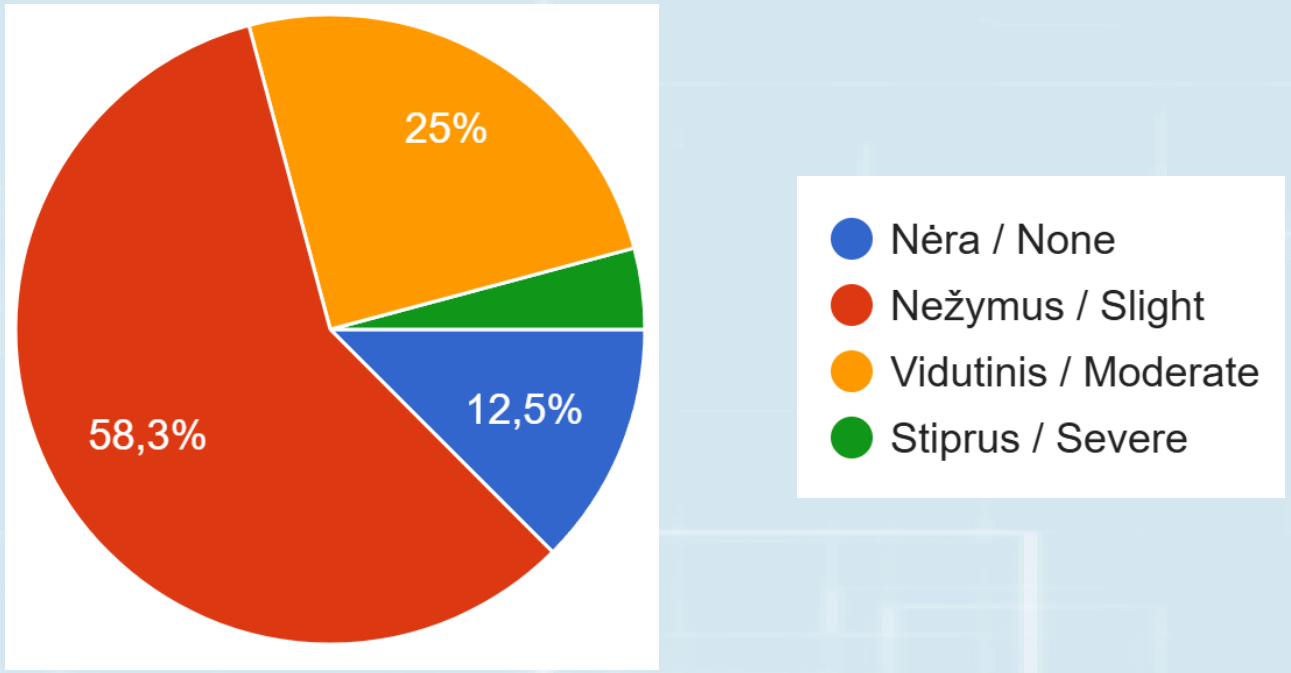
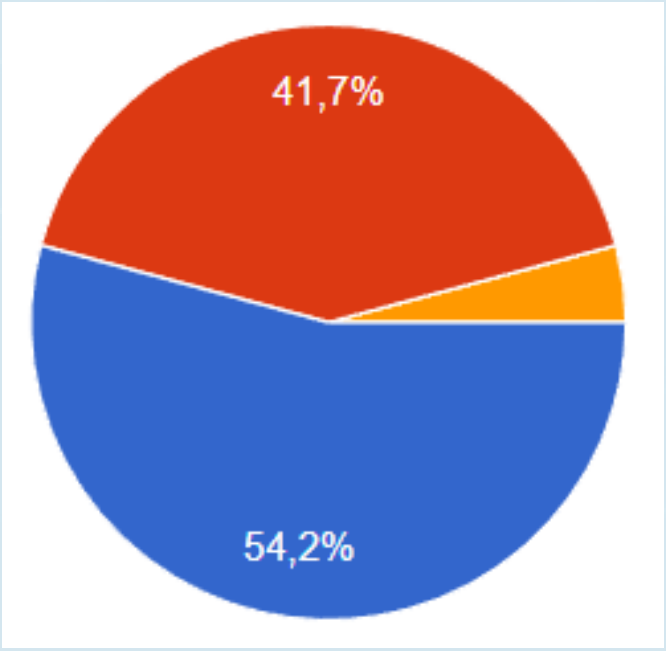
1. Bendras nepatogumas / General discomfort



2. Nuovargis / Fatigue



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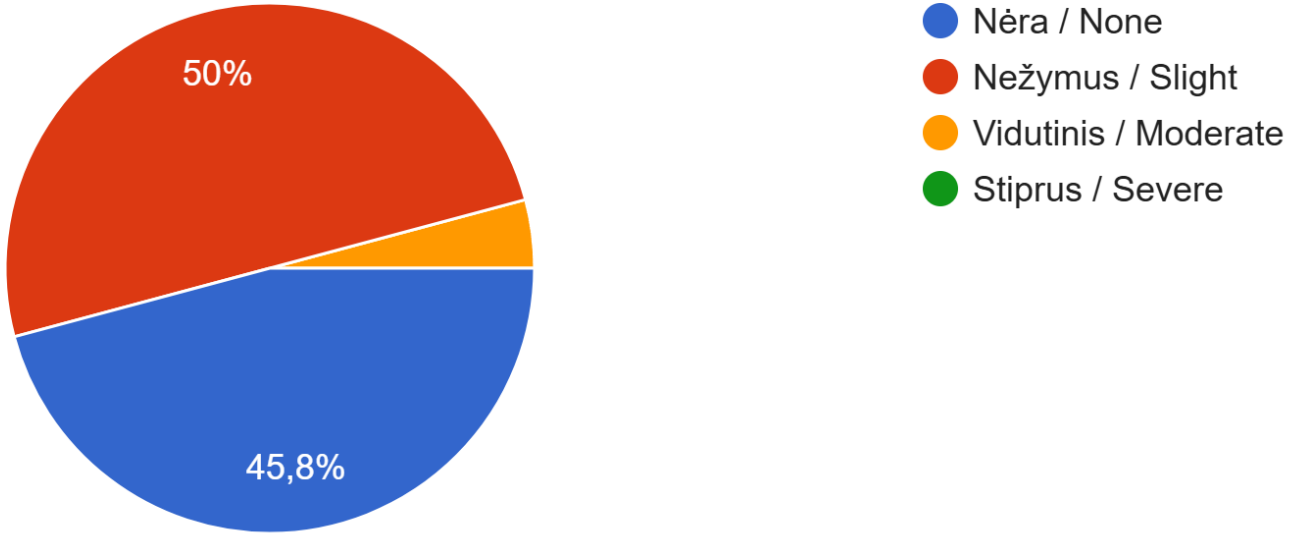
4. Sunkumas susikaupti / Difficulty focusing

24 atsakymai



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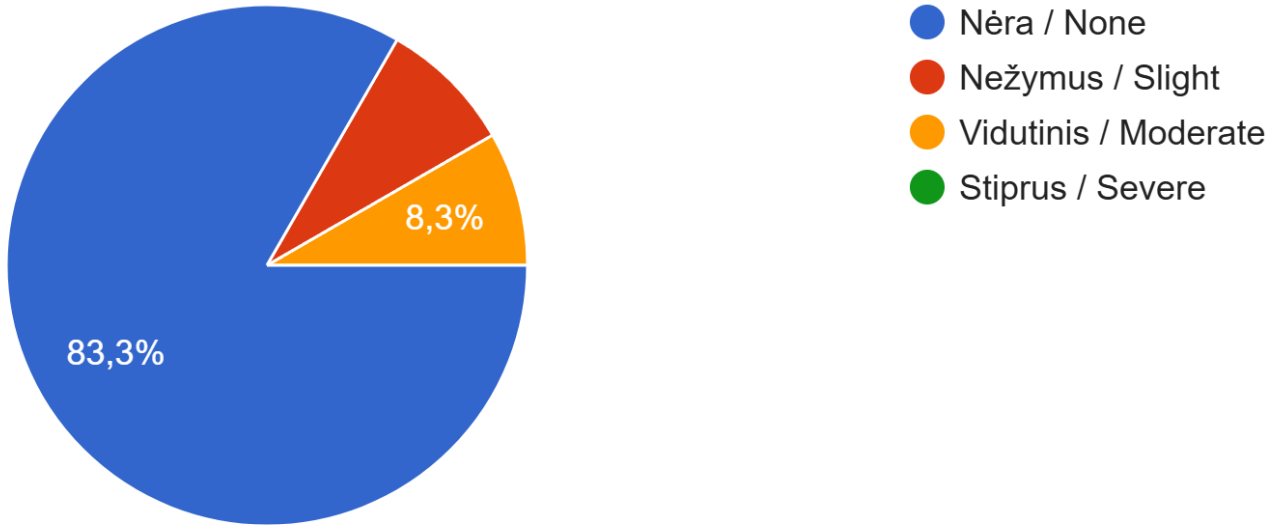
5. Galvos skausmas / Headache

24 atsakymai



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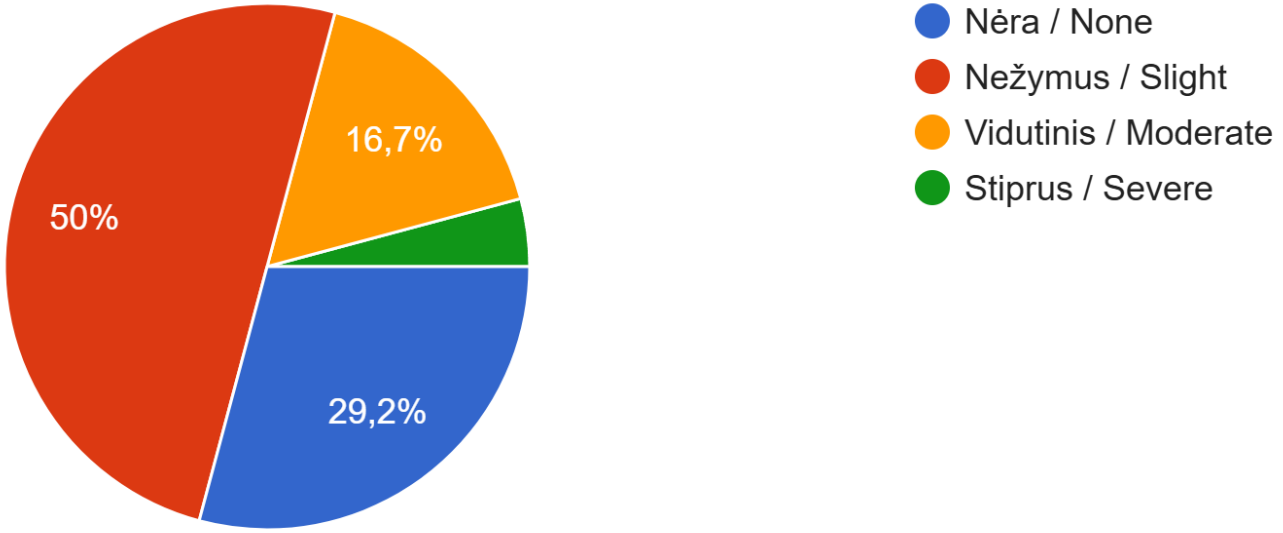
7. Neryškus regėjimas / Blurred vision

24 atsakymai



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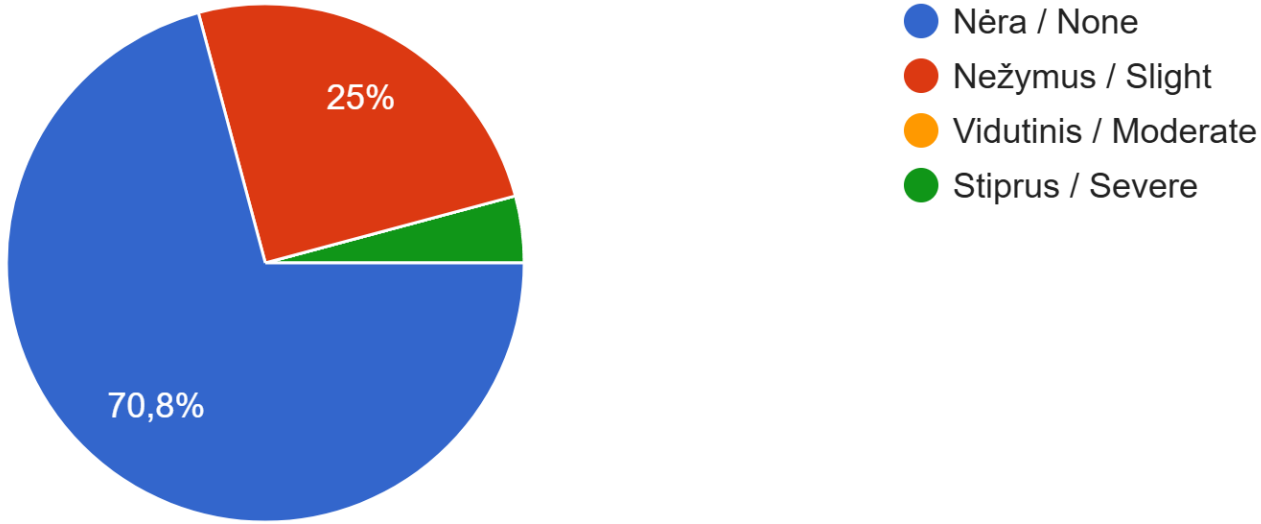
8. Galvos svaigimas (užmerkus akis) / Dizzy (eyes closed)

24 atsakymai



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SUBJECTIVE OPINIONS OF MEDICAL STUDENTS

- We need better, more accurate and sensitive haptic devices.
- We need a more interactive virtual environment.
- We need smoother operation of the VR environment and greater realism.
- We need training on VR, AR, MR, haptic technologies, their management, use in education and medicine, and management.

- We need targeted adaptation of tasks to existing curricula.

- The virtual environment "forces" you to focus more on the action and task completion.

- We need larger-scale studies with larger numbers of respondents.

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Immersive Surgical Edu

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Results of the simulation evaluation of medical students at the Lithuanian University of Health Sciences.

Lithuanian University of Health sciences (LUHS)
15-16 October 2025, Kaunas, Lithuania

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