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Cognitive Load/flow and Performance in Virtual Reality Simulation Training of Laparoscopic Surgery

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IEEE VR
LISBON 2021

How to evaluate the influence of virtual reality based surgery simulator on medical students?

Traditional methods:

Interactivity	1 When I play the game there is very little waiting time between my actions and the computers response
	2 Interacting with the game is fast
	3 The game I played usually load quickly
Challenge	1 Playing the game challenges me
	2 Playing the game challenges me to perform to the best of my ability
	3 Playing the game provides a good test of my skills
Skill	1 I am extremely skilled at playing the game
	2 I know somewhat more than most users about playing the game
	3 How would you rate your skill at playing the game, compared to other things you do on the computer?
Telepresence	1 I forget about my immediate surroundings when I play the game
	2 Playing the game often makes me forget where I am
	3 After playing the game, I feel like I come back to the ' real world ' after a journey
	4 When I play the game, I feel I am in a world created by the game I played
	5 When I play the game, my body is in the room, but my mind is inside the world created by the game I played
	6 When I play the game, the world generated by the game I play is more real for me than the ' 'real world'
flow	1 Do you think you have ever experienced flow in the game?
	2 Most of the time I play the game I feel that I am in flow
Involvement	1 I give myself pleasure by playing the game

Questionnaire

Anonymous scoring

Interview

Subjective approaches

How to evaluate the influence of virtual reality based surgery simulator on medical students?

Our methods:

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flow	1	Do you think you have ever experienced flow in the game?
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Involvement	1	I give myself pleasure by playing the game

Physiological & Psychological Data

[Heart rate, EEG**]** & **[**Flow, Cognitive load**]**

Subjective approaches

Objective approaches

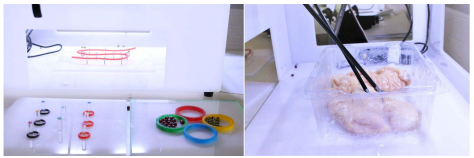
Our Contribution

Experiments

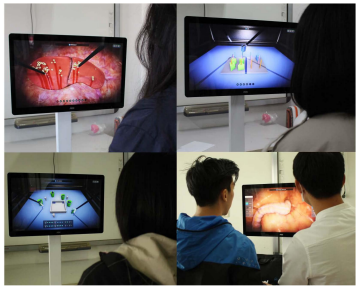
Step 1:
Surgery tasks
on training box


Polar H10


Muse S2



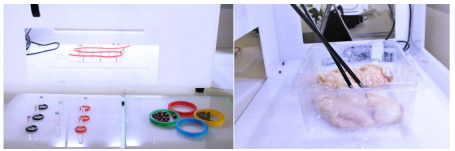
Step 2:
Surgery tasks
on VR smulator



Step 3:
Surgery tasks
on training box


Polar H10


Muse S2



The heart rate and EEG is recorded during step 1 and step 3.
The oporation videos are recorded during step 1 and step 3.
The medical skills of participants are evaluated using their operation videos.

Data

Laporoscopic surgery Tasks:

1. FT : fundemental laparoscopic surgery tasks
2. CRT: colon resection task

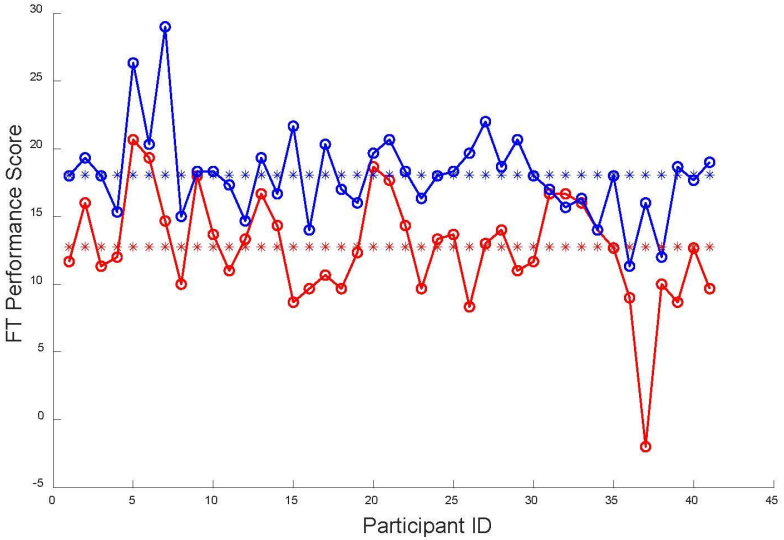
Raw Data:

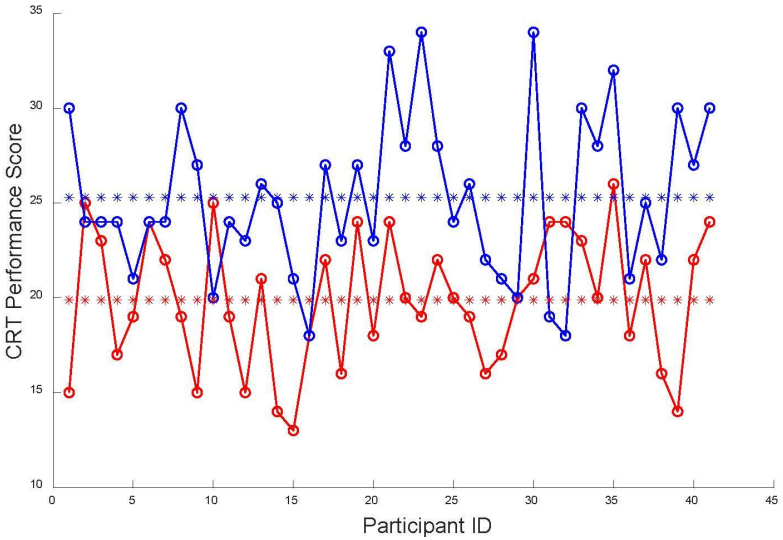
3. Operation videos (step 1 and step 3) of participants
4. EEG and heart rate
5. Questionnaires about flow experience and cognitive load

Data after preporcessing

1. Performance scores from operation videos
2. Cognitive load scores from EEG
3. Flow experience scores and cognitive load scores from questionnaires

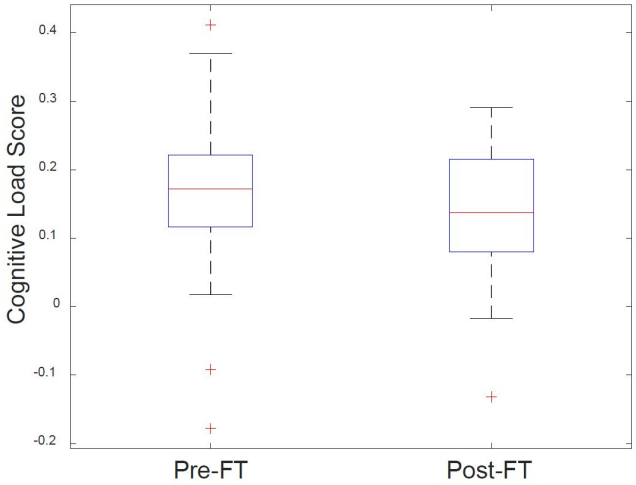
Results: Performance

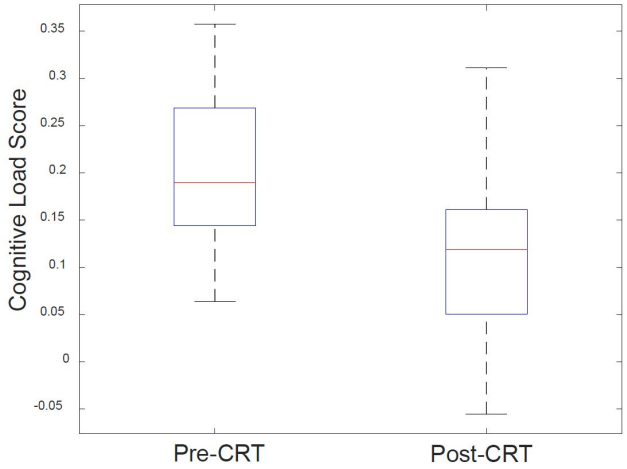




The blue curve is the performance scores of pre-test.
The red curve is the performance scores of post-test

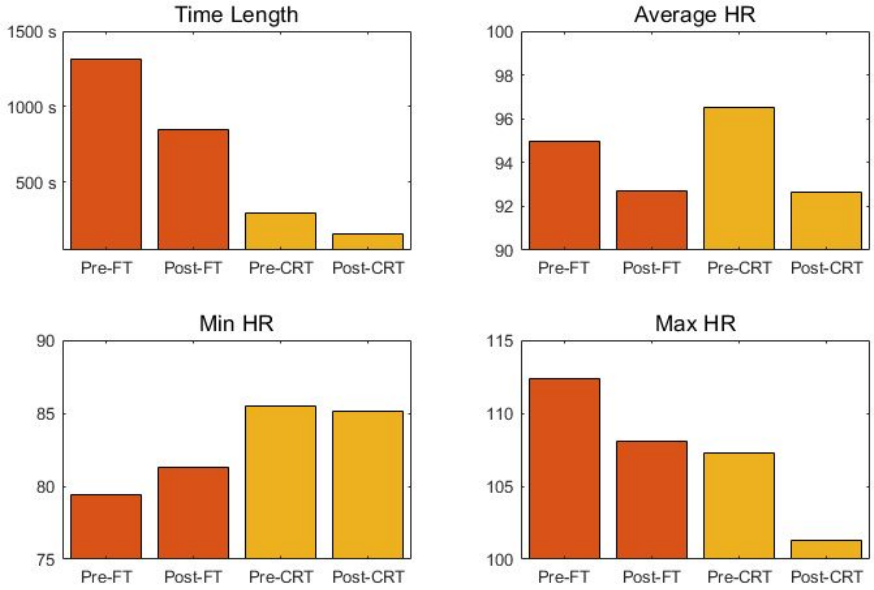
Results: Cognitive load





FT means fundemental laparoscopic surgery tasks
CRT means colon resection task

Results: Heart rate



Results: Correlation

	Pre-test Performance	Post-test Performance
Pre-FT	↓ *	NA
Pre-CRT	↓ **	NA
Post-FT	NA	↓
Post-CRT	NA	↓ *

**: 0.01 level significant, *: 0.05 level significant, NA: Not Available

The correlation of performance and cognitive load computed by EEG data. (The downward arrow↓means negative correlation.)

Conclusion

We quantitatively investigate the influence of VRLS on medical students from three aspects:

1. performance evaluation,
2. physiology (heart rate and EEG)
3. self-reported cognitive loadand flow experience.

The experimental results demonstrate that the VRLS could highly improve medical students' performance and enable the participants to obtain flow experience with a lower cognitive load.