Smart-learning: home-workplace effect on (dis)comfort and lessons effectiveness during Covid-19 lockdown

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ABSTRACT

The COVID – 19 pandemics paralyzed the traditional “in presence” classes and obliged professors and students to organize their homes to make them suitable to provide and attend the online courses. The institutions quickly shifted to eLearning and provided online courses through several technological platforms and virtual classes. Students organized their home-workstation to recreate a comfortable learning environment. This closure led to solving several problems, such as adapting complex/traditional lessons in eLearning format even though problems with Wi-Fi connections. A published survey among Italian academic staff and students allowed to identify and highlight the factors that affect ergonomics of a workstation (learning and teaching place), postural and environmental comfort and teaching/learning effectiveness. Based on these factors, students’ most popular workstation layouts were identified through a previous experiment with 32 students. In this paper, those layouts were deeply investigated, analysing in-depth effects on perceived (dis)comfort and learning effectiveness by considering anthropometric variability and body postures. Results showed that the best layout in terms of postural comfort, visual comfort and learning effectiveness is the one with laptop and notebook placed frontally.

KEYWORDS

eLearning effectiveness, perceived (dis)comfort, electronic devices layout

Introduction

The health emergency COVID-19 (World Health Organization, 2020) forced students and professors to change, suddenly and radically, their learning and teaching way: the traditional "in presence" lessons were converted into online lessons (Girik Allo, 2020; Mulla et al., 2020). The current scenario had no previous similar situations, and it was something new at the very early stages of the pandemic. The new eLearning approach implied several changes that positively or negatively impacted the teaching/learning effectiveness and wellbeing of all the people involved (Girik Allo, 2020; Malkawi et al., 2021; Mulla et al., 2020; Reyes-Chua et al., 2020; Roman & Plopeanu, 2021). Naddeo A. et al. (Naddeo et al., 2021) investigated factors that affected teaching/learning effectiveness and general human comfort and wellbeing after the sudden transition from classrooms to eLearning platforms due to COVID-19 in Italy. The necessity to interact with colleagues, adapt our apartments for eLearning courses, and use several devices are examples of the various aspects that emerged from this work (Naddeo et al., 2021). As a main result, essential influencing factors, in terms of learning/teaching effectiveness and perceived postural comfort/discomfort, that need to be deeply investigated have been highlighted in a table (Naddeo et al., 2021). Some of them, like cognitive factors during the eLearning process, devices', postures', distraction's, and visual comfort-related factors, have been investigated through Califano’s work (Califano et al., 2021), giving guidelines to recreate the best workstation in terms

of high perceived comfort and learning effectiveness. In this paper, three different workstation layouts were analysed. The aim was to investigate if and how a different layout influenced the (dis)comfort perception and the eLearning effectiveness.

Methods & Materials

Questionnaires

Questionnaires were developed with the Google Forms platform and spread during the online lessons. First clustering questions regarded gender, age, weight, height, left/right-handed. Also, information about the type of desk and table and the screen size of the utilized devices were acquired. Then, Body Part Discomfort questionnaire with 5-point scales (Grinten, 1992), global discomfort, global comfort, visual comfort (on 10-point scales) were asked to monitor students' wellbeing. Moreover, since there was a break, students were asked to rate the global perceived comfort on a 10-point scale and select the actions taken during the break to analyse the break's influence on wellbeing. Finally, the last question (multiple choice) regarded the disturbing factors that emerged during the online lesson. As far as learning effectiveness, students were asked to perform an end of lesson test about the topic covered during the attended lesson.

Participants

Thirty-Two Master Degree students (5 Females and 27 males) took part in the experiment. 28 of them were right-handed, 2 left-handed and 2 both-handed. Experiments were designed according to Ethical Guidelines of University of Salerno and all participants signed the Experiment's Informed Consent. Participants' anthropometric data are gathered in Table 1.

Table 1: Anthropometric data (n=32)

	Age (years)	Height (cm)	Weight (kg)
Mean	24.91	175.19	74.42
Std. Deviation	1.78	9.30	15.32
Range	22-30	155-193	47.50-115

Layouts

For the experiments, students adopted a workstation with a desk, an office chair and a laptop whose screen size varied between 14" and 17".

During the experiments three workstation layouts were analysed (Figure 1):

- Layout 1 (test 1 & test 4): Laptop and notebook (or draft book) frontally and the smartphone beside (right or left indifferently)
- Layout 2 (test 2 & test 5): Notebook (or draft book) frontally, the smartphone beside (right or left indifferently) and laptop on the opposite side to the hand each student was writing with, so laptop on the right for left-handed and laptop on the left for right-handed
- Layout 3 (test 3 & test 6): Notebook (or draft book) frontally, the smartphone beside (right or left indifferently) and laptop on the same side to the hand each student was writing with, so laptop on the right for right-handed and laptop on the left for left-handed

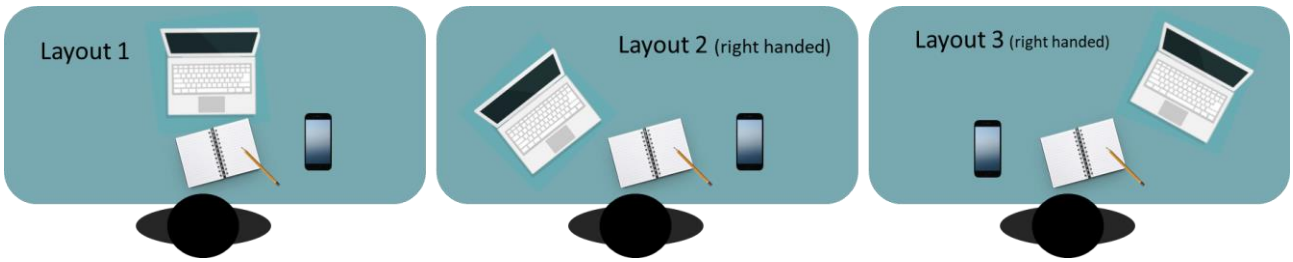

Figure 1: Layouts used during experiments (with examples for right-handed)

Protocol

Each layout was analysed twice, a two-hour lesson (with one break) and a three-hour lesson (two breaks). Thus, experiments were conducted in 6 online lessons. The experiment protocol for a two-hour lesson was the following:

1. Before beginning the lesson, students filled the first part of the questionnaire (5 min) about personal data, the type of chair and desk, and the laptop screen size.
2. Forty minutes of online lesson.
3. Immediately after 40 minutes of the lesson, students were asked to evaluate Body Part Discomfort questionnaire on 5-point scale, the perceived global discomfort, global comfort and visual one on 10-point scales.
4. Break of 10 minutes.
5. Immediately after the break, students were asked to report their actions during the break (coffee break, talk to someone, make a call, etc.) and their overall perceived comfort.
6. Same of points 2 and 3.
7. At the end of lesson, students had to report information about disturbing factors during the 2-hours lesson (5 min).
8. Finally, the professor gave a test (20 min) to evaluate the learning effectiveness of the topic covered during the lesson.

The experiment protocol for the 3-hour lesson was the same but with 2 breaks, so points 2-5 were repeated twice.

Results

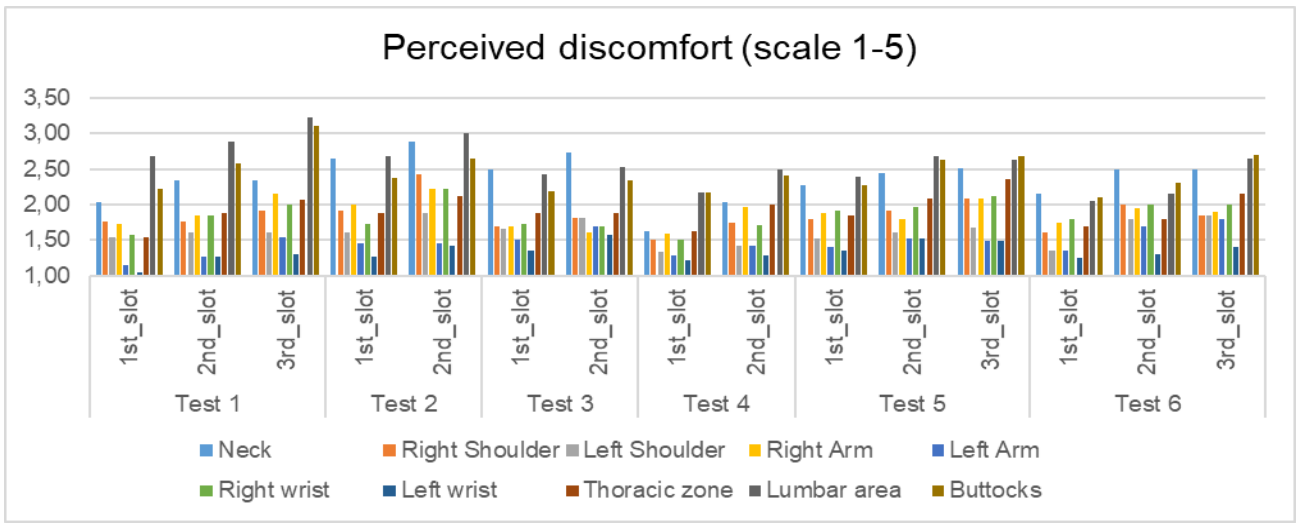

Figure 2: Results from Body part discomfort for 6 lessons

Figure 2 shows results from the Body Part Discomfort rated after each 40-minute lessons. For each lesson, the perceived discomfort arose, and the most affected body part were the neck, lumbar area

and buttocks. Adopting the eLearning approach implies staying sitting for several hours, which influences discomfort in the back (particularly in the lumbar area) and the buttocks. Moreover, following the lessons on the laptop and at the same time taking notes means that students have to move their heads very often (their gaze switches continuously from the desktop to the notebook and vice versa). Data analyses show that the break, for almost all body parts, did not improve the perception of discomfort

Figure 3 shows Global Perceived Discomfort, Global Perceived Comfort and Visual Comfort rated after each 40-min lessons and break. For all the setup, the trend is similar. The pause had a positive impact on Global Perceived Comfort (Figure 3). The Global Perceived Discomfort increases overtime for all the setups, and this trend is aligned with the students' Body Part Discomfort. For the visual comfort, the trend varies for each setup slightly, and the values are higher for Layout 1 (Table 3). The most actions taken during breaks were walking (26%), using social media (20%), physiological/personal needs (28%), chatting (16%). Moreover, there were disturbing factors most of the time, either related to device/connection problems (about 30%) and presence of people in the house or calls/texts during lessons (50%).

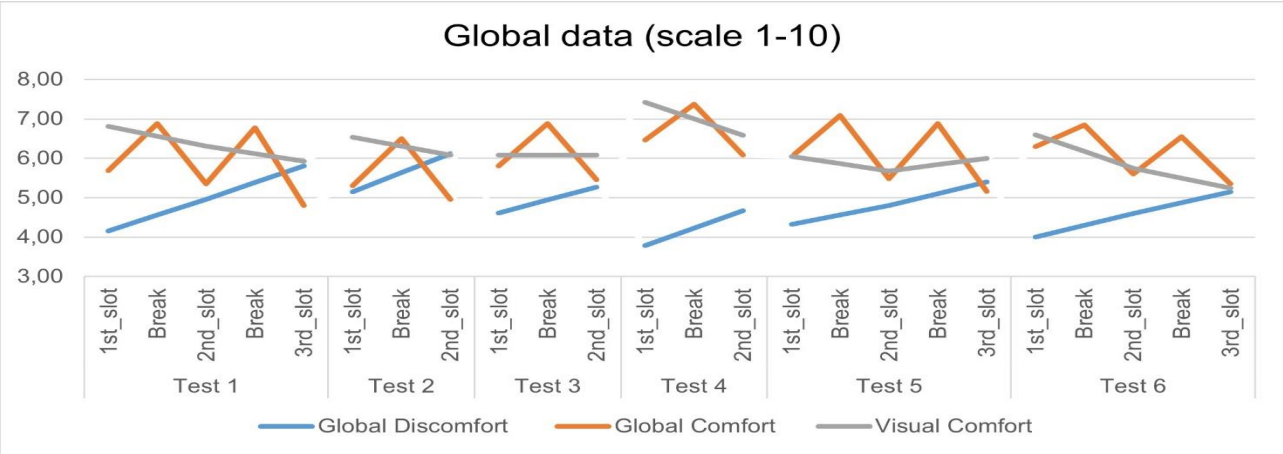

Figure 3: Results from questionnaires for global perceived discomfort, global perceived comfort and visual comfort for each test

Table 2:Mean values of Visual Comfort

	Layout 1		Layout 2		Layout 3	
	Test 1 (3h)	**Test 4 (2h)**	**Test 2 (2h)**	**Test 5 (3h)**	**Test 3 (2h)**	**Test 6 (3h)**
Visual Comfort (Mean)	6,34	7,00	6,31	5,88	6,08	5,86

As far as the learning effectiveness, evaluated with a test, thus students' marks, it has been statistically analysed with global perceived comfort, global perceived discomfort, visual comfort and disturbing factors. Results showed there are correlations only with visual comfort (Table 4). In particular, as visual comfort increases, learning effectiveness increases.

Table 3: Significant Spearman correlations between students marks and visual comfort

	Test 1	**Test 2**	**Test 3**	**Test 4**	**Test 5**	**Test 6**
Vis_1	0,229	0,323	-0,172	,494*	0,013	0,368
Vis_2	,407*	,433*	-0,118	,476*	0,036	0,422
Vis_3	0,278	-	-	-	0,079	0,271

* The correlation is significant at level 0.05 (2-queues)

So, considering the data collected and the results obtained, at this point, the question is: which is the layout that guarantees the best performance in terms of comfort? Are these results confirmed by the students who took the test? In Figure 4 results overview is shown. Layout 1 scored higher levels of global perceived comfort and visual comfort and lower global perceived discomfort. The students confirmed this result. At the end of the tests, indeed, students were asked to choose the preferred layout out of the three. From the test emerged that 61% of the sample preferred Layout 1, 35% Layout 2 and 4% Layout 3. One of the reasons is that placing the laptop in front, the neck, which is the more stressed body part (Smulders et al., 2019), was less subjected to lateral flexion and rotation. Moreover, Figure 4 shows that Layout 3 is better than Layout 2 in terms of comfort and discomfort. Despite this, only 4% of students preferred Layout 3 because the laptop position limited the available space to write. All these motivations emerged from feedback discussions with the students.

Figure 4: Analysis of the 3 layouts in terms of perceived Global (Dis)comfort and Visual Comfort. The data relating to the 2 online lessons (2 and 3 hours) have been merged in their specific layout.

Conclusions

In this study, three different layouts, during eLearning lessons, have been analysed on a class of 32 Italian Master Degree students. Students have been following eLearning for over a year and are aware of the problem faced. Each layout was characterized by a laptop, a draft book, and a possible smartphone, placed differently. The aim was to evaluate if and how a different workstation layout influenced the (dis)comfort perception and the eLearning effectiveness. Results showed that the best layout in terms of (Dis)comfort perception and Visual comfort was Layout 1, which was with laptop and notebook (or draft book) placed frontally and the smartphone beside (right or left indifferently). Indeed, Layout 1 implied fewer neck movements such as lateral flexion and rotation, and it was the preferred layout for students. About the body part discomfort, no essential differences among the setups emerged. Furthermore, for all setups, the most discomfort affected body parts were the neck, lumbar area and buttocks; perceived discomfort increased over time (also showed in (Cecco et al., 2019; Vink et al., 2017)), and the break was beneficial for student's perceived comfort. About the learning effectiveness, there was not an essential difference among the tests. At the same time, the statistical analyses showed a significant positive correlation with visual comfort. It is interesting to underline that, even if data analyses indicated the layout 3 (laptop at the same side of the arm with which students write) was better than layout 2 (laptop on the opposite side of the arm with which students write), layout 3 was preferred only by 4% of students. Students motivated by this choice affirmed that this layout limited the space available. The results could be useful to recreate and organize an ideal workstation for eLearning to reduce discomfort and to increase learning effectiveness. However, some limitations need to be acknowledged. The sample is homogeneous and the setup with more screens was not investigated. Thus, further research with different samples and layouts is recommended.

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