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Time and space dimensions of computer laptop use amongst third year students of the University of the Free State

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ABSTRACT

To broaden the knowledge base of occupation, therapists should understand how spaces, objects and time components support, shape and inhibit occupational performance. The aim of this study was to describe the spatial and temporal dimensions of laptop use amongst students at the University of the Free State in 2013. A descriptive study design was used with a sample of 216 third year students who make use of a laptop computer for academic and/or recreational purposes. Data were collected by means of an anonymous self-administered questionnaire in which the spatial and temporal dimensions were investigated. Student's postural configurations were identified and prioritised according to frequency of preference. The three most preferred positions during the academic year were sitting at a table on a chair with backrest (39.8%), sitting with one's back against a vertical surface (17.6%) and lying on one's back (11.1%). The median time spent on a laptop was 38.5 hours per week, which occurred in a variety of spatial contexts. Specific postural configurations and time components relative to the occupation of laptop use are conceptualised in this study. Recommendations call for a study to investigate the association between the preferred postural configurations and postural risks with the use of laptop computers.

Key words: Laptop, university students, occupational therapy, spatial dimension, temporal dimension, technology

INTRODUCTION

Technology is an undeniable and crucial part of modern day living[1,2]. The demands and burdens of this fast-paced lifestyle can be made lighter with the aid of quick access provided by portable devices such as laptops. Bowman, Braswell, and Cohan[3] stated that computer usage has shifted in the last decade from desktops to laptops, especially among college and graduate students.

In a study amongst 154 college students, Chang and colleagues found that 88% of the population in the United States of America owned a laptop and that a growing number of students prefer to make use of laptop computers instead of desktop computers[4]. This finding is supported by the Pew Research Centre and the American Life Project who indicated that 88% of undergraduate college students made use of laptops in 2010[5]. Results from these studies confirmed that, due to the convenient size and portability, the laptop was, second to the smartphone, the preferred choice of all technological devices amongst students. No previous studies were done in the South African context on the use of laptops amongst university students. Within the Student Computers and Networks (SCAN) initiative, the University of the Free State joined forces with twelve other universities to implement the "Student Laptop Initiative"[6]. The aim of this project is to provide a laptop to every first-year student who registers at the University of the Free State.[7]

Evidence from literature indicates concern regarding the effects that laptop use has on the human body[8]. Straker, O'Sullivan, Smith[9] and Gold, Driban and Yingling[10] investigated the deviation from ideal posture associated with laptop use and confirmed the positive relation between the use of laptops and the compromising effects on the human body, such as musculo-skeletal disorders (MSD's). Although assuming an awkward posture is known to put laptop users at high risk of MSDs, other risk factors must also be considered, such as working over a prolonged period of time, having insufficient rests in between work sessions, and maintaining a static work posture[11].

From an occupational performance perspective, the study reported in this paper focussed on the components of time and space when students use laptop computers, as these components are still under-reported in the research domain. Pierce[12]classifies these components as temporal and spatial dimensions within the context of occupational participation.

Important dimensions of the spatial context of occupation include the objects that a person uses, as well as the conceptualisation of spaces in which occupation takes place. The design of the current laptop computers have a screen attached to the keyboard. This design presents a severe restriction to the user in choosing a comfortable position to work from. Laptop use encourages postural mal-alignment such as forward flexion of the neck and head, which result in biomechanical responses that may lead to a mal-alignment in the natural curvature of the neck and spine[13].The design of laptops does not accommodate ergonomic principles of normal postural alignment, which necessitate amongst others that the keyboard be located at elbow height and the top of the screen be positioned at eye level. Prolonged periods of laptop use may lead to repetitive strain on joints and soft tissues due to the postural position that the user assumes. In a study amongst 100 college students, Chavda and colleagues established that students frequently used a prone posture, floor sitting and sitting with laptops on lap[14]. Chavda et al emphasised the need for more research between laptop usage and musculo-skeletal disorders. The American Occupational Therapy Association states that the physical area in which an individual lives daily can either support or limit his or her performance[15]. The way in which the physical environment provides support for or limits use of laptop computers will influence individuals' behaviour and responses to the environment.

In addition to the spatial context, Pierce[12] also emphasises the equally important aspect of the temporal context of oc-

cupational engagement. The temporal context encompasses an individual's physical, mental and behavioural changes within a 24-hour cycle. While performing tasks using laptop computers, Hochnanadel[11]demonstrated significant relationships between the percentage of respondents who present with MSDs and both the hours and years of computer use in a study that surveyed 3300 employees in a factory setting.

Anecdotal evidence exists about the high number of students who use laptops, as well as the ergonomic challenges and work-related musculo-skeletal problems that are associated with their use. However, no evidence was available at the time of this study about the positions that students assume, nor the time that students spend while using their laptop computers on campus. Information on these two factors relates directly to dimensions of space and time as it translates to the knowledge base of occupational dimensions of activity performance.

The aim of this study was to investigate and describe the time and space dimensions that were integral in the use of laptop computers amongst third year students across academic disciplines of the University of the Free State in 2013, as well as the changes that students made in relation to specific and general spatial dimensions. Results from this study will assist in the development of intervention strategies to minimise the incidence of musculo-skeletal disorders related to the use of laptops amongst students.

METHODOLOGY

This was a descriptive study. Ethical authorisation was obtained from the Ethics Committee of the Faculty of Health Sciences at the University of the Free State (ECUFS: 05/2013). After receiving clearance from the Ethics Committee and academic authorities, Housing and Residence Affairs arranged for a 30-minute slot and venue at a convenient time with each of the 18 student residences for the collection of data. The study was conducted over a two week period. A total of 450 third year students were invited to participate in the study. Students were informed of the study at a house meeting in the respective residences, and the inclusion and exclusion criteria were presented to the students. Students in their third year, who had no spinal cord disorders and who exclusively made use of a laptop computer were included in the study. All the participants who met the inclusion criteria were asked to complete the questionnaire after the house meeting. Questionnaires and consent forms were handed out by the researchers and they were present for any questions. After the participants completed the questionnaires, they posted the questionnaire into a closed box with a slip as they left the room. The response rate was 48%, as only 216 attended the house meetings. The study was anonymous and due to time constraints no other opportunity was available for data collection.

The decision to include third year students only was pre-empted by the assumption that third year students have already established an occupational pattern relating to time and space dimensions when using a laptop computer. Schlossberg, Morrow, Llosa[16] and Shantakumari, Eldeeb, Sreedharan[17] mention that improper ergonomics manifest even before students reach graduation.

Data collection Instruments and procedures

Data were obtained from participants by means of an anonymous, self-administered questionnaire which was compiled and drawn up by the researchers after perusal of relevant literature[10,12]. The items on the questionnaire comprised both open and closed questions. The questionnaire was available in Afrikaans and English. The content of the questionnaire reflected theory of contextual dimensions of occupational participation, previous experiences of the researchers in the field of musculo-skeletal disorders, as well as information obtained from literature pertaining firstly to the postural positions assumed during laptop usage, and secondly, related musculo-skeletal complaints. The questionnaire consisted of two sections, namely (1) demographic information and (2) contextual dimensions that specifically focuses on the time and space dimensions. Nine selected positions related to the most primary spatial aspect for laptop use (as described by Frank[18]), see *Table I* (see page 29), and were graphically illustrated as options from which students could select. The time and space dimensions were measured by means of questions regarding where the laptop is used, adaptations or changes, such as lighting, sound and temperature, made during laptop usage and for how long the position is used.

Prior to the study, a pilot study was conducted with four second year students (two from each type of residence), selected conveniently, who owned a laptop. The purpose of the pilot study was to identify possible terminology errors; test the clarity of the information letter, consent form and questionnaire; ensure that the correct language was used; prevent coding errors; and to determine how long it would take to complete the questionnaire. Students were interviewed afterwards to determine whether they had any problems. No changes were needed.

The researchers were responsible for the distribution and collection of the questionnaires. The purpose of the study, as well as the inclusion and exclusion criteria, were explained to all participants before the distribution of the questionnaires. Selection occurred at this time if problems were identified. Participation in the study was voluntary and participants were informed that they could withdraw at any time. On completion of the questionnaires, each participant placed his/her questionnaire in a box, before exiting the venue.

Data analysis

Descriptive statistics, namely medians and percentiles for continuous data and frequencies and percentages for categorical data, were used to analyse the data. The genders were compared by means of 95% confidence interval (CI) for the percentage difference.

RESULTS

A total of 216 third year resident students (61.1% female) participated in the study (48% response rate). The median age was 20 years (range 19 to 23 years).

The median time spent on a laptop was 38.5 (range 10.5 to210) hours per week, with most (96.8%, n=216) spending 14 hours and more on a laptop per week. The majority of participants

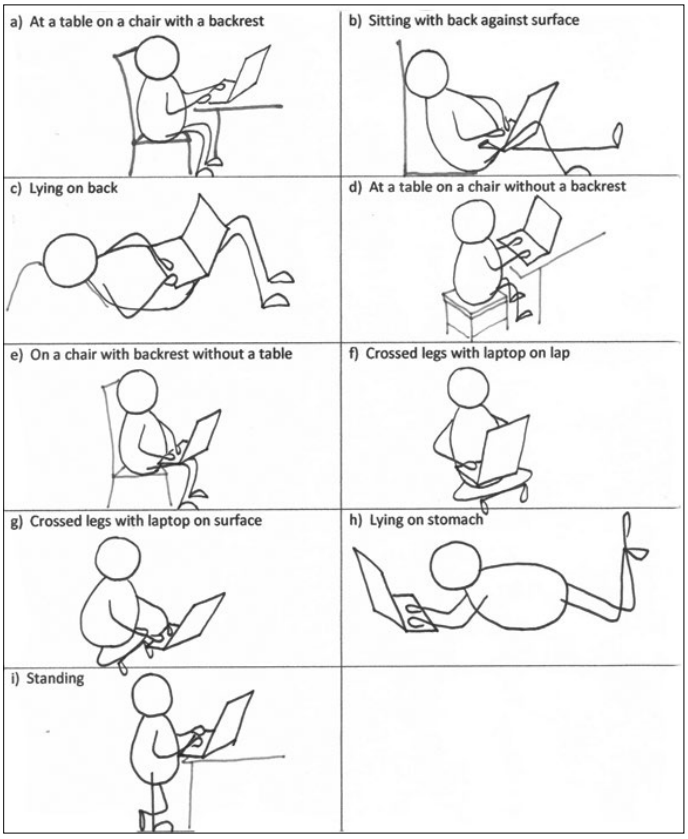

Figure 1: The nine positions assumed during laptop use

Table I: Description of various activities performed on selected technological devices

	Device used by participants (n=216)			
	Kindle	Tablet	Smartphone	Laptop
	2.3% (n=5)	13.9% (n=30)	68.9% (n=149)	100% (n=216)
WORK	75% (3)	90% (27)	71.8% (107)	100% (216)
Assignments	40% (2)	43.3% (13)	26.2% (39)	90.3% (195)
Research	40% (2)	73.3% (22)	51.7% (77)	84.7% (183)
Studying	40% (2)	60% (18)	24.8% (37)	84.3% (182)
Reading	60% (3)	66.7% (20)	38.3% (57)	48.6% (105)
Reports	40% (2)	23.3% (7)	12.1% (18)	59.7% (129)
RECREATION	100% (5)	100% (30)	96.6% (144)	96.3% (208)
Series	20% (1)	30% (9)	20.8% (31)	73.6% (159)
Movies	40% (2)	53.3% (16)	23.5% (35)	85.7% (185)
Music	40% (2)	76.7% (23)	71.1% (106)	81.5% (176)
Games	20% (1)	66.7% (20)	44.9% (67)	39.8% (86)
Social Networking	40% (2)	83.3% (25)	81.2% (121)	73.2% (158)
Blogging	20% (1)	20% (6)	9.4% (14)	13.4% (29)
News	40% (2)	40% (12)	43% (64)	42.6% (92)

(96.3%) used their laptops for both work and recreation, while 3.7% used laptops for work only. *Table I* indicates that laptops were the preferred choice amongst all technological devices for both work and recreation. Most (81.4%, n=210) participants indicated that they did not intend to replace their laptops with another device, such as kindles, tablets or smart phones. As can be seen in *Table I*, other devices were not used as frequently as laptops for assignments, research and studying. In addition to this, laptops are used less frequently for reading (48.6%) in relation to other devices.

Findings of this study indicated that a smartphone was found to be the device preferred second to the laptop while tablets and kindles were ranked third and fourth respectively. When requested to indicate what participants use their laptop for, work was indicated as the most prevalent option (see *Table I*).

Figure 1 on page 28 illustrates the nine positions included in the questionnaire for the purpose of determining the three most preferred positions while using laptops, as indicated in *Table II*.The three most preferred positions, in order were: a) at table on chair with backrest, b) sitting with back against a surface e.g. as sitting on a bed or against a wall on the floor, and c) lying on back. More than half (58.3%) of the participants chose to use position a) at table on chair with backrest, less often during leisure time than class, test and exam times. Fifty six percent of the students chose position b) sitting with back against surface, and 44.9% of participants chose position c) lying on back, more often during leisure time than during class, test and exam times.

Table II: The percentage of participants assuming different positions, whilst working on a laptop, during different times of the academic year. (n=216)

Positions	Classification of temporal context (frequency)			
	Class time	Test and/ or Exam time	Leisure time	Academic year*
a) At table on chair with backrest	71.8% (155)	79.2% (171)	58.3% (126)	39.8% (86)
b) Sitting with back against surface	51.4% (111)	37.9% (82)	56% (121)	17.6% (38)
c) Lying on back	39.4% (85)	30.6% (66)	44.9% (97)	11.1% (24)
d) At table on chair without backrest	27.3% (59)	25.0% (54)	18.1% (39)	7.4% (16)
e) On chair with backrest without table	26.4% (57)	23.6% (51)	18.1% (39)	6% (13)
f) Crossed legs with laptop on lap	19.4% (42)	15.3% (33)	15.3% (33)	3.7% (8)
g) Crossed legs with laptop on surface	16.7% (36)	14.4% (31)	10.2% (22)	2.3% (5)
h) Lying on stomach	11.1% (24)	12.9% (28)	15.3% (33)	2.8% (6)
i) Standing	8.8% (19)	11.1% (24)	6% (13)	2.3% (5)

*Academic year refers to class, test, exam, and leisure time collectively

Table III: Changes made in the dimensions of laptop use in relation to general and specific spatial contexts

	Laptop use in general (n=216)	Laptop use within specific spatial context		
		Desk	Bed	Floor
Percentage of participants (frequency)		91.7 (n=198)	52.8 (n=114)	3.2 (n=7)
Changes in dimensions of laptop use				
Additional mouse	45.4% (98)	46.5% (92)	38.6% (44)	71.4% (5)
Additional key-board	6.9% (15)	7.1% (14)	7% (8)	14.3% (1)
Height adjust-ment of screen	18.1% (39)	17.7% (35)	21.1% (24)	0
Pillows	37% (80)	37.4% (74)	39.5% (45)	57.1% (4)
Personal chair	19.9% (43)	21.2% (42)	N/A	14.3% (1)
Additional screen	4.6% (10)	5.1% (10)	5.3% (6)	14.3% (1)
Other	6% (13)	6.1% (12)	7.0% (8)	14.3% (1)

Other such as internet cord, speakers, phone, lap-desk, pillows on bed

Table III on page 29 indicates the proportion of participants using their laptops in relation to each specific spatial dimension while using a laptop. In addition to this, the changes made in the dimensions of laptop use within these respective spatial dimensions, are indicated. As seen in the table, an additional mouse and pillows were the changes mostly made during laptop use. Within the respective spatial dimensions, the same tendency was observed. Most participants (86.6%) made changes, though there was no difference found between the genders (95% CI [-16.8% ; 1.2%]).

Changes in the spatial dimensions of laptop use were also made regarding environmental factors. These changes can be seen in *Table IV*. The majority of the participants (98.6%) were influenced by various environmental factors while using laptops. These factors include lighting, sound, temperature and smell, and were measured by asking students to indicate what adjustments they made when these factors had an influence on their laptop use and also whether these adjustments had a positive influence. Few (23.6%) of the participants were influenced by all of the above-mentioned factors. More than 75% indicated that these changes positively influenced their usage of a laptop.

Table IV: Changes made to environmental factors that influence laptop use and the percentage of participants whose occupational performance is positively enhanced

Environmental Factors	Changes in relation to dimensions of laptop	Number (%) of participants	Occupational performance positively influenced by making changes (%)
Lighting (n=183, 84.7%)	Change own position	122 (66.7%)	148 (84.1%, n=176)
	Move light source	72 (39.3%)	
	Move to different room	5 (2.7%)	
Sound (n=153, 70.8%)	Use earphones/earplugs	129 (84.3%)	124 (82.7%, n=150)
	Move away	21 (13.7%)	
	Remove sound	15 (9.8%)	
Temperature (n=117, 54.2%)	Open window	86 (73.5%)	85 (75.9%, n=112)
	Use a fan, air conditioner or heater	43 (36.8%)	
	Change own position	35 (29.9%)	
	Move to a different room	6 (5.1%)	

Students were asked whether they experienced pain while using their laptop and to indicate where they experienced pain. Less than half of participants (47.7%; n=214) experienced pain while using their laptops. These participants (n=102) experienced pain in the lower back (57.8%), neck (52.9%), shoulders (38.2%) and upper back (24.5%), while 22.5% of participants experienced pain in both the neck and lower back. Students were not asked how often they experienced pain.

More females (95.2%) than males (86.4%) spent 21 hours and more per week on a laptop (95% CI [0.5% ; 16.3%]). Though no difference between genders were found regarding the anatomical regions where they experienced pain, statistically significant more males (55.4%) experienced pain than females (35.7%) (95% CI [6.0% ; 32.2%]).

DISCUSSION

In the late 1980's and early 1990's Clark et al. [19] and Yerxa[20] suggested that basic research be conducted on clinical issues as they relate to typical occupations in order to enhance therapeutic efficacy and meaning of occupations. During this time Mosey expressed a critical need for research on clinical issues and the usefulness of research into occupation was regarded as only limited, unless the research was complemented by specific strategies to bring this knowledge into practice[21]. The occupational design approach[12]offers concepts to translate basic knowledge of occupation into practice by focussing on the client's typical context in which the occupation takes place.

Results from this study confirm findings by Chang et al.[4], De Beer[22] and Bowman et al.[3] that indicate laptops to be the preferred technological device for educational purposes amongst university students. (see *Table I*). Bowman et al.[3] studied the ergonomic effects of laptop computer use, and stated that research is becoming increasingly more essential because of the popularity of this technology, and the possible detrimental effects on the musculo-skeletal system.

Laptops were originally designed with inherent design features to enable the user to perform computer related activities outside of the traditional office space.The inherent design features of a laptop however, make it suitable for use in non-traditional settings, often in combination with poor posture and for extended periods of time.

The appreciation of how spaces and objects support, shape and inhibit individual experiences and performance guided the researchers to select the nine positions, as described by Frank[18], that are representative categories of the positions that individuals assume during laptop use. These nine selected positions provided the study participants with a variety of options to choose from.

Gold et al.[10] established that in a population of twenty students between the ages of 18 and 24 years, the three most frequently selected postures in a non-desk setting were i) crossed legged ("Indian style") while seated with or without back support, ii) lying down with legs out, and iii) seated on a chair, or bed, with knees flexed at 90° or greater. Contrary to this finding, the results of the current study revealed that the most popular position chosen by participants throughout the academic year was sitting at a table, on a chair with a backrest. The second and third ranked positions were to sit with their backs against a surface and lying on their backs, respectively. The academic year consists of leisure- class-, exam- and test time. When comparing these three periods, leisure time was found to be the most popular time in which participants chose to assume positions marked b) and c). (see *Figure 1* and *Table II)*. The positions that students assume when working on their laptops directly relate to the design features of the laptop which do not allow for ranges of adjustability with reference to the compact feature of the device and the fixed keyboard-screen combination. The user is therefore subjected to constrained postures when performing laptop related activities.

Anthropologists Chapple & Coon[23], stated that individuals adapt to challenges of their environment due to the complex material culture of humans. It was found that this is also true for students when using laptops, as all participants in the study made at least one change from the options listed. As seen in *Table III*, spatial contexts have a direct influence on the changes in the dimensions of laptop use made by participants.

The influence that the spatial context has on an individual's unique experience is evident when considering that 98.6% of participants indicated that one or a combination of factors in the environment directly influences their laptop use. There seems to be a need amongst the participants to make changes within their residential environments in order to create a comfortable and meaningful experience when working on their laptops. These

changes mostly involved the use of an additional mouse and the use of pillows. The use of an additional mouse enables the user to rest the forearm and wrist on a supporting surface, whereby prolonged contractions are prevented, and less force is generated in the surrounding soft tissue. In the sitting position, at a table, the use of pillows to sit on, enabled the user to raise the body position to better align with the work surface in order to obtain a position that adheres to principles of mechanical efficiency of joint alignment.

Findings from this study showed that 47.7% of participants indicated experiencing pain during laptop use. This may have an effect on the quality of performance, as well as the meaning that participation in the activity holds for the individual. Furthermore, considering the median time, 38.5 hours, that students spend on laptops and the experience of pain may indicate possible musculoskeletal risk. This may necessitate further investigation and possible modification of the users' method of laptop use.

Results from the current study indicate that more males mentioned pain and that females spent more time on their computers. This finding differs from literature[9,24] where females tend to mention pain more often than males and males spent more time on computers than females.

Although the researchers aimed to construct a questionnaire which was as comprehensive as possible, with specific reference to spatial and temporal aspects, final results reflect limitations regarding the exact duration of time spent in a position as well as the amount of time spent on individual tasks on a laptop in a day. Although nine most probable categories of positions were included in the questionnaire, this is not necessarily inclusive of all possible individual variations of the selected positions that an individual can assume during laptop use.

Limitations to cross-sectional study designs are that the cause and effect cannot positively be determined, and that factors such as forgetfulness could have had an effect on recall of positions used, and consequently could have influenced the results. An essential weakness of the self-administered questionnaire is that it cannot adequately assess the clinical status of the participant. This is particularly true in this population as early adults are less likely to have been examined by a health care practitioner for musculoskeletal conditions.

CONCLUSION AND RECOMMENDATIONS

In this study the researchers aimed to investigate the use of laptop computers in relation to the study participants' customary context, with reference to the particular spatial and temporal dimensions of laptop usage

The study showed that a variety of spatial contexts where participants use their laptops in residences include their desks, beds as well as the floor. The desk was found to be the most preferred of these spatial contexts. Out of the nine possible positions, sitting at a table, on a chair with a backrest, was the position most frequently used while working on a laptop. Other positions were identified and indicated in priority order of choice by the participants.

It has been established that residence students make changes to their environments in order to function optimally in their work and recreational spaces.

Results from this study provide a foundation to understand the typical spatial and temporal dimensions of a significant aspect of student occupation namely the use of laptop computers.

In order to bring this knowledge into practice, the researchers firstly recommend follow-up studies to investigate the musculoskeletal dimensions that relate to the three preferred positions as identified in this study; and secondly to investigate gender differences in the use of laptops amongst university students.

Competing interests

The authors declare that there were no financial or personal relationships that might have inappropriately influenced the writing of this paper.

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