



Carpet Tiles

Interactive and Modular Carpets to support International Students in Shared Dorms to Feel at Home

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ABSTRACT

Moving to another country to study can be daunting and is connected to practical and emotional challenges. Here we present the results of an exploratory study on how smart textiles could be used to support international students in student housing to feel at home. We undertook seven situated interviews. Based on three key findings - the importance of social connections, cultural elements (food and carpets) and the limited duration of stay - the concept of a modular carpet with different interactive elements was developed. The carpet offers a social space, where students can spend time with friends. Its modularity allows personalization to the available space and room layout. With a proof of concept prototype we aim to open up a design space for tangible (textile) interventions.

CCS CONCEPTS

• **Human-centered computing**; • **Interaction Design**; • **Empirical Studies in Interaction Design**;

KEYWORDS

tangible interaction, smart carpets, smart textiles, international students, flat share

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1 INTRODUCTION

Many students who study in another country find themselves in a new culture, with different customs, language and a new environment. A lot live in fully furnished student dormitories, where almost everything is included in the contract and other students from their home country may live next door. Nonetheless, some are overwhelmed, and homesickness can become a common feeling [12]. Increasing their comfort when shaping their individual rooms, may help to ease the transition into life abroad and increase their sense of feeling at home and welcome.



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We led situated interviews with seven international students in shared flats in Weimar, to learn which factors influence comfort and well-being and their feeling of home, starting with their room furnishings and relations to them. Our findings indicate that comfort and connectedness is less tied to artefacts and memories, but more towards relationships with people. Based on our insights, we present “Carpet Tiles”, an interactive, modular carpet that can be adapted to user’s wishes and room layout, that can be taken apart and donated to the next occupant. Its functionalities, comfortable seating, lights and music, support communication and community building. We describe our research as well as the conceptual prototype it inspired and the implication for this design space.

2 BACKGROUND AND MOTIVATION

Domestic technologies and the feeling of being at home have received much interest in HCI (see e.g. [2]). But Desjardins et al. observe that the focus tends to be on “*collocated family members*” [10]. Increasingly, alternative forms of living are explored [9, 10], which opens the design space up to homes that are fluid in nature and might change over the lifetime. Our research adds to a novel understanding of such alternative living forms.

International students often have to ‘make a home’ abroad, with limited resources, over a limited period of time. Technologies are mainly considered as a means to connect with e.g. friends and family [11]. The way people engage with their home and what makes them feel at home is less understood. While flat shares have emerged as a topic of interest, the focus often is on organizational issues or conflicts between flat mates, concerning e.g. reducing food waste. [4], noise disturbance of neighbors [7] or more general social conflicts in a student dorm [5]. The focus is on the reduction of stressors rather than actively enhancing wellbeing. In contrast, our work explores how students engage with their environment to explore how we can support them to connect more with it and feel at home.

Desjardins et al. [2] suggest to add a material component to the research of the home. Therefore, we started with an exploration of the material objects that make up the domestic environment for international students, while drawing on the emotional connection to and through these objects. We put our emphasis on textiles, which are ubiquitous in the home [3] and interior design. A wide range of fabrics in the home have been studied (e.g. [1, 3, 13]). Interactive textiles offer opportunities for sensing and shape-shifting that can blend into the environment (see e.g. [8]). Some prior research has looked at interactive or sensing carpets, whose position on the floor for example is useful to detect cross-legged sitting through embedded sensors [6]. They also support aesthetic purposes, e.g. when designing an interactive rug to support children on autism

spectrum disorder [15]. Our study adds to this, by drawing on insights how carpets might be indicators and facilitators for social contact in the home.

3 RESEARCH APPROACH

We asked students to show us their room while conducting a semi-structured interview for seven visits of 14:49 min to 41:26 min duration. International students were recruited via social connections. Participants had to live in one of two student dorms, (Astreet & Bplace), selected because they feature different flat layouts. The research team aimed to find students with different nationalities and durations of stay in Weimar, for a variety of experiences. Seven participants were recruited (P1 to P7 in the following), aged between 25 and 34 years (two female, five male). They came from Egypt (2), Syria, Jordan, Pakistan (2), and India and they lived in Weimar between six months and three years. All four participants from Astreet share flats (private room, with shared kitchen/living room & shared bathroom) with three other students. Two participants in Bplace have a private apartment with an integrated kitchen and private bathroom, while another has a private room and a small shared kitchen and bathroom in the hallway.

Visits were conducted in teams of two: one observer and note-taker, and one interviewer. Interview teams were matched with participants so that the team had no close personal relations to the participant and not recruited them. The situated interviews were carried out in the private room of each participant in a casual style, while interviewers and interviewees shared a cup of tea, coffee or water. A template of the floor plan was annotated while note-taking, pictures were taken and conversations audio-recorded. Conversation focused on how the participants arranged their rooms, their routines at home, relationships with technology, emotional connection to elements in the room and their opinion on 'feeling at home'. Interviews were transcribed and anonymized, combining them with photos and annotated floor plans to support visual analysis. Our observations were then divided into: material objects and the meaning or emotions that they represent, and immaterial topics. To discover the underlying meaning of groupings and how they were connected to each other, a process of recontextualization and categorization was done.

4 FINDINGS

The findings are divided into the three sections: social life, space and time. Participants had a lot of personal things, not all of which held memories. Often, these were linked to other people, e.g. gifts from parents and friends, or embodied memories of events. Other items were used more practically, such as lights for creating ambience or as party lights. In addition, participants had a variety of things that made them feel at home, though not all were material. P7 shared the importance to *"invite friends to come to my place, that makes it home"*. For P1, P2 and P5, the shared kitchen was the place of most interactions with other people. P5 said he felt at home, because of friends around the city and a good friend living next door. For P4, it was more about people from the same country. For P1 it is *"more about the people you have, the family' than places', because I lived in many places before, so I think for me they are the same"*. When talking about the room, P2 was the most explicit about items: *"The way I*

customize the place; the room resembles the room in my hometown". P6 in contrast argued that they are *"living outside my home"* and therefore *"will not feel at home"*, thereby negating the importance of material or immaterial things that could make the current room home for them. The short-lived nature of their stay, played a large role in the experience of the participants. As we outline below, the furniture available in the room had a strong impact on space and opportunities available to socialise.

Material objects in the rooms were subcategorized into furniture, textile elements, technical devices and personal things. Here we focus on seating, which we found to have a large impact on social life and comfort of students, and other items that impacted their feeling of home. Chairs were the only seating opportunity in the standard equipment of dorm rooms, but for some (P2, P3) lacked comfort. As a result, beds were also used for seating, because it was more relaxed (P3). Couches were found in all but two rooms – which were too small – even though they were not standard equipment. They were mostly seen as places to relax and spend time with friends (P1, P4, P7), where music often played a large part. The couches of P1 and P5 were directly on the ground, as is common in their home countries (see e.g. Figure 1).

From textile elements, carpets were a common element found on multiple occasions (P1, P4, P5, P6), but are not standard room equipment. P1, P4 and P6 owned prayer carpets. But carpets were also used for comfort, e.g. P4 used it for friends to gather to sit and eat together. P2 and P3 were planning to acquire a carpet. Additionally, pillows were common items to add comfort to couches (P2, P7) and beds (P3, P6). P1, P4 and P5 used bed covers that all were brought from home. P1 had it for a long time and considered it a reminder of home.

It was very common to inherit furniture from friends or via friends of friends, who moved and handed their things over. This was true for small items, such as chairs (P1, P6) but also larger items, such as carpets (P1, P5) or couches (P1, P4, P5). The fact that participants could only stay in student housing for a limited time, influenced their attitude towards owning things. P1 stated, *"I would not purchase expensive accessories now, because it would be additional effort when moving out, . . ."*. P2, was in the process of *"downsizing, so that I am ready to move on"* and P7's mentioned: *"certainly it is temporary"*. While most were satisfied with what they had, many would wish a bit more space, like P2, *"because I also like sitting on the floor and it will be nice if there is enough empty space to have like a small carpet area, where I could just hang out as well"*. Both the time frame and the space available to students influenced the way they decorated and interacted with the space, sometimes preemptively avoiding future problems.

5 DESIGN CONCEPT: THE CARPET TILES

Our findings indicate that social environment and cultural elements are much more important than single elements in the participants' rooms for feeling 'at home'. The major conversations were around personal connections and how they were encouraged or hindered through layout and furnishings of rooms. Friends become the new family and therefore the opportunities to socialize and interact with other students contributes to feeling at home. Culture is represented by food and music, but also traditional objects, like low couches



Figure 1: Some participants had only their chair and the bed to sit on (left), while others furnished their room more elaborately with carpets and (low) couches (right)

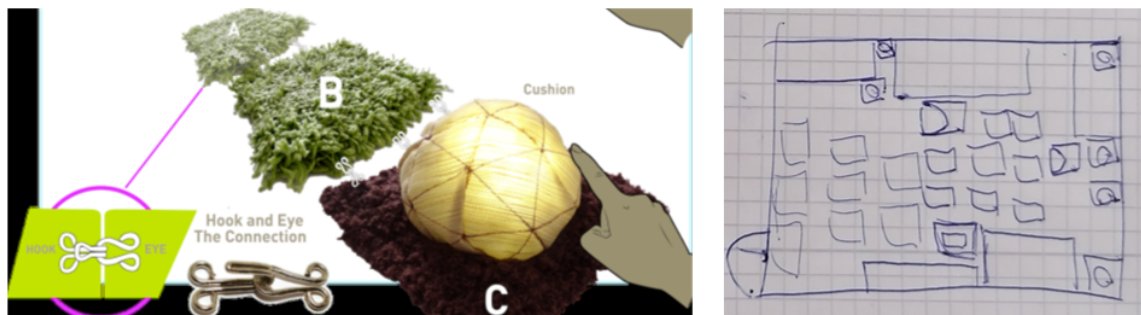


Figure 2: The prototype of the modular carpet (left), a plan how P5 would arrange the carpet tiles in their room (right, see section 6).

and carpets. A range of factors influence what students invest in, with space and time setting constraints. Many saw it as a burden to own things and had decided to not invest in them at all or were trying to keep them at a minimum. Passing furniture on after use, eases the decision to get rid of it, and is a cheap way for newcomers to personalize their rooms. Based on these insights, we wanted to develop something that enables participants to be comfortable in a space, alone or with friends, to encourage social behavior, while ideally being culturally familiar. The design should be lightweight, modular, so it is customizable to room layout and needs, as well as easy to pass on to future generations of residents. As carpets were mentioned regularly for making a room comfortable, but also enable social togetherness as seating arrangement, we focused on this idea and developed the Carpet Tiles. To enhance how carpets could be used as a social space, we included interactive elements.

Different, modular types of tiles connect with each other. Each tile is 40 x 40 cm, which fits with the measurements of other room elements, like bed (2m = five tiles) or desk (1,2m = three tiles). Four tile types were designed: a regular carpet tile, (module B in figure 2); a game table tile, with a board game imprinted on the surface (not shown); a glowing cushion tile (module C in figure 2) and a backrest/table tile (not shown). The carpet could be used as follows: Students pick regular carpet tiles and connect them with a backrest and the glowing cushion, when reading or listening to

music. When friends come over, the carpet pieces are re-arranged for sitting down, while the backrest is turned into a small table for drinks and a Bluetooth speaker, and a board game table is placed in the middle. When not in use, the tiles can be stacked in a corner.

The glowing cushion is both a comfortable seat and a light source. A person can sit on it or rest their head on it. The light inside is controlled by touching the surface. The geometry of a 2-frequency geodesic icosahedron hemisphere was used, which creates a dome shape with a strong surface tension. The lines of each triangle were sewn with conductive thread, and connected with the electronics of the internal LED light strip. Linen and cotton were chosen for the cover, being rigid enough to hold the structure but letting enough light through.

The backrest tile allows to lean against when sitting on the carpet and can be turned into a small table for snacks or drinks and to hold a Bluetooth speaker. Music control elements are embedded into the fabric covering the wooden frame, which are supposed to work similar to the gestures used on some Bluetooth over-ear headphones. A double tap pauses and plays music, while upwards or downwards sliding controls volume. Initially considering a built-in speaker to keep cost low, we opted to instead support use of existing Bluetooth speakers.

A solid connection is needed for the tiles to stay in place, which still enables modularity. This connection has to be conductive, as the

wiring between tiles needs to be independent of the arrangement of tiles, and should be small, so it isn't noticed when stepping on. It also needs to be easy to (dis)connect tiles when rearranging. On each side, a tile has a small conductive hook on the left and an eyelet on the right. This allows every tile to be connect in any desired orientation. To connect two tiles, the hook of each is put into the opposing eyelet.

6 FEEDBACK FROM POTENTIAL USERS

We first showed the concept with a larger group of people at the university during an end of year exhibition, before showing our proof-of-concept prototype to some of the original study participants.

For the exhibition, we showed the prototype with a poster about the general idea, the research, the tile's modularity and interaction. Some visitors suggested it might fit well into the dorms and support getting together, while others did not see a need, as rooms were well equipped. The ability to customize the carpet by choosing from textile patterns and the versatility of the approach created interest, partly because it could cover uncommonly shaped areas. Concerns were raised it might be difficult to clean. The glowing cushion was liked by many as a standalone product, although some were afraid they might trip over the fixed cushion in the dark or when not paying attention. People extended the idea to wall hangings instead of carpets on the floor and combined it with pin boards which are a common feature in student rooms. Additionally, the use of small speakers inside the glowing cushions was suggested to play environmental sounds typical of the home country, when resting one's head on it.

We were able to interview four of the initial participants. Our focus was on whether the concept idea met their needs and how it could be improved. We also asked if they would take advantage of the modular approach, when given the chance to build their own carpet area. We presented the idea and functionality through a Wizard of Oz approach, to ensure our prototype responded reliably. We prompted participants to experiment with sketching different layouts of carpet tiles in their own room (see e.g. figure 2). While the initial research was undertaken before the Corona pandemic, we moved to online interviews for this evaluation. This revealed that most of the elements had to be put where they do not interfere with general movement, which was rather difficult in the limited space available. This especially concerned the glowing cushion and backrest tile. P4 already had a sofa, which reduced the appeal of the carpet. In general, up to four of the glowing cushion tiles were placed in students' sketches, often close to the bed and desk. They wanted speakers inside the cushion to create surround sound and also tried to distribute light to important places. The backrest was used twice, close to the bed or as additional small storage element next to the desk. The game table tile was not popular. The normal carpet tiles were used as connection elements. Students named multiple use cases for the carpet, to interact with other people, playing games, watching a movie alone or in the company of friends and many would sit or lie on it. The students could not think of a typical soundscape of home when presented with the idea, instead, they would enjoy calm nature sounds to help them

relax. All mentioned that at the end of their study time they would probably hand over the carpet to another student.

7 DISCUSSION

We presented findings of an exploratory study with situated interviews in student rooms on what factors influence internationals' students in Germany feeling at home. First, the space available and the stay duration had a strong impact into what people had available or were willing to invest in. Second, the importance of items was less about specific objects in the rooms, but often linked to how they enabled social gatherings. Building on these insights, we developed an interactive carpet. Nonetheless, a comfortable room does not necessarily mean that a person feels at home, as P6 made very clear. The aim of fostering the feeling of being at home might have been too ambitious as it varies between even our seven participants. While the carpet tiles might not be able to strengthen the feeling of being at home *per se*, they can help in offering guests a comfortable space to spend time, which in turn can support well-being. A narrower focus on homesickness or just increasing the comfort in the rooms would be recommended for future research. Our work provides first insights that might be useful for other researchers to explore how international students can be supported in settling in into their new hometowns: Items should be modular to accommodate for different layouts of rooms and circumstances. In addition, they should be durable as they are likely to be passed on between different cohorts. Our research indicates that participants prefer simple designs that are not too dominant of the space. The most important factor was that they wished for areas for getting together comfortably. While it was not part of our research, this might also extent to domestic students living in dorms, who are also away from their families.

Due to time constraints within the project, we focused on the simpler conceptual ideas to be able to gain feedback on the idea. Nonetheless, other functionalities are easily imaginable. Multiple glowing cushions could be combined to form a reaction game; the glowing cushions could also be used for buzzers, e.g. for a quiz night. Music control is an important part, as it might make it easier to play music and therefore help students with emotion regulation, as suggested by Wadley et al. [14]. While not currently implemented, the tiles could further include options for connectedness outside of the student room as well, e.g. to signalize the motivation to socialize with others in the dorm. More extensive communication could be achieved through more sophisticated input and output modalities that could easily expand this initial frame. A promising opportunity could further be to use the tiles as a connection to other people outside of the dorm as well, e.g. to connect to family or friends abroad. What impact that would have on the relation with the current space of residence might offer interesting new areas for research. This artefact is a tangible reminder to think through questions of comfort and support we can give to international students. Future work in this area is needed.

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