

# Towards Visualising People's Ecology of Hybrid Personal Learning Environments

Glenda Caldwell

School of Design

Queensland University of Technology

Brisbane QLD 4000, Australia

[g.caldwell@qut.edu.au](mailto:g.caldwell@qut.edu.au)

Mark Bilandzic

Urban Informatics Research Lab

Queensland University of Technology

Brisbane QLD 4000, Australia

[mark.bilandzic@qut.edu.au](mailto:mark.bilandzic@qut.edu.au)

Marcus Foth

Urban Informatics Research Lab

Queensland University of Technology

Brisbane QLD 4000, Australia

[m.foth@qut.edu.au](mailto:m.foth@qut.edu.au)

## ABSTRACT

Ambient media architecture can provide place-based collaborative learning experiences and pathways for social interactions that would not be otherwise possible. This paper is concerned with ways of enhancing peer-to-peer learning affordances in library spaces; how can the library facilitate the community of library users to learn from each other? We report on the findings of a study that employed a participatory design method where participants were asked to reflect and draw places, social networks, and activities that they use to work (be creative, productive), play (have fun, socialize, be entertained), and learn (acquire new information, knowledge, or skills). The results illustrate how informal learning – learning outside the formal education system – is facilitated by a personal selection of physical and socio-cultural environments, as well as online tools, platforms, and networks. This paper sheds light on participants' individually curated ecologies of their work, play, and learning related networks and the hybrid (physical and digital) nature of these places. These insights reveal opportunities for ambient media architecture to increase awareness of and connections between people's hybrid personal learning environments.

## Categories and Subject Descriptors

Human-centered computing → Participatory design,  
Applied computing → Interactive learning environments.

## General Terms

Design, Experimentation, Human Factors

## Keywords

Ambient Media, Urban Informatics, Responsive Architecture, Personal Learning Environments, Free-Choice Learning, Informal Learning, Library Studies, Visitor Engagement, Participatory Design

## 1. INTRODUCTION

It is out of lived experiences and through applied meaning that people as groups or as individuals change spaces into places [11, p.120]. Architecture as a discipline is concerned with informing the design of physical infrastructure in a way that accommodates the conceived function of a particular space, therefore creating

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place. Information and Communication Technology (ICT), in particular social media, helps to overcome proximity and time challenges within physical space, thus affording social interactions that would not be otherwise possible.

Ambient media are a combination of both, architecture and ICT, combining assets and affordances of the physical as well as digital space. Ambient media is said to "convey knowledge distributed in time and space throughout the natural environment of consumers through a digital overlay morphing with physical daily objects" [30, p.338]. Ambient media has the ability to create an embodied hybrid space with publicly visible and accessible properties that form part of the physical environment. This can be done using digital assets, allowing people to bridge spatial, temporal, and social barriers as part of their situated spatial experience. In contrast to mobile phones or laptop computers, ambient media is, similar to physical architecture, continuously perceived in the periphery of people's attention. The nature of ambient media shapes people's spatial experience when at a place, rather than just providing information. The adaptation of location-based services, social sensor networks, ubiquitous computing devices and the Internet of Things, promises semantic ambient media installations [40] that are capable of providing context-aware, personalised, and interactive services.

The design space of ambient media embraces both bits as well as atoms. Hence, ambient media designers make use of skills and practices from traditional architecture as well as ICT and digital media. This gives rise to a new discipline that is specifically concerned with the design of ambient media. We hereinafter refer to this discipline as "ambient media architecture." Ambient media architecture provides opportunities for situated experiences and social interactions by combining digital space with physical place. However, similar to traditional architecture and media development, the design of ambient media architecture needs to be informed by the socio-cultural nature, needs, and issues of the place that the artifact is targeted at.

This paper aims to inform designers how ambient media architecture can augment public library spaces in their role as informal learning environments. By examining the opportunities for ambient media architecture to reveal personal learning environments, the library user experience can be enriched.

## 2. BACKGROUND LITERATURE

Informal learning is learning that happens outside the formal education system, such as by visiting a library, zoo, museum, or reading a book during one's leisure time. Public libraries, as traditional advocates of open and free access to knowledge and learning, try to attract people from all kinds of professional, cultural, and socio-economic backgrounds. This exposure to diversity has been shown to generate trust, tolerance, and social capital among people in the local community and society at large

[4, 14, 22], but also claimed to be a fruitful platform for the peer-driven creation and co-creation of knowledge [2, 46, 48]. In addition to the socio-cultural diversity of its user community, the library as a place provides opportunities for serendipitous discoveries and learning. For example, library visitors find a particular book and are exposed to other books, magazines, community event brochures, and co-located visitors that are dispersed within the library space. These encounters provide affordances for people to serendipitously stumble upon information that they would not otherwise browse or explicitly search for [9, 10]. Such room for game and serendipity is a useful quality of the library as a place, and a reason why people often prefer it to e-library services.

Björneborn argues for libraries to provide design interventions that encourage divergent (explorative) information behaviour across physical, digital, and social library interfaces [9]. However, serendipitous exploration of physical and digital information resources is limited by their ambience and visibility in the physical space that library visitors are exposed to. Open bookshelves, signs, posters, and event brochures are examples to facilitate divergent behaviour. In terms of online resources, a sign or a pointer to a URL somewhere in the physical space increases the chances for being serendipitously stumbled upon by an interested user. With social library interfaces, Björneborn refers to the librarian as an additional information resource who can be consulted by visitors for questions and issues. Recent research studies recognise libraries as attractive meeting places [1-3, 5], not only librarians, but in particular other, co-located library users are seen as potential information resources and facilitators to acquire new knowledge.

This paper is concerned with ways of enhancing such social library interfaces; how can the library facilitate the community of library users to learn from each other? Information, knowledge, experiences, and skills of co-located users in the library, which might potentially trigger interest, shared encounters and serendipitous discoveries, remain invisible and hard to identify. While online spaces, such as blogs, forums, wikis and social networks are more transparent and provide powerful tools to search and discover specific (social) information, they lack the richness of face-to-face encounters, and all benefits of immediate social interaction. Ambient media architecture has the potential to combine the benefits of online and physical spaces by materialising relevant information through digital fabrication, interactive public screens, 3D projection mappings, amplified or augmented reality, and other technologies in the hybrid space.

This research matches learning theories with opportunities provided by ambient media to augment the library as a place for social and informal learning. What are the opportunities for ambient media architecture to tap into the knowledge of its user community and provide it as an additional (social) information resource to other, co-located library users?

## 2.1 Informal Learning Environments

Learning is situated in and facilitated by different environments. Formal learning environments such as schools or universities are highly institutionalised and follow a strict curriculum. Non-formal learning environments are based on voluntary participation outside the formal education system, but are still organised and coordinated by a central institution with a fixed curriculum, such as schools providing cooking classes, driving lessons, and language lessons.

However, not all learning occurs in the classroom. Informal learning environments are often places of physical, emotional, and

social comfort that provide stimuli to the senses outside of the typical educational setting. In contrast to formal and non-formal learning, informal learning is learner-centric, driven by the learner's personal needs, interests, and motivations. Livingstone defines informal learning as "any activity involving the pursuit of understanding, knowledge or skill which occurs without the presence of externally imposed curricular criteria" [29, p.4]. The significance of informal learning is substantial. According to Grebow [23], 75% of the knowledge and skills people acquire and adopt through their lifetime, are based on informal learning activities, as opposed to only 25% through formal learning. Learning is more effective when driven by intrinsic motivation and interest, rather than extrinsic motivations such as grades or certificates.

Schugurensky describes such self-directed learning as "learning projects undertaken by individuals (alone or as part of a group) without the assistance of an 'educator' (teacher, instructor, facilitator), but it can include the presence of a 'resource person' who does not regard herself or himself as an educator" [42, p.50]. Learning can take place anywhere, anytime, but what is critical for informal learning is that the learner decides when, where and how they learn [39]. There are many places (i.e. informal learning environments) that facilitate different types of learning. Falk and Dierking [18] define such environments "Free Choice Learning Environments" (FCLE). FCLEs such as history and science museums, wildlife parks, zoos, or aquariums facilitate learning, but leave it to the individual visitor "to control what to learn, when to learn, where to learn, and with whom to learn" [18, p.6]. However, the physical and socio-cultural context of the space [18, p.37] stimulates, facilitates, and supports learning.

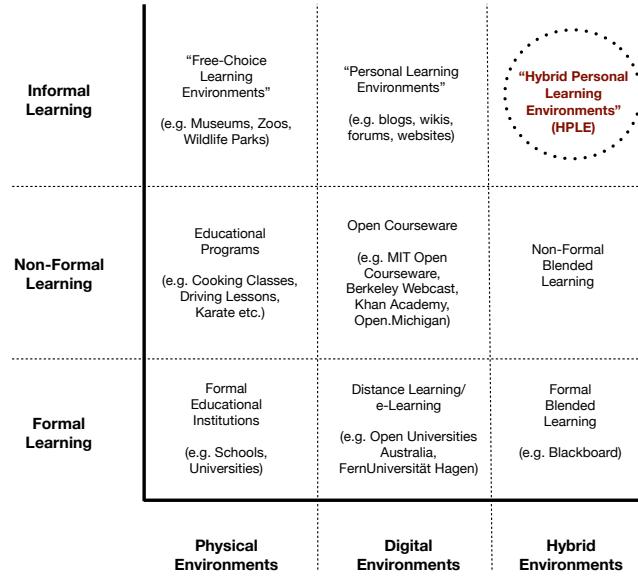
In accordance to that, Schugurensky [42] highlights that informal learning does not always have the form of dedicated learning projects that follow intentional and conscious activities. It is often incidental and socialised, embodied in physical and social experiences that we make through interactions with the external world and the social system that we are exposed to. Such learning often happens serendipitously and sometimes without the learner being actually aware of what they have learnt. It is part of human nature to learn through sensuous connections and relationships with the physical environment and the social world. Thus, different types and qualities of learning environments, places or spaces – physical or virtual – can provide alternative learning experiences [15, p.507, 32]. Mathison et al. [32, p.206] found that addressing emotional states and stimulating the senses triggers brain function and assists in the learning process. The informal learning process is an individual experience where different types of environments are suitable to different types of people.

Crucial to the success of informal learning environments is the creation of communities around these environments and their development. Communities are not defined by fixed or homogenised collectives but are fluidly created by the diverse people that act within the group through informal networks [15, p.509]. "Context is relevant to informal learning. It involves the interrelationships of people and place" [15, p.507].

## 2.2 Physical and Digital Learning Environments

Physical, digital, or hybrid environments can facilitate learning, where the digital and physical properties augment each other. The matrix in Figure 1 provides an overview depicting how different environments facilitate formal, non-formal, and informal learning.

Universities exist as physical places, however sometimes also offer dedicated e-learning platforms to pursue courses or entire degrees over distance that do not require physical attendance. Non-formal learning environments such as language schools exist as purely online or offline services. Many universities have joined the open courseware consortium [36], providing free and open study materials to the general public. These materials still follow a structured curriculum and evaluation tools, but in contrast to enrolment in official university programs, they do not require previous schooling and do not offer an official degree upon completion.



**Figure 1: The physical, digital, and hybrid nature of formal, non-formal, and informal learning environments**

Formal learning institutions have recognised the benefits of blended (or hybrid) learning. Schools and universities increasingly provide digital platforms that complement their offline courses with supplementary learning materials, links to external resources, online communication channels between learners and teachers, etc. Those tools are often controlled by the educational institution, and provided as integrated parts of the courses.

However, communities of practice and informal learning evolve due to the nature of mobile devices and increasing possibilities to connect virtually outside of the physical classroom [47]. Students augment their social learning experience by connecting through their selected online environments of choice such as Facebook or Skype rather than the digital platforms and infrastructures provided, mandated, or supported by the learning institution [7, 25]. Mobile learning by way of iPad, iPhones, smart phones, and other intelligent devices affects how and when students learn. Many students of today have embraced using technology to communicate, socialise and access information [8]. Such practices, as Beetham puts it, form an “underworld” [7, p.465] of informal learning outside the “classroom,” but are frequently enabled and sustained by the use of technology.

Siemens [45] describes connectivism, a learning theory that builds upon the self-directed style of informal learning, the social aspects of learning highlighted by social constructivism, and the significance of digital tools and media and communication channels as part of the learning experience. Connectivism values learning as knowledge that does not reside in an individual’s head, but rather spread across a complex environment of many external

resources, for example social networks, online databases, fact sheets, books, videos, and blogs. Hence, learning in this sense is based on the learner’s ability to recognise and connect to specialised nodes of other knowledgeable people and information sources. As Siemens describes, one of the core principles of connectivism is that the “capacity to know more is more critical than what is currently known” [45, p.5].

Every learner creates their own Personal Learning Environment (PLE) according to their needs and preferences. In contrast to a Learning Management System that is course-oriented and controlled by the educational institution, a PLE is an individually curated ecology of online tools (search engines, social bookmarking platforms, etc.), sharing services (YouTube, Flickr, WordPress, etc.), information resources (wikis, databases, e-books, e-journals, etc.) and communication channels (instant messaging, video-conferencing, forums, etc.) that people use to assist, document, and share their learning progress [16]. The nature of PLEs, evolved through the rise of Web 2.0, are interactive and collaborative in a way that they enable learners to provide feedback and comment on each other’s content. Such connections between PLEs form a Personal Learning Network (PLN), a network of individual people and their PLEs established to support and accompany each other’s learning processes.

### 2.3 Hybrid Learning Environments

Most literature on informal learning environments study informal learning either as a phenomenon that is situated in the physical space, or online. Former are focused on the design or nature of physical settings that facilitate learning, such as in museums [6, 17], wildlife [19] and other educational leisure environments [38], libraries [31, 34, 44], and dedicated learning environments in general [12, 13, 28, 35]. Connectivism and PLEs are described as purely online-based networks of tools, platforms and services.

Blended learning as a phenomenon that is fertilised by both the richness of physical face-to-face interactions, as well as opportunities and connections provided by digital tools, is mainly discussed in formal learning literature. Behling and Klinger [8] question the appropriateness of technologically rich tools within formal learning environments to support face-to-face learning. Osborne et al. [37] investigate the effect of blended learning environments on architectural education and conclude that blended learning has different levels of success within the formal education of architecture based on factors ranging from pedagogy, technology, and environmental compatibility. Attention needs to be paid to the range of learning environments – face-to-face and blended learning – to allow for different experiences for students with different learning styles.

### 3. RESEARCH QUESTION

The learning theories described previously point out that informal learning is facilitated by many factors, in particular personal context, physical context, socio-cultural context, digital tools, and media, to collaboratively create, share, discuss, interpret, and evaluate information, skills, and knowledge. Individuals shape their personal ecology of learning environments in the physical as well as digital space. The ecology’s curation is made up of physical places to read, work, socialise, and to pursue personal hobbies and leisure activities; through the choice of one’s social environment such as meetup groups and community clubs; as well as through digital channels of choice, such as blogs, wikis, forums, or YouTube channels. We call an ecology of learning environments that is diversified and spread across digital and physical spaces: *Hybrid Personal Learning Environment*, Fig. 1.

The public library as a space strives to facilitate peer-to-peer learning, and embrace its user community as an information resource and asset for fellow library users. One way of doing this is to expose people's personal learning environments and networks to each other. When these are exposed and communicated to each other, they can be enriched and built upon by others. Seeing objects or places that are relevant to an individual may attract others with similar interests and lead to a face-to-face interaction based on serendipitous discoveries of new topics and interests. Ambient media architecture provides tools to morph such social user information with the physical space of the library building.

This is the point of departure for our study which asks, what should these mediated, social interfaces look like? What content and information should they provide? And, how should they be represented? In order to provide answers to these questions, we employ a participatory design research method that asks participants to reflect on their personal learning environments.

## 4. METHODOLOGY

Rather than restricting the insights to learning resources within the library, the method focuses on revealing any personal places, activities and social networks where people *work* (being productive, being creative), *play* (having fun, socialising, enjoying, being entertained) or *learn* (being inspired, acquiring or modifying knowledge and skills), as well as the relationships between these environments. The vision is an ambient medium within the library that visualises a collective network of personal learning environments and resources, enabling library users to explore, serendipitously stumble upon, and be inspired by each other's learning environments. The insights from this study will inform the design of such an ambient medium.

In response to our research question a participatory design [24, 43] method was devised. Participatory design is used in many fields including architecture, urban design, and computer systems design with the common goal of including stakeholders' participation in the exploration and development of a design problem. Our main concern revolves around how participants communicate their personal learning environments. As discussed by Sanders et al. [41, p.195] the participatory design method can be utilised to generate a starting point for subsequent development. Based on the framework for participatory design created by Sanders et al. [41] we can describe our participatory design activity as a creative intervention.

The method is designed with two goals in mind: First, it aims to shed light on people's perceived geography and ecology of their learning environments, and how learning is embodied across their everyday lives, activities and places. Second, the methodological design aims to close the gap between ethnography, which is often regarded as a "prolonged activity" [27, p.59] that causes time pressure if particularly dedicated to inform system design, and "quick and dirty" ethnographic methods, such as short term observations or quick user interviews. The method consists of a 30 minute + 30 minute activity with 1-2 researchers and 5-10 users to provide a first overview of people's learning environments. This serves as a stepping-stone to better direct follow-up ethnographic research or in-depth user interviews. We designed the method in particular to inform the role of ambient media architecture installations within an individual user's ecology of personal learning environments, however it might also be useful for researchers, curators, and managers of informal learning environments to inform other design interventions.

## 4.1 Research Participants

The *form* of the intervention was based on making tangible things such as drawings, followed by focus groups, allowing participants to describe their drawings. The *purpose* of the activity was to get a deeper understanding of participants' experience of places associated with work, play, and learning. The *context* involved face-to-face sessions with two different groups of people. Both sessions were conducted in participants' own usual environment. The first intervention was conducted with a meetup group that meets on a weekly basis at The Edge, the digital culture centre and collaboration space of the State Library of Queensland in Brisbane, Australia. The group is named "Hack The Evening" (HTE) and consists of 14 people that regularly attend the meetings every week, including 3 high school students, and one young woman. The rest of the participants are male ranging in age from 22-55 years. During the meetings people usually socialise, exchange and discuss news, and collaborate on projects related to interactive technologies and media. Some of the participants have known each other from the Hackerspace Brisbane (HSBNE), a workshop space open to like-minded people interested in DIY technology and hacking. The HTE meetup group has been meeting weekly for approximately 18 months and participants are familiar and friendly with each other. This comfortable atmosphere may have assisted in the high level of engagement by all participants.

The second intervention included a group of five higher degree research (HDR) students that work together in a research lab at Queensland University of Technology, in Brisbane. The group consisted of 4 men between 25-38, and one 31 year old female participant. These participants have known each other for approximately 12 months or more. The HTE meetup group and HDR student group were selected as participants who are likely to have a rich established network of informal learning resources, hence providing valuable insights as pilot groups for the exercise.

## 4.2 Participatory Design Exercise

The participatory design exercise was developed utilising basic and familiar materials such as coloured markers, paper, and stickers. These materials were intentionally chosen to be low tech so that any person could relate to them. The use of coloured markers and stickers were used to distinguish information but they also gave the intervention a sense of fun and playfulness. The participatory exercise was explained to the participants asking them to draw places relating to three key themes: work, play, and learning. It was our primary concern to make participants feel comfortable with the drawing exercise; therefore the quality of the drawing was secondary.

In accordance with the theories described earlier, informal learning is a messy process, distributed across various physical places, online tools, platforms, and social networks embodied in other everyday activities, such as hobbies or social events. In an attempt to capture the full body of informal learning experiences in people's everyday lives, we asked the participants to focus on places and activities where they work, play, and learn. Work, play, and learning places are not mutually exclusive, but can overlap. We, for example, introduced "work," not only as one's business office and workplace activities, but rather any environment and activity where one feels as being productive or creative. Similarly, we introduced "play" for people to reflect on places and activities where they have fun, socialise, enjoy themselves, or are entertained. "Learn" relates to any places or activities where people feel inspired, acquire or modify knowledge and skills.

The same process was employed with both groups. The participants were given a series of six instructions directing their reflection process during the drawing phase. First, participants were asked to think about the work, play, and learning places, which are part of their daily lives. They were asked to draw these places on a piece of paper and then notate and label the places with keywords indicating the nature of the place. On a sheet of trace paper participants were asked to draw activities that are not attached to a particular place. Then, participants used between 1 and 3 coloured dots to indicate levels of intensity of work, play, and learning that related to the places and activities that they had drawn on their papers (1 dot = low, 2 dots = medium, 3 dots = high intensity). The drawing exercise was followed by a focus group where participants discussed their drawings. Each phase, drawing and the focus group discussion took approximately 30 min. The following guidelines were used to assist the execution of the participatory design exercise.

**A. Drawing Activity (30 min):** Let participants draw on an A3 sheet of paper guided by the following instructions:

- 1) Starting with the place you are in now, draw a diagram of places where you engage in working, playing or learning activities [use colour 1].
- 2) Write down keywords of your activities / interests that you pursue at these places [use colour 2].
- 3) Grab a trace paper, write down keywords of any other activities/interests/social networks (that are not necessarily fixed at a particular physical place) [use colour 3].
- 4) Place between 1-3 dots depending on how productive (work: blue dot), how much fun (play: yellow dot) or how much you learn (learn: green dot) at the different places / activities.
- 5) Place between 1-3 red dots depending on how relevant physically co-located people are for your work, play, learn experience at the different places / activities.
- 6) Add anything else to your drawing that seems important to you as part of your work, play, learn experience.

**B. Focus Group Questions (30 min):** Discuss with fellow study participants the following aspects of the drawings:

- 1) Explain your drawing and what you did in order to communicate your relevant places and activities.
- 2) Explain the relationship between work, play, and learn at different places.
- 3) Explain the role of co-located people at your relevant places and activities.

## 5. FINDINGS

The participatory design intervention provided rich data and insight into the way that people perceive and communicate a wide range of physical and digital places that are a part of their everyday lives. The findings are broken down into two main sections. The first one discusses how the participants represent places for work, play, and learning through the act of drawing. The second section examines the relationships of places for work, play, learning, and the informal learning environments, which participants choose to occupy.

### 5.1 Analysis of Drawings

Through the making of a drawing it is possible to observe how people visualise and communicate their understanding of places for work, play, and learning. When examining the drawing of places, four common trends emerged: the use of objects, symbols, shapes, and plans, all of which can be seen in Figure 2.



**Figure 2. This drawing shows a combination of drawing techniques to communicate different places**

Common attributes of drawing approaches are categorised into four groups: hierarchy of place, geographical relationships, sub-location, and time. The hierarchy of place is communicated in the drawings by a range of approaches including size, position, and order. Placement on the paper in order of importance is evident with some of the drawings, where the most significant place is at the top of the page followed by lesser important places. The size of the place drawn also indicates hierarchy, for example Figure 3 shows how one participant drew home as a large circle in the middle of his paper indicating it is central to his everyday life.

*"I drew my home in the centre as a big circle, because that's the centre of everywhere, I am either going to or from home," (J1).*



**Figure 3. Drawing of home as central to everyday places**

Geographical relationships are communicated in some of the drawings by including major geographical features such as a river. Places are drawn and positioned on the paper in relation to the river, therefore indicating the geographical relationship of places with one another and their location within the city.

*"I draw a map essentially, it's not (to) scale. I have a river in the middle, that's that line. Well, Brisbane river... because I live on the south side, but mostly places I go to are on the north side as well," (J1).*

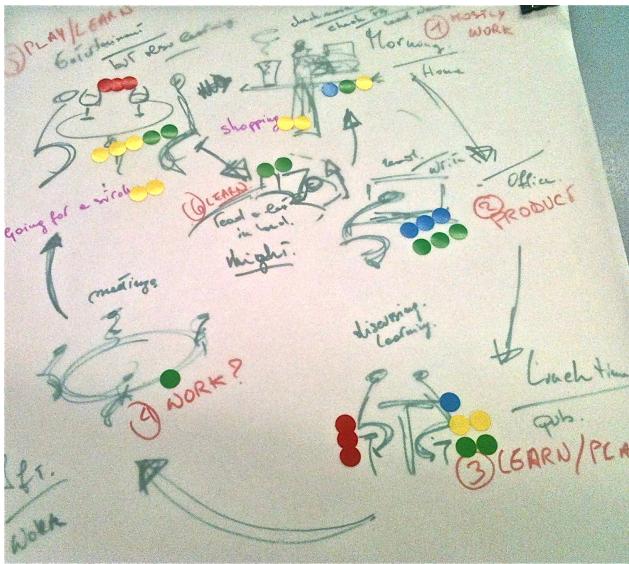
By combining drawing techniques some participants began to draw sub-locations or smaller parts of larger places. Different activities occur in different sites within home or work (Fig. 4).



**Figure 4.** This drawing shows different desks with different activities occurring in the sub-locations

Often participants drew computers and TV screens acting as portholes to digital media and the Internet. The Internet itself is sometimes drawn as a separate place or cloud, indicated through a description of online activities such as “gaming,” “reading,” or “blogs.”

One participant organised his drawing based on time. Examining Figure 5, it can be seen that the positions of places on the paper were drawn in a cyclical manner based on a typical day.



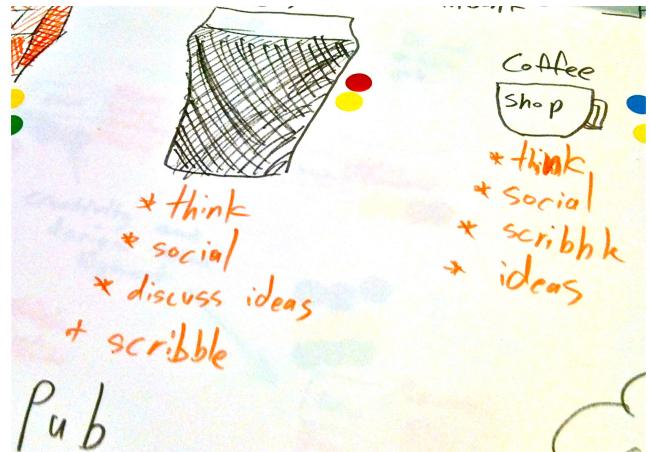
**Figure 5.** A drawing of work, play, and learning places based on time

The top of the cycle began with the morning where the participant drew himself at the breakfast table reading the newspaper and checking his phone. This is followed by the morning at a desk at work. Midday or lunchtime is positioned at the bottom of the paper. The afternoon shows a meeting room where work meetings take place and the cycle ends with dinner followed by the participant in bed reading. In the focus group this participant described how he negotiates the amount of play in his day based on how productive he has been during the day. He allows himself to read a fun book at night if he has been productive at work, if not he reads a heavy book that is work related and therefore ending the day with increased productivity.

## 5.2 Relationship among Work, Play, Learn

Examining the drawings gives an overview of the sorts of activities each participant engages in at the places they have drawn. The intensity of work, play, and learning associated with these activities is indicated by the participants’ use of coloured dots. Typically places are characterised by a range of one or more activities associated with work, play, and learning. Rarely would a place have only a dot of one colour. This reveals a cross-correlation of such activities within multiple places.

The drawing from one of the participants in Figure 6 shows that he drew the coffee shop with associated blue dots (work) and yellow dots (play). The participant did not include any red dots meaning there is no importance of co-located people to his experience at the coffee shop. His experience of that place is purely personal. This same participant drew a pub, which did include red dots (co-located people) indicating there is an importance of co-located people to his experience at that place. Although both the pub and the café are public spaces typically associated with social activities, it can be noted that these places have different meanings for different people.

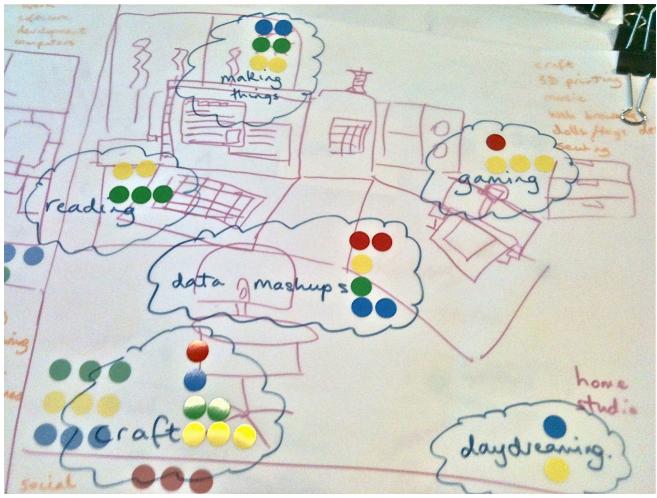


**Figure 6.** The importance of co-located people

Another example of this is highlighted when examining how participants represent their home. For one participant home is the central and largest place on his drawing (Figure 3) indicating it is very important in his life. His home has elements of play as well as socialising, revealing it as a fun place dependent on the other family members who are at home.

One of the participants dedicated a large portion of her drawing to home (Fig. 7). She seems to do everything at home including crafts, gaming, reading, and daydreaming. She spends a lot of time playing and learning at home, indicated by yellow and green dots. Home appears to be a creative place for this participant as many activities are described by key words such as making interactive dolls and 3D printing. Her home has a sub-location represented by the drawing of her bed, a place for other activities such as reading, web browsing, sewing, learning, playing iPad games, and listening to music.

*“I’ve got my studio at home which is where I do the most stuff, and I have the most fun and I do a lot of learning. I drew a lot of stuff that is in that room and it’s the biggest,” (A1).*



**Figure 7. Home is drawn to show where a lot of different work, play and learning activities take place**

Conversely, for another participant home was not even drawn on his paper.

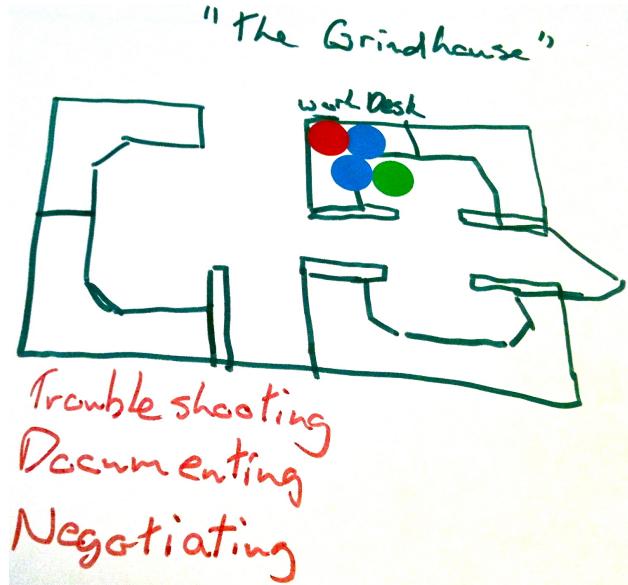
*"I haven't mapped out home, because even though I am there outside of work it's not really anywhere I do anything specific in..." (B1).*

When examining the participants' drawings and looking at the workplace, the intensity of work indicated by blue dots varies from one person to the other. Some of the workplaces include elements of play (yellow), some include learning (green), and some include the importance of co-located people (red). For one of the participants the workplace can be understood as a fun place with high amounts of play (yellow) and learning (green). However, play and learning are not dependent on other people as there are no red dots. The actual work itself is fun for the participant without needing to interact with anyone else.

*"...because I love going to work, it's a great place... I ahm... don't like all the people at work. Basically I go there to work, and I sort of keep to myself. Cuz I am the only one who does what I do at work, so I don't need to interact with anyone," (J2).*

The intensity and range of dots tended to correspond to how much people liked their place of work. Places of work with high levels of play and social elements seemed to be more enjoyable places than those with only elements of work (blue) and learning (green). For some of the participants the workplace is purely about producing or conducting a service (Fig. 8).

*"...I've defined my work as the 'grind house' because it really is... you get a task, you do a task, consistently, repeatedly, so yes you are being productive, but not in a way that actually feels to me as being productive..." (B2).*



**Figure 8. Drawing of work as the "Grindhouse"**

Places that are marked with all colours are associated with work (blue), play (yellow), and learning (green). Per definition, those places provide an experience to users where they feel creative, entertained, and have a social experience all at the same time.

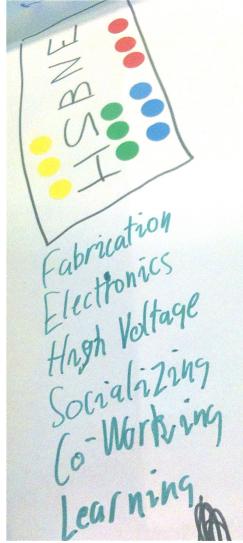
*"...there is band practice which I have been doing lately with my friends, that is interesting because it's a bit of learning and also equal parts learning equal parts play, there is a bit of work there because, um, writing songs are being constructed..." (K).*

We are interested in what such personal “buzzing” places have in common, and filtered them accordingly. The criteria for a “buzzing” place are a minimum of two dots of each colour. The resulting locations turn out to be places such as friend’s houses, the library, public urban places, particular suburbs, the internet, as well as hobbies, leisure activities, community places or meetup groups such as a dance performance group, local board games / cards club, where people come together and interact based on their common interests. The common factor amongst these places is that they are places where people can meet face-to-face and rely on these encounters to be productive, to learn from one another, and to enjoy the company and knowledge of others.

*"I was going to say about The Edge, I am not sure I would come here if there was no one else here, because... if I wanted to work on something that didn't need anyone else's help, I would do it at home, but you come here because you want to talk to other people because you want to or because you need their help, their opinion," (K1).*

Figure 9 shows a drawing that depicts a “buzzing” place, the Hackerspace Brisbane (HSBNE), a workshop space for like-minded people interested in DIY technology, tinkering and hacking.

*"...the space [Hackerspace Brisbane] is probably where I spend a lot of my efforts. I get a lot of work done there, a lot of play done there, I get a lot of learning done there, because there is a lot of like minded people that know a lot more about some things than I do and I know a lot more about some things than they do so it's very much a collaborative environment..." (B3).*



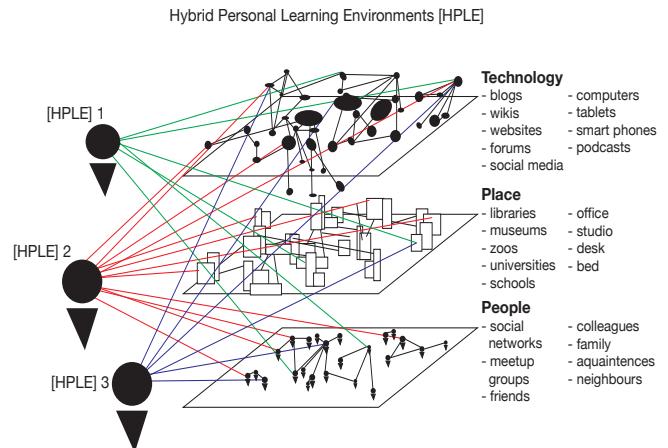
**Figure 9.** This drawing highlights places with dots from each category highlighting “buzzing” places

## 6. DISCUSSION

The drawings illustrate how informal learning occurs across a network of online and offline learning environments that are particular to each user. In contrast to the separation in research literature, informal learning is not a purely online or purely offline experience. It is shaped by an individual’s participation in activities and social networks across virtual, as well as physical environments.

Furthermore, informal learning does not exclusively take place at dedicated informal learning environments (e.g. library, museum, etc.) or during dedicated learning activities (e.g. reading a book), but rather embodied in everyday activities and places that involve social interaction, productivity, and fun. Every individual is involved in a range of physical places, online spaces, activities, community groups, social networks and technologies that facilitate access to, interaction with, and across those networks. Individual needs and interests shape the choice and intensity of involvement in such networks. Hence, each person’s informal learning experience is a personalised patchwork of online and offline networks that facilitate learning in one-way or another. Previous literature has used the term ‘communicative ecologies’ [21, 26] to describe social communication and interaction patterns as experiences that are formed, shaped and maintained across different media, technologies and physical environments. Similarly, the findings in this paper give rise to the assumption that informal learning is formed, shaped, and maintained as learner-specific ecologies of hybrid personal learning environments.

These findings provide a starting point to understand how people experience, create, and maintain their personal ecologies of learning networks and environments. Figure 10 is a diagram of the nature of people’s ecology of hybrid personal learning environments (HPLE) as personal selections of networks across three different layers (HPLE 1-3): Technology, place, and people [20]. Each layer and the connections between the layers differ from person to person, as these connections create HPLE networks particular to the individual. This initial study provides empirical grounding for the theoretical concept of HPLEs.



**Figure 10. Hybrid Personal Learning Environments are personal selections of networks across different technologies, places and people**

What do these findings mean for the design of ambient media architecture in libraries?

Our participants, for example, outlined interests and hobbies such as interactive doll making through microcontrollers, circus performance practices, the making of laser light shows, or strategy card games. Each of those activities is bound to particular places, community groups, or other networks.

Ambient media architecture that reflects such ecologies of HPLEs, for example, through representations of people’s places, social networks, hobbies, activities, communities, subcultures, special interests groups, tools, media and technologies, may provide valuable insights, inspiration and serendipitous discoveries of new topics and interests to other library users. Such ambient media architecture would provide an interface to the social capital within the community of co-located library users. An example would be a digital wallpaper that tells all users “who knows what” to facilitate connections to people with similar interests or complementary skillsets. However, how can the individual networks of learning environments be visualised and fed back to the user community? What design language can or should be used for communication?

The findings from the participatory design exercise reveal ways that participants intuitively represent their own learning environments and networks. Through the process of making a drawing, participants had to reflect upon their personal learning experiences in order to visually communicate their work, play, and learning places. These drawings – similar to a rich picture [33] – provide insights into the ways in which non-designers visually communicate. From the drawings it can be seen that many of the participants rely on the use of symbols and objects to signify place. Written words were also used to describe the places and activities they drew. The use of different fonts and graphics helped participants communicate a hierarchy of importance and emotion. From this we can begin to derive a design language that is in direct response to the stakeholders’ perceptions. The design language used to create ambient media architecture should speak in a language that is understood by the stakeholders to encourage their interest and participation. This design language will develop as a result of the design process and the input from the participants. The opportunity for ambient media architecture in the library space will be to visualise the urban ecology of personal learning environments and feed it back to the community.

Furthermore, the drawings and follow-up focus groups identify personal “buzzing” places where people learn, but also feel they are creative, entertained, and having a rich social experience all at the same time. The Hackerspace for example appears to be one such place for some people. Three of our participants report the Hackerspace as a regular hotspot for them to socialise, be creative, and learn new things through copious interactions, collaboration, and exposure to other likeminded members with complementary skillsets. The identification of such buzzing places provides a step towards further research about what happens when people engage in work, play, and learning activities at the same time.

Further in-depth ethnographic research at different “buzzing” learning environments (e.g. Hackerspaces) will provide insights about people’s interactions and learning experiences at these places. Why do some people perceive such environments as “buzzing”? What makes those people feel creative, entertained, and having a social experience all at the same time, and others do not? What is the nature of the physical and digital infrastructure at such places? What do the interactions at such places look like, and how do work, play, and learning activities combine and potentially cross-fertilise each other? Shedding light on these questions will help inform ambient media architecture as well as general design interventions towards making libraries more attractive environments to engage in informal learning activities.

Finally, the drawings also provide an understanding for how people organise their personal learning spaces. Our participants for example have different desks at home to pursue different activities, such as fiction writing, graphic design, coding, or 3D printing. Beds are used to surf the web and read blogs on iPads while relaxing at the same time. Such insights inform how the library as a learning space can be organised towards better accommodating people’s learning styles, needs, and habits. Designers might for example consider creating different zones for different activities, such as noisy areas for socialisation; small desks for focused individual work, and day beds to accommodate relaxed learning activities.

## 7. CONCLUSION

This paper presents a participatory design research method that asks participants to reflect on their personal learning environments. The participants reveal personal places, activities, and social networks where they work (being productive, being creative), play (having fun, socialising, enjoying, being entertained) or learn (being inspired, acquiring or modifying knowledge and skills). The findings give rise to the assumption that informal learning is formed, shaped, and maintained as learner-specific ecologies of hybrid personal learning environments (HPLEs). Informal learning is embodied in everyday activities and places that involve social interaction, productivity, and fun.

The results discuss opportunities for ambient media architecture to augment public library spaces by reflecting representations of people’s HPLEs, hence provide affordances for divergent information behaviour, serendipitous encounters, and inspirations between fellow library users, which would otherwise remain invisible.

This research will inform our further work. We plan the development of two design interventions, which sit within the domain of ambient media architecture: *Gelatine* and *Fraggle Rock*.

*Gelatine* is a check-in system that allows public library users to “check-in” with a personal HPLE profile confirming their

presence at the library. Public screens and 3D projections will reflect a collective representation of all checked-in library users’ HPLEs. Observations about user interactions and perceptions of the installation will provide further insight and feedback about the value of such ambient media architecture in library buildings.

*Fraggle Rock* uses digital fabrication for participatory media architecture in order to produce an interactive installation in a library. The installation will incorporate digital fabrication methods to translate social media data into physical artifacts to be used and combined by participants to represent their hybrid personal learning environments and networks. The artifacts are inspired by the crystal structures made by the humanoid ‘Doozers’ in the *Fraggle Rock* TV series. The purpose of the installation is to expose the interests and activities from each participant to each other by collectively building a physical construct. Once the networks are revealed and made public, participants can make connections with one another based on common interests. Based on the findings in this paper that people’s learning experiences benefit from social interaction in physical places, the research aim of *Fraggle Rock* will be to examine how ambient media architecture crossing digital and physical representations can facilitate face-to-face encounters and social interactions in public places.

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