Mobile Learning and Immutable Mobiles - using iPhones to support informal learning in craft breweries

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Abstract

How are mobile devices used to support learning in informal settings? The majority of m-learning research to date has focussed on formal or professional learning contexts and is marked by controlling the devices used and the tasks to be completed. Studying learning and practice in an informal context provides an insight into how mobile devices are used when the device, applications, and practices are determined by the participant rather than a research agenda.

In this observational study we draw on multi-site and focussed ethnographic approaches to trace the connections between practices, calculation, evaluation, a learning community and the central role of an iPhone in forming these connections in two craft breweries. An actor-network theory (ANT) sensibility provides the vocabulary and focus for a consideration of the agency of the heterogeneous actants in the breweries.

We use ANT to consider not only the human and non-human actants observed, but also the processes of calculation and qualitative evaluation which are brought together in the concept of 'qualculation'. We introduce the challenge of ANT to conventional notions of the process of learning, drawing on the work of Steve Fox (2001), and note the limits of this work in setting out the challenge but not what would show *evidence* of learning in an actor-network.

We trace how a recipe is transformed from originating beer through both physical and calculated transformations and show the role of the iPhone in achieving these in two breweries. A novice brewery expends significant effort in attempting to maintain the immutability of the recipe and to conform to its predicted outcomes. We consider in detail moments of breakdown and mistranslation and show how the recipe remains mobile but immutable while the brewery itself becomes the location of change and development. An experienced brewery transforms and changes the recipe with the help of the iPhone to make rapid calculations and alterations. The recipe here is a fluid object with experience used in making substitutions and adjustments.

Our conclusions do not put forward ANT as an *account for* learning or a *theory of* learning. Rather we seek to illustrate the application and potential of ANTs sensibility in attending to the processes of socio-material practice. We also seek to extend the understanding of how learning can be seen in actor-network terms through providing evidence of learning's transformative effects in the assemblage of a actor-network.

Keywords

Actor-Network Theory, informal learning, mobile learning, iPhone, craft brewing.

Mobile devices and informal learning

The rapid increase in both the capabilities and adoption of mobile communication devices, especially 'smart phones', has become a focus for educational researchers interested in their potential for learning and teaching. In a literature review of research in this area Wright and Parchoma (2011) critiqued the practices and discourses of these research reports. Most research projects controlled both the device and tasks for completion in formal educational settings despite advocating their use due to their ubiquity (and noting heterogeneity) in learners' lives. Drawing on actor-network theory (ANT) the manner in which this research agenda advances a discourse promoting mobiles as 'learning technologies' to complete set tasks was contrasted with accounts of the active

self-selected use of mobile devices without such controls in informal contexts where goals are self-set and there is self-determination in the choice and adoption of mobile technologies. This is informed by Steve Fox's work and valorisation of the importance of studying networked learning outside of educationalised settings (Fox, 2001).

Fox considers ways in which ANT challenges conventional conceptions of what learning is, and where and how it happens. He argues that

> One of the first ways in which traditional learning theory should be revised concerns the hallowed notion of "the learner" and the associated notion of "the learning process"… learning at some point in a network can transform the network.... Learning is one of the processes which builds up and breaks down networks, although there may be other processes which achieve similar effects" (Fox, 2001, pp. 84-85)

In moving the focus of attention of learning away from the *individual* learner Fox (2001) takes an ambitious step into attempting to consider learning as a process within the ontology of actor-network theory. However Fox does not extend this line of reasoning to consider what *effects* there may be on the actants in an assembled network. Fox's work stops short of examining what *evidence* there may be of learning within an actor-network. Here we seek to extend his theorisation of actor-network theory in networked learning to consider and suggest some of the ways that we can trace such decentralised learning within a heterogeneous actor-network arising from the close observation in the fieldwork of this study. As well as this theoretical contribution to extend ANT's contribution to a field in which cultural-historical activity theory (CHAT) and communities of practice theory (COPT) are considered more influential (Engestrom & Wenger, 2010). We also seek to address some issues and possibilities in the methods for studying learning with mobile devices.

ANT was "developed to analyse situations in which it is difficult to separate humans and non-humans, and in which the actors have variable forms and competencies." (Callon, 1998, p. 183).One of the challenges when first encountering ANT is the plethora of specialist terms and their associated meanings which are used to enable a 'generalised symmetry' (Callon, 1986, p. 200)wherein both human and non-human elements of the world are considered using the same terms. The term 'actant' is borrowed from the semiotics of Greimas and Courtes (1979) to denote the heterogeneous elements and attempt to move away from the human-centred notion of the term 'actor'. In order to further a project heterogonous actants seek to enrol each other into an 'actor-network' through which constructed facts, materials, people, objects or ideas may move, and in movement there will be transformation, betrayal and change through a process termed 'translation' such that few actants emerge without having been changed. These attempts at definition may well be more rather than less confusing. As John Law notes that while

> it is possible to describe actor network theory in the abstract. … this misses the point because it is not abstract but is grounded in empirical case studies. We can only understand the approach if we have a sense of those case studies and how these work in practice.(2009, p. 141)

The following case study attempts to introduce the terms of ANT and show their analytic use in practice by considering their application to the diverse actants and objects at play when mobile devices are used in the practice of all-grain home 'craft' brewing. Such breweries incorporate diverse technologies, enzymes, micro-organisms and chemicals in order to transform barley, hops and water into beer. The equipment used is *adapted*. There is *innovation* and there are frequent *breakdowns:* all three of which are "situations where an object's activity is made easily visible"(Latour, 2005, p. 79).

Of methods and methodologies: ethnographic mobility, multi-modality and focus

Fieldwork, primary analysis and visual representations were developed by the principle investigator (PI) – the 'I' and 'my' of the method. The second author contributed analytical insights, writing and extensive feedback - the 'we'- in the crafting of this account. These distinctions are preserved as part of our work to ensure authenticity, accountability and honesty in this report.

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Humphreys notes that it is "field studies [that] add significantly to our understanding of how mobile devices are contextually defined and used"(2006, p. 55). Such fieldwork is often complex and difficult due to the inherent mobility of the objects under study – leading to the 'mobilities turn' (Büscher & Urry, 2009, p. 99) and engaging with mobile methods (Büscher, Urry, & Witchger, 2011). In this paradigm fieldwork involves following the objects and people under observation and using both the ethnographers' *and* the participants' mobiles for recording and description devices as

> the technologies of writing, photographing and videographing are part of that self-same evolution out of which these enquiries rise. (Laurier, 2011, p. xv)

During periods of observation this involves moving and walking with them as they move around and, as Laurier (2011) suggests, involving participants in the documenting of the case study though taking screen shots of their device, capturing digital images and videos both at the time of observation and afterwards and then sharing these with the ethnographers. There is also a need to enquire and trace their connections to artefacts from other locations as

> research is designed around chains, paths, threads, conjunctions, or juxtapositions of locations … with an explicit logic of association or connection among sites.(Marcus, 1998, p. 90)

In observing a single day's activity – a 'brew day' – my approach was also heavily influenced to the 'focussed ethnography' method used in Human-Computer Interaction (HCI) research. Knoblauch summarises this as "a form of short-term ethnographies by which information relevant to the development or change of technological systems are collected in an intensive and rapid way"(Knoblauch, 2005, p. 8).

The data gathered through field notes with synchronised audio, ethnographic interviewing during activity, photographs and videos taken on my camera, mobile and also by the participants on their iPhones. From my desk analysis extended to the tracing of references to other locations both 'virtual' websites and internet radio stations and 'physical' books and shops. In seeking to create an account containing an explicit logic of these associations I developed visual representations, diagrams, and images to trace the transformation and movement of a recipe as it travels through the two breweries.

The activity, actants and objects of study in a home brewery

'All grain' brewing is brewing from raw materials: grain and hops, rather than using pre-manufactured extracts. Its practitioners often describe it as 'craft' brewing to assert its qualities of skill, practice, creativity and knowledge. Brewing involves steeping grains in water (mashing) to extract the fermentable sugars then boiling this sweet liquid 'wort' with hops which add bitterness, flavour and aroma before rapidly cooling it. Yeast is then added to ferment the wort. After fermentation it must be packaged for dispensing in keg or bottle. ANTs' notion of 'generalised symmetry' focuses the researchers on observing and considering how these relationships are formed between both the human- and non-human entities of the practice. At each stage of the process summarised above, a series of complex interdependent calculations of temperature, time, volume, and specific gravity. An example is shown in Figure 1 below which is a formula for calculating bitterness from an addition of hops:

$$\text{mg/l of added alpha acids} = \frac{\text{decimal AA rating} * \text{grams hops} * 1000}{\text{volume of finished beer in litres}}$$

$$\text{Bigness factor} = 1.65 * 0.000125^{(\text{wort gravity} - 1)}$$

$$\text{Boil Time factor} = \frac{1 - e^{(-0.04 * \text{time in mins})}}{4.15}$$

Figure 1 - Calculations for hop utilisation and bitterness (Palmer, 2006)

Calculations like these are a process where one assemblage of diverse elements is 'translated' into another. In the equation above time, volumes of water and amounts of hops are 'translated' through the actions of a wide

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variety of 'actants' – a recipe, the brewer breaking up and adding the hops to the boiler, the digital scales, the boiler and the wort to transform a written instruction into a perceptible, pleasant bitterness. Such processes of transformative calculation are not seen as abstracted but highly situated

> calculation and noncalculation reside not primarily within human subjects but in material arrangements, systems of measurement, and methods of displacement. (Callon & Law, 2005, p. 718)

Figure 2 illustrates this conceptualisation of the materiality of these arrangements of calculation.

The calculation is meaningless without the assembly of the recipe, the hops, the scales, the brewer, the boiler, the wort. Added to these are the measurements of time, volume and the recording and demarcation of these – which have all become functions of the iPhone. It is these transformations of the recipe through a process ANT articulates as translation and it is the way the iPhone has enrolled the other elements, the 'actants' identified above, that gives this ethnographic study its logic and allows us to explore the processes and effects of learning.
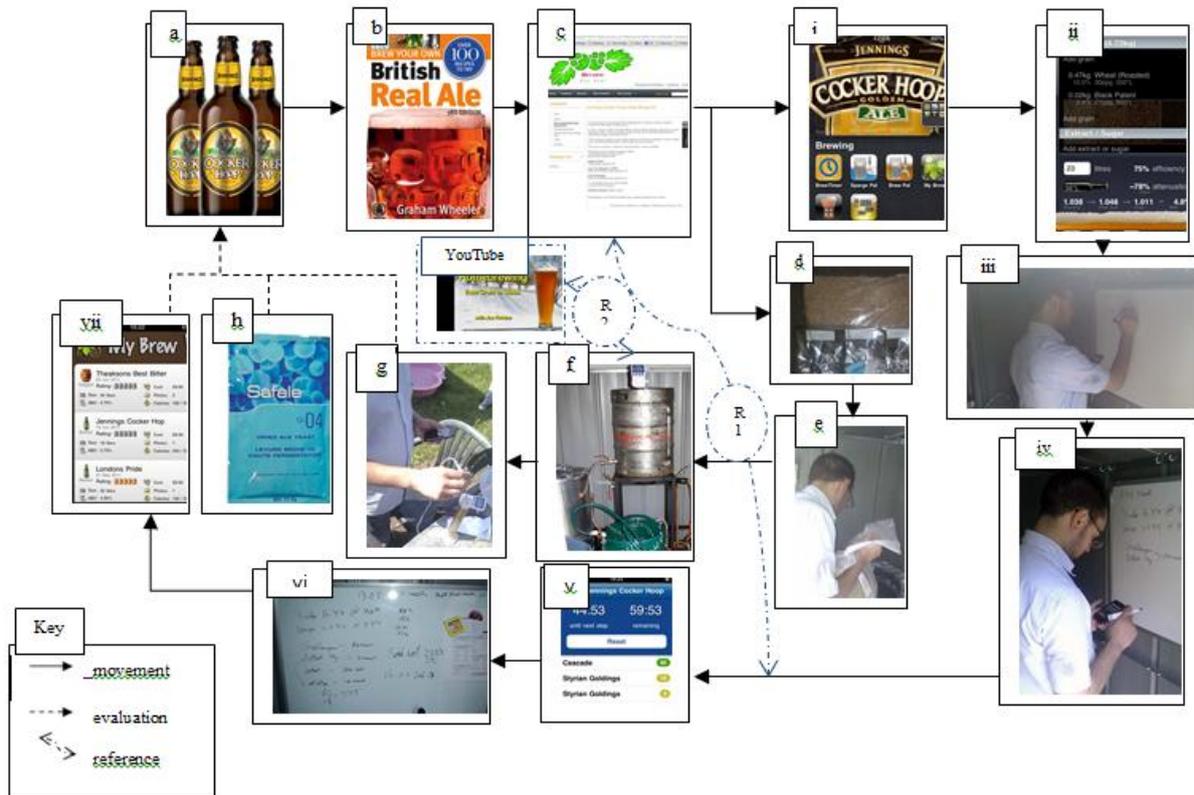

Figure 2–the materiality of calculation

Fieldwork Site 1: Novice brewery, mobile device and immutable mobile recipe

We use the term 'novice brewery' intentionally to consider the human and non-human actor-network of brewer, mobile device, brewery equipment and ingredients rather than to isolate the brewer as the repository of 'experience'.

In **Error! Reference source not found.** below we represent the sequence of activities in the transformation of a recipe in a craft brewery in a process of translation from original, through written recipe to its attempted recreation as something new. The images are purposefully chosen to illustrate clearly the on-going and frequent use of the iPhone in this craft practice. Photos from the fieldwork are supplemented with screenshots captured by the participant and shared via email. Translation is the overall process and is not merely changes of state or the movement of a something from one place to another but moments of *transformation.* This key consideration will become clearer through the description of the diagram.

Figure 3 - Translations in an experienced brewery

The process starts with the originating commercially produced beer (a) made at Jennings brewery in Cumbria, UK. The recipe for this beer is published in a book for home brewers (b). (How this came to be derived and written is unclear as to whether this came from the brewery, or was 'reverse-engineered'.) The recipe was then reproduced on a homebrew supplier's website (c) where the suppliers offer to make the recipe up and send it pre-weighed and pre-packaged to the brewer (d) along with the instructions of times, temperatures and volumes of water to make it. The grains are mixed with heated water (e), boiled with hops then cooled (f). The final gravity and volume checked (g) with results that are unexpected – the effect of which we consider below - before yeast (h) is added.

Callon's (1986) four-step process of translation provides insight into this socio-material assemblage. Calculating these times and temperatures, recording them and from the results making other calculations about the efficiency of processes and equipment is 'problematised' for the novice brewery. The iPhone offers a solution through downloading and running some of the brewing apps available which have been selected and installed (i). The mobile seeks to lock the brewer, grains, hops, water and time into relationships it can resolve and control – actants in the socio-material assemblage become 'interested': invested in problem-solving, and through practice 'enrolled' into specific problem-solving roles. The iPhone enables the recipe as entered to be emailed, printed and attached to the whiteboard. However, it has failed to enrol all the acts of recording which, while possible, are more time consuming and slower to alter than using a pen to write on the whiteboard (iv). ...ng a different app, the information from the whiteboard is copied back into the phone (5v) to time hop ...ecipe *should* not have changed in its journey from book to website to mobile app to whiteboard ...le app – it can move through this network maintaining its 'immutable, mobile', translation and ...hould only occur in its materialisation. However, this is not the case. A slip of the finger leads ...whole chain of events as another part of the meaning of translation, that of 'betrayal' (Callon, ...l or intended signification is played out, which I consider further below.

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The final whiteboard at the end of the brew (5vi) is a record of the physical transformations, a check-list of completed actions and a record of the outcome of calculations. Finally these results are entered into another app MyBrew (5vii) to track the process of fermentation and to record assessment of the finished beer.

Moments of reference, moments of betrayal

The processes and events occurring within the overall process of translation from written recipe to material, fermenting beer considered above can also be understood through Callon's (1986) notion of translation. Each actant can itself be considered a network, but many of the processes are hidden away, 'black boxed' with only the inputs and outputs visible, while the activities are hidden from view. However, when the outcomes do not match predictions this black box can be opened up and the processes revealed. The moments when the unexpected occurs, when the 'black box' of hidden activity, transformation, or agency is revealed can provide the potential for adaptation and change in the network, either leading to learning or simply incoherence and confusion requiring effort be expended to reassemble the network and re-establish forms and relations but with a return just to previous configurations without learning – both effects occurred in the actor-network of the novice brewery.

Much has been written on the "affordances for learning" of mobile devices(Cochrane & Bateman, 2010; Scanlon, Jones, & Waycott, 2005) and have been critiqued for advancing an uncritical view of affordances which is used to promote a discourse of technologies that promote learning. The confusion and effort required by P1 due to problems here provides empirical evidence challenging the simplistic championing of mobile devices as 'affording' learning. When the wrong menu item is selected through a slip of the finger on the touch screen, the recipe in BrewPal app no longer matches the ingredients. Rather than looking to the app for the source for this error the participant instead refers (5R1) to the supplier webpage saying:

> "I should have some centennial hops, why have they sent me challenger? … I think it must be the recipe… I'll have to go have a look at recipe on't website."

We see two processes: the mobile app has become an obligatory point of passage for the recipe and is now acting as an authoritative 'voice' for it – it has become a 'spokesperson' for the recipe, however it has betrayed its role. Another meaning comes into the account: "translation also implies betrayal"(Law, 2009, p. 144).

When the betrayal is discovered the role of the mobile device becomes clearer – it has enrolled the recipe and the acts of calculation into its network and become a spokesperson for them. Resisting this agency requires work, reference to the original form of the recipe (the at-hand materials are insufficient) and then the whiteboard is changed. However in this process there is just a return to earlier configurations. Mutation is reversed and immutability returns. There was no evidence of learning in these exchanges, probing questions or subsequent communication – rather than affording learning the mobile interface afforded confusion.

Another event when the unexpected occurs in matching predictions on the iPhone to empirical observation shows a very different chain of events. The resulting wort is both lower in volume with less sugar than expected or predicted by a notional 'typical figure' for the efficiency of a home brewery. Rather than the 75% efficiency the results once measured, recorded and entered into the BrewPal app show the brewery equipment working at 49%. The calculations of the mobile app from empirical observation and measurement lead to the 'black boxing' of the processes of mashing and equipment performance being opened. The result was not observed but reported after the event as the brewery equipment was adapted, sections swapped and processes changed. These adaptations transformed the objects that appeared the most immutable: stainless steel kegs and soldered copper piping into a fluid assembly rather than a fixed configuration with the result of a major improvement (now reported to be working at 79% efficiency). Fluidity, even with stainless steel, has led to adaptation, change and improvement.

Fieldwork Site 2: Experienced brewery the fluid object of a recipe

Fieldwork location 2 was in a more experienced brewery. Participant 2 (P2) "started kit brewing 4 years ago … been all grain for 2 years and 3 months" and had been brewing approximately 2-3 times per month. He estimated that about half of his brewing was based on published recipes and the other half his own formulations.

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Figure 4 follows a similar pattern to **Error! Reference source not found.**. The original beer (4a) is an American Ale which the brewer knows well and likes. A recipe for 'cloning' the brew is published in a book (4b) which P2 is using for the first time. He wants to "take a beer [he knows] quite well, see how it matches up [but] if it's miles apart [he] probably won't brew anything else out of it". Unlike P1 the published recipe is *also* under evaluation rather than just the end product. This evaluation is informed by P2's regular listening to podcasts on brewing different beer styles and recipes from "The Brewing Network," which he downloads to his iPhone (R1).

The recipe is entered into "BeerAlchemy" on P2's computer (4d) as he "prefers to use a keyboard" (helping to avoid the errors in translation witnessed with P1). The recipe is then transferred via two intermediaries: a printout (5f) and via a Wi-Fi connection to P2's iPhone (4e) which P2 to uses "on brew day for the calculations really ...you can do all the adjustments on here, the amounts and everything". (P2)

The recipe begins as an immutable mobile without translation, but is then translated into ingredients (4g) which are weighed and combined. However the brewery inventory is insufficient to translate the recipe in the amounts specified. Substitution is required and immutability becomes fluidity. The materials for calculations are assembled (4h) and pencil, paper, iPhone calculator, scales and substitute grains are translated into a new assemblage to give the same predicted outcomes of volume and fermentable sugars for the adapted recipe. Water is added to the grains (4i) and the temperature measured. The materials to make the calulcation and enact it for correcting the temperature by adding the right amount of boiling water are assembled: kettle, thermometer, spoon and mobile app and measurements undertaken as the calculation is enacted. The water chemistry is also transformed through adding salts (4j). This requires reference (R2) to both the water utility website for water composition and a web-based calculator (4k) which is preferred to the app as it gives "how many grams to put in rather than working out grams per litre".

Hop additions are measured (4l) and at the end of the boil the specific gravity of the wort is measured with support for temperature correction from the app. The improvised nature of the assembled materials caused breakdown at the end of the process with a blocked filter. This then required that the ethnographer translate his role from participant-observer to full-blown participant helping to tip and strain the wort out of the boiler. Finally yeast was pitched and fermentation started rapidly (7n) and fermented fully.

Figure 4 - Translations in an experienced brewery

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The final assessment was that the beer was "very good, though not a very close approximation of the original beer!" Subsequent to the fieldwork P2 reported brewing another recipe from the book, but again rendered the other recipe fluid by making amendments with reference to information from downloaded "The Brewing Network" podcasts. This access to 'expert knowledge' via the iPhone is a common feature with P1's use of YouTube videos for the construction of equipment.

Summing up: Where is the learning?

In the descriptions of the novice brewery and the experienced brewery there is a clear difference in the way that the recipe is transformed. In the novice brewery of P1 effort is expended to ensure the recipe is unchanged and followed exactly – it is supposed to be an 'immutable mobile' and effort is expended to return it to its original mobile form when translation betrays this. The brewer is keen to stick to making pre-defined recipes and kits rather than formulating his own or adapting them as "until [he thinks he has gotten] the gist of the different flavours and stuff like that [he] just [doesn't] think it's even worth doing it." However the apparently fixed brewery is subject to change and development – with changes to equipment in response to the outcomes of calculations to change these figures and improve efficiencies towards those assumed in recipes, and therefore enabling more accurate reproduction. The brewery is fluid, but the recipes are fixed.

In the experienced brewery of P2 recipes are themselves objects for investigation, adaptation and assessment. When the ingredients needed are not in stock substitution occurs. The 'immutable mobile' (recipe) has lost its 'immutability' and become fluid. Later work in ANT considered exactly this change.

> If objects may be treated as immutable configurations of relations, then these are at best only the tip of the iceberg … might it not be the case that, if we want to understand objects, to characterize and study them, then we need to attend as much to the mutability of what lies invisibly below the waterline as to any immutability that rises above the surface? (Law & Singleton, 2005, pp. 335-337)

Our suggestions from these two observations are that the translation from immutability to fluidity in practice can be seen as evidence of learning and the application of experience in the network. The novice brewer adapts his practice and brewery in response to the calculations and transformations of an immutable mobile. An experienced brewery transforms this supposed immutability and the whole system is more fluid. The calculations to achieve this, which transform the recipe, can support this development but can just as easily disrupt it. Our conclusions do not put forward ANT as an account for learning or a theory of learning, rather we seek to illustrate the application and potential of ANTs sensibility in attending to the processes of socio-material practice. We also seek to extend the understanding of how learning can be seen in actor-network terms through providing evidence of learning's transformative effects in the assemblage of a actor-network.

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