X Modal
X Cultural
X Lingual
X Domain
X Site
Global OER Network

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ABSTRACT

Within the X5GON project we conduct human-centred research that focuses on the learner experience with OERs. While WPs 1-5 are building the technical infrastructure, our work in WP6 involves the design, development, and evaluation of novel interfaces that can lead to engaging, satisfying, and enjoyable learning experiences.

This report summarises the key findings and outcomes achieved in year 1, including in-situ OER user observations; a series of learner-centric interface designs and evaluations; in-the-wild testing of a novel mechanism for peer support in OER; and a conceptual framework to guide the exploration and evaluation of novel and existing OER use cases.

A published research paper is attached in Appendix A.

1. INTRODUCTION

In-the-wild research is a common approach in Human-Computer Interaction. Its primary aim is to ensure that the methods and tools we create are indeed effective and satisfactory for users, not just in a controlled lab setting, but also under real-life conditions which are often more multi-faceted and complex (Rogers and Marshall, 2017).

In practice, learning activities are subject to a variety of challenges, such as finding the right resources, knowing where to get help, overcoming frustrations, managing distractions, interruptions and stress, how to fit studying among other commitments, reflecting and planning ahead, whether to studying alone or with others (face-to-face or in virtual groups), and how to stay motivated over long periods of time.

While these challenges are common across all kinds of learning scenarios, they are most evident in self-determined adult learners (as opposed to students at university). This is due to the high diversity of individual backgrounds, skills, knowledge, needs, life situations, commitments, time resources, preferences and goals that can be found in this target group. Consequently, we could expect considerable variation in the ways that relevant real-life factor manifest themselves in practice, how they are perceived and expressed, the impact they have, and how they are dealt with. Therefore, the majority of our studies in year 1 focused on self-determined adult learners in the wild.

Key objectives in year 1 were:
To collect in-situ evidence of how adult learners use OER recommendations in the wild, their needs and expectations (observation, interviews, data logging);
To understand how learners define their goals, progress and achievements;
To explore novel ways of learning with OER that X5GON can enable, and to understand what types of support are needed by learners in these new contexts;
To inform the design of new user interfaces and learning platforms for OER recommender systems.

Through observational studies, iterative participatory design and evaluation with learners in the wild, we have accumulated a thorough understanding of the learner's perspective in the context of OER. This knowledge has been shared through a peer-reviewed academic publication and continuous rapport with experts in education. Through collaboration and technical meetings with other WPs, our work has informed the design of initial systems, produced a series of prototypes, and revealed promising directions for further development in year 2.

The following sections summarise our research efforts, broken down into four main categories. Their order roughly reflects the chronological sequence in which the studies were conducted, subject to minor overlap.

2. IN-SITU OBSERVATION

While the design of the user modelling and recommendation system were still in the planning phase, we conducted an initial literature review and interviews regarding how learners handle OER in the wild. Particular attention was paid to the aspect of recommendation because it constitutes a critical goal of X5GON. In addition to the literature review and interviews, a participant observation study was conducted, in order to better understand how human experts go about recommending OERs to learners. The study is summarised in the following, along with key findings and implications for X5GON.

Because the topic of recommendation is central to X5GON, an ethnographically-informed study was conducted to investigate the interactional patterns between human experts and learners when recommending OER. The goal of this study was to inform the design of OER recommender systems and interfaces that are effective and efficient from a learner's perspective.

The study was conducted at a Makerspace in Germany, where weekly meetups were held to help people learn about technical topics, such as Internet of Things (Arduino, Raspberry Pi, etc). These meetups were open to the general public and attracted learners with all levels of prior technical expertise, who were in the process of planning or implementing a project. The meetup was facilitated by two human experts (including one of the researchers) who were observed over the course of two months. Notes were collected about the following points of focus:

1. How do learners ask for recommendations?
2. How do learners frame their learning needs in terms of goals, obstacles, ambitions, preferences?
3. What exactly do learners expect from the expert: OER / content recommendations, web links, technical help, hands-on support, advice, clarification, mentoring, encouragement, scaffolding, warnings, risk assessment, workload estimates?
4. How does the expert triage or clarify the request if needed?
5. How do learners refine their requests?
6. How many questioning cycles are typically needed before the expert can make a final recommendation with confidence?
7. What form do the final recommendations take: OERs (websites, tutorials, courses, etc), learning strategies, tools, activities, step-by-step instructions, empathetic support, prerequisites (skills, knowledge, confidence), warnings and caveats regarding planned projects (safety, security, legal issues), best-practice dos and don'ts, peers, meetups and other events?

FINDINGS

The findings from this study resulted in an in-depth understanding of typical characteristics of the learner-expert interaction when recommending OER. Observations were made regarding all of the above points. It was found, despite typical characteristics, that the interactions varied substantially from case to case. The analysis identified three main themes as relevant to the design of OER recommender systems and interfaces. The themes are described and discussed below.

Importance of triage

Triage was found to be a crucial part of giving informed advice. Learners' initial requests were typically framed either as descriptions of planned projects or as narrative accounts of how the learner encountered a problem within a project. Because these accounts rarely contained sufficient detail about prior knowledge, objectives and priorities, the expert typically asked several clarifying questions before making a recommendation. The expert was then able to make a well-informed recommendation as a result of adapting to the learner's context and asking clarifying questions.

Directionality and next steps

In order to continue with their project, learners wanted to know what to do next, or what to learn next. Consequently, the expert's advice was usually geared towards enabling the learner to continue in the current direction. In some cases, the expert recommended a change of direction, e.g. when a different approach, tool or material was considered substantially more promising. Either way, the learner-expert interaction was grounded in a shared understanding of where the learner was heading next.

Advice beyond content

Many recommendations included some type of content (usually OER). However, pure content recommendations were the exception, rather than the rule. In most cases, content was recommended in the context of other advice, such as:

- A breakdown of a given problem into sub-problems / a topic area into subtopics
- A set of skills and knowledge required to solve a problem, including prerequisite knowledge or skills
- Caveats, clarification of common pitfalls and misconceptions
- Safety advice
- Alternative approaches / tools / materials etc - including pros and cons
- The expert's rationale behind the given advice
- Other places to ask for advice

Occasionally, the expert's advice concentrated on one of the above points without mentioning specific content.

Implications for X5GON

The above findings contribute to a better understanding of how human experts interact with learners when making recommendations in the wild. X5GON can learn from these findings when it comes to designing recommender systems and interfaces for learners.

The patterns that we observed run contrary to the way that recommender systems are commonly used on the web, e.g. in retail and entertainment. Commercial websites like Amazon, YouTube and Spotify recommend their own content, in order to retain user traffic on the site. These recommendations are made without the user's request and are based on similarity rather than the kind of information that a human expert would likely consider in a learning context. Table 1 highlights the differences between our observed patterns and the YouTube-like pattern.

	Human experts	YouTube sidebar
Who initiates the recommendation	Learner	Content provider
When is the recommendation made	After triage	At page load
What does the recommendation consist of	• Advice on content • Content from various sources • Content of different types • Sequence of content • Breakdown into subtopics / subproblems • Prerequisite skills and knowledge • Caveats, pitfalls, misconceptions • Safety advice • Pros and cons • Rationale for advice • Other sources of advice • Learning activities, peers and events, e.g. meetups, hackathons	• Advice on content • No content by other providers • Only one type of content (e.g. videos)
Types of information considered	• Relevant details of the learner's prior knowledge, skills and objectives • The problem at hand • Learner's direction and intended next steps	• Similarity to currently visited content • Similarity to previously visited content • Similarity to other users
What happens when the learner's problem isn't a lack of content?	Appropriate advice is given instead of content	Content is given regardless

Table 1: Human versus typical web content recommendations

The YouTube model is prevalent throughout the web, to the extent that its design is considered a standard component in web design. Particularly, the typical layout of a recommender sidebar (see Figure 1) is often found emulated in non-commercial websites, including educational websites, such as videolectures.org.

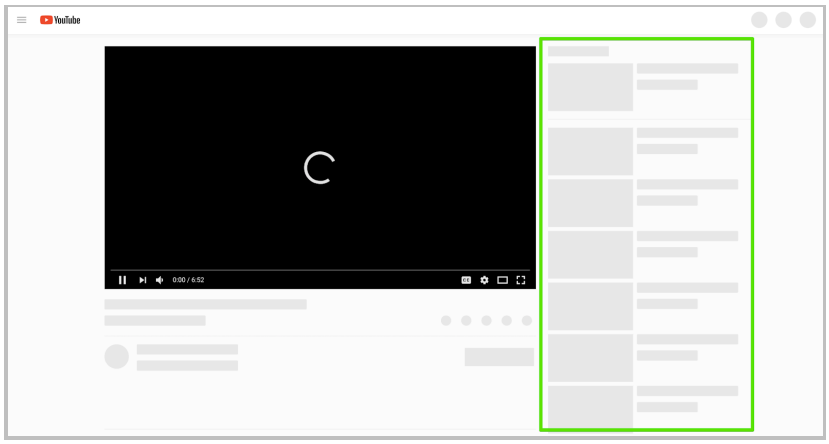

Figure 1: Typical web layout for unprompted recommendations of on-site content

The predominance of this model is striking because, while its design makes sense for commercial purposes, educational websites have different requirements. Indeed, a review by Drachsler et al. (2015) shows that in Technology Enhanced Learning (TEL), recommender systems have been used for a variety of purposes, including:

1. Finding good items (content)
2. Finding peers
3. Recommending a sequence of items
4. Predicting learning performance
5. Suggesting a learning activity

The aim of X5GON is to build bridges between different providers, modalities and languages. In the light of this research, the YouTube model seems grossly inadequate for X5GON's purposes. There is therefore a necessity for innovation in this project, which may also have implications for other WPs, such as 1, 4 and 5.

Our study with human experts provided a necessary first step towards this goal of innovation. It informed WP6 by suggesting a roadmap for learner-centric research in the following areas:

- When and how to present recommendations to learners: how much information, etc.
- How to make an abundance of OER recommendations navigable and manageable
- How to source information from learners, including the learner's current intent and need for recommendations (see also WP3 report D3.1)

Our progress towards these goals, which has already led to a published research paper, is described in the following sections.

3. DESIGN IN THE WILD

A substantial portion of UCL's research efforts have focused on learner-centric prototyping and evaluation of novel interfaces for dealing with OER. Informed by the literature (e.g. Zhao et al. 2015; Rogers and Marshall 2017) and our own preliminary research, a series of iterative design studies was conducted to collect in situ evidence of: (a) how adult learners use OER recommendations in the wild, (b) their needs and expectations, and (c) what interface structures and metaphors are perceived as intuitive and effective.

RESEARCH METHODS

These studies used various combinations of human-centric methods, including participatory design with learners, one-on-one observation, user diaries, data logging, semi-structured interviews and feedback from education experts.

Additionally, some of the studies adapted a Wizard of Oz method (Green and Wei-Haas 1985), whereby the OER recommendations were manually performed by a researcher behind the scenes. The reason to use this method was twofold: firstly, to account for the fact that the "real" recommendation system was still under development at the time of conducting this study; secondly, to gain detailed insights into learners' inputs to the system and their expectations, which could be expected to feed back into the design of the recommender system.

In order to provide learners with a realistic user experience, the designs were implemented as high-fidelity web prototypes that could be used on participants' own laptops and mobile devices. A minimalistic Python server in the back-end provided basic functionality, such as login, persistence of application state over time across devices. Furthermore, the client-server architecture allowed the researchers to insert curated OERs in advance and in response to emergent demand.

ITERATIVE TESTING OF INTERFACE METAPHORS

To begin, we designed a minimalistic web interface, based on the results of initial interviews suggesting that learners need to (1) find OERs, (2) preview and compare search results, and (3) keep track of selected resources over days and weeks. Many interviewees said they were happy with the results from Google search but expressed frustration about having too many browser tabs open, which made it difficult to preview, compare and keep track of things over time and across devices. Consequently, our initial design started with a Google search for a popular topic, in this case "Introduction to machine learning". We selected a number of resources, and decided how best to structure and present these at the interface and how they should adapt to the user. The details of the design process, evaluation and findings are documented in a published research paper (Appendix A).

For illustration, the following Figures (2-6) highlight key stages in the evolution of the prototype based on feedback from users and experts over the course of two months. The list represents only a handful out of more than 20 redesigns and variations that were created in the process.

Lists

As a starting point, our initial design borrowed heavily from Google search, which most of the participants had described as their primary go-to place for finding OER. Predefined OER recommendations were presented as a scrollable list of links that opened in a new browser tab (Figure 2).

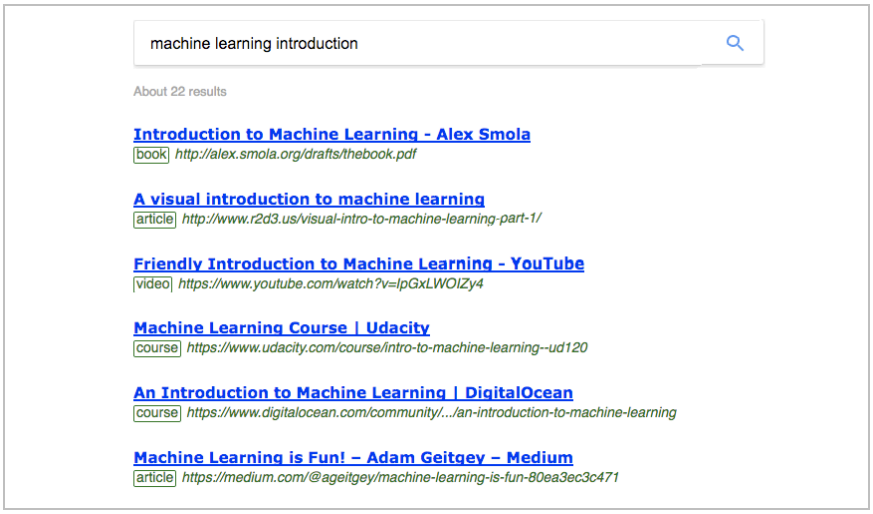

Figure 2: List representation

As expected based on the interviews, participants found this interface usable at first. However, the problem remained that opening many browser tabs quickly became confusing, making this kind of interface less suitable for assessing, comparing and managing OER.

Thumbnails and likes

In response to feedback and suggestions from participants, an alternative interface was evaluated that offered abundant possibilities for collaborative filtering, rating, voting and annotation. OERs were represented as thumbnails along with basic information like title and tags. This pattern is known as the "|media object" pattern in web design and used extensively, e.g. by Facebook. Selecting a resource opened an extended view with more information, rather than an external link. Moreover, users could add resources to a collection (Figure 3).

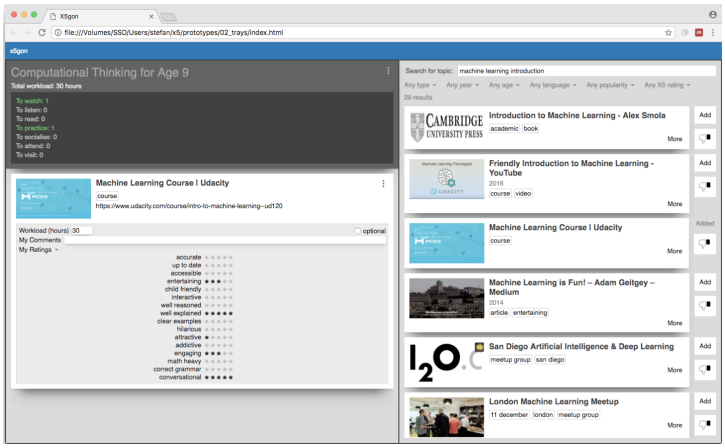

Figure 3: Thumbnails, likes and ratings

Playlists

We also took inspiration from familiar websites like Netflix and Amazon, that people are very familiar with using. The design shown in Figure 4 presents the items as horizontal icon-based lists, categorised by media type and other criteria, such as "Because you are interested in learning Python". By selecting an item, users could see more information, take notes and mark the item as started or completed. In response to participants' requests, two dedicated lists allowed learners to easily find started and completed items again. Basic functions for note-taking and diary were also provided.

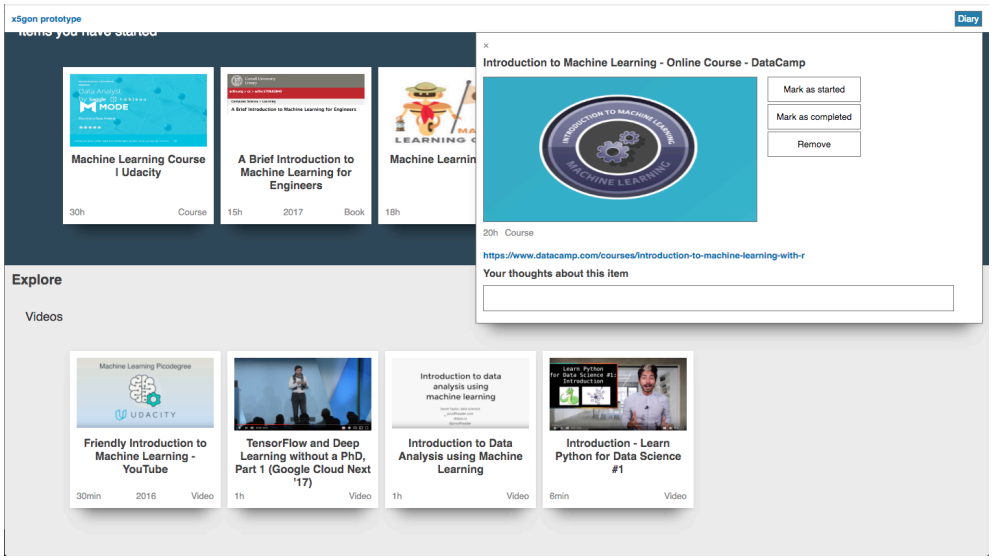

Figure 4: Playlist-based interface

Favourites

In response to user feedback, the categories "started" and "completed" were renamed as "bookmarks" and "archive", in order to better apply to certain types of resources, such as meetups, short videos, and articles intended for continuous reference. This seemingly minor change reflected the potential for learning to be open-ended (Fig. 5).

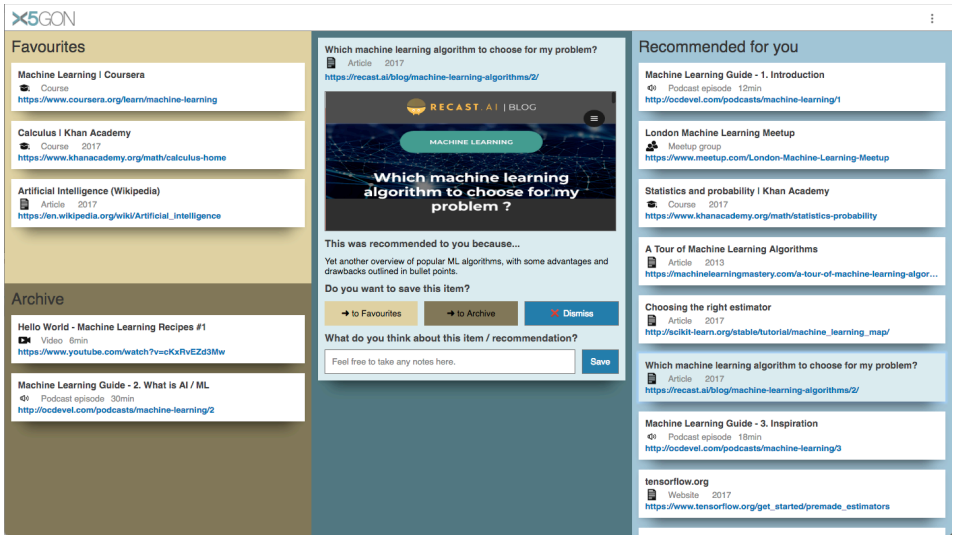

Figure 5: Favourites and Archive

Context tabs

As learners used the interface over several weeks, the majority of participants expressed an increased need to organise their collection of OERs into meaningful groups. Different designs were considered and tested with participants, including "tags", "folders", "projects", "problems" (perceived as sounding too negative), "workspaces" (too static), and "journeys". The latter was found most appropriate by the majority of participants, as it matched best how they perceived what they were doing when interacting with the OERs. A journey can be short or long, focused or exploratory, completable or open-ended.

Tabs were added to allow switching between contexts: Explore, Bookmarks, People, Notes, Diary and Settings. In response to many user requests, functions to add peers to the journey were explored using a Minimum Viable Product (MVP) approach.

Moreover, this design experimented with ways to make transparent to the user why the system recommended a particular resource. Figure 6 shows a version where the rationale for recommendation was added as natural language text below the resources. This representation was found very usable, although care needs to be taken to let users easily distinguish between descriptions that came with the resource and annotations that were added by our interface.

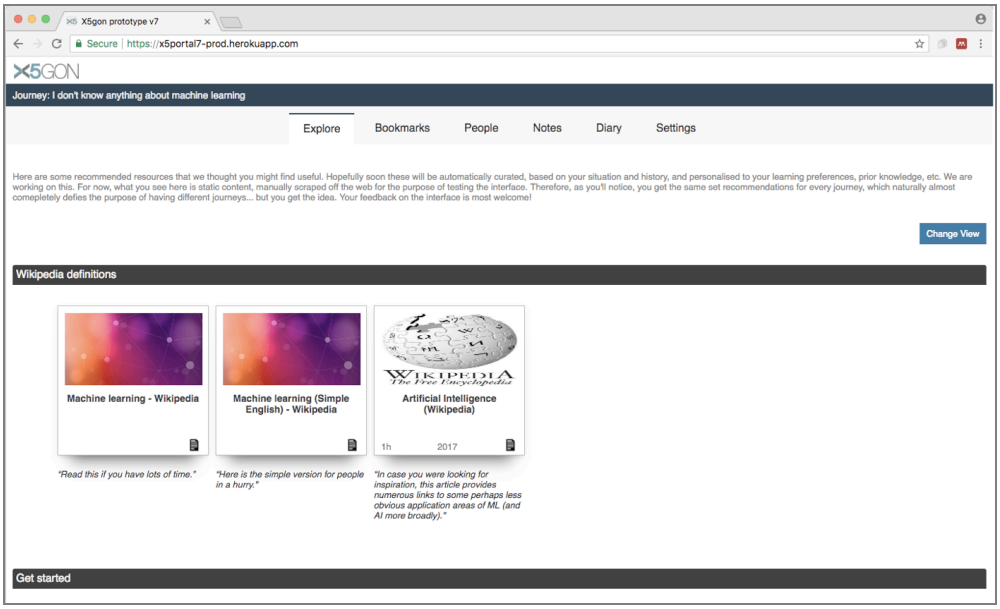

Figure 6: Tabs for different contexts, text-based rationales for recommendations

IMPLICATIONS FOR X5GON

In summary, the second main outcome of WP6 in year 1 was a series of prototypical web interfaces for using OER. These were derived through iterative design and evaluation with adult learners, as well as feedback from education experts. A peer-reviewed paper (Appendix A) documents the design process and insights gained regarding learners' needs and how to support them using effective interface structures and metaphors. Importantly, the "learning journey" metaphor resulted from this work. It provides an analytical lens that focuses on the learner's experience, complementary to the prevalent metaphor of "learning pathways" which is content-centric.

4. NOVEL USE CASES FOR PEER LEARNING

Following on from our design-in-the-wild study, and using the learning journey as the primary unit of analysis, an ongoing in-the-wild study has been investigating the benefits of collaborative learning in **pairs of adults**. Participants have been studying with an OER over several weeks. While data collection and analysis are ongoing, preliminary findings from this study constitute the third important outcome of WP6 year 1.

WHY PAIRS?

Research in pair programming has repeatedly shown that pairs benefit from mutual knowledge transfer and better problem solutions (Plonka et al. 2015). In a controlled trial conducted by Nagappan et al. (2003), undergrad pair programming students were found to perform better than students who learned to program individually. Furthermore, the authors reported a reduced workload for the teaching staff, as the pairs were remarkably self-sufficient in their joint problem solving. Basic questions, e.g. regarding syntax, were often resolved within the pair, thus increasing their ability to progress fluently and dedicate more time to higher-level learning.

These encouraging findings align well with collaborative learning theory holding that *"the interaction among subjects generates extra activities (explanation, disagreement, mutual regulation, ...) which trigger extra cognitive mechanisms (knowledge elicitation, internalisation, reduced cognitive load, ...)"* (Dillenbourg 1999).

Pairs are the smallest unit at which these cognitive benefits can be achieved. In addition, pairs have the practical advantage of being relatively flexible when it comes to (re)scheduling study meetings, compared to larger study groups and classes. Presumably, this practical benefit is especially relevant in adult learning, with learners needing to fit their study time into busy and dynamic schedules.

EXPLICIT COMMITMENT AND PLANNING IN PAIRS

Recent research suggests that giving students a small planning tasks at the start of an online course can positively affect their retention in the course. Getting students to write a small paragraph was shown to be effective (Yeomans and Reich 2017) and other kinds of tasks are conceivable. For the purpose of this study, we designed a short questionnaire for pairs to fill in together during their study meetings, with check boxes and open fields regarding how they intend to orchestrate their shared Journey, what types of shared activities or homework to include, etc (see Appendix B). The goal was to see whether providing them with a way to explicitly reflect and agree on specific shared commitments (making a "pact" together) would help to sustain their learning for the duration of the course.

HYPOTHESIS

Considering a fair amount of prior research suggesting that face-to-face learning tends to lead to greater student satisfaction compared to online learning (e.g. Platt and Yu 2014), we hypothesised that pairs who meet face-to-face once a week to do a tutorial together would express more satisfaction than pairs who did the same via Skype. Furthermore, we hypothesised that this difference can be ameliorated by encouraging pairs to make an explicit pact.

SETUP

We recruited 4 groups (face-to-face vs remote and pact vs no-pact) of 15 pairs and gave them access to a custom-designed learning interface which encapsulates 10 episodes of a video tutorial on applied Machine Learning (Figure 7). Participants were given the choice to either bring their own study partner or be paired up with another participant based on compatible schedules (and location in the face-to-face condition). The pairs were explicitly encouraged to go about their learning journey in a self-sufficient way, since the researchers did not offer any additional lectures, mentoring or technical support. Qualitative and qualitative data has been collected through system logs, user diaries and pre/post questionnaires. Semi-structured interviews with individual participants were scheduled at the beginning, six weeks into the course and at the end.

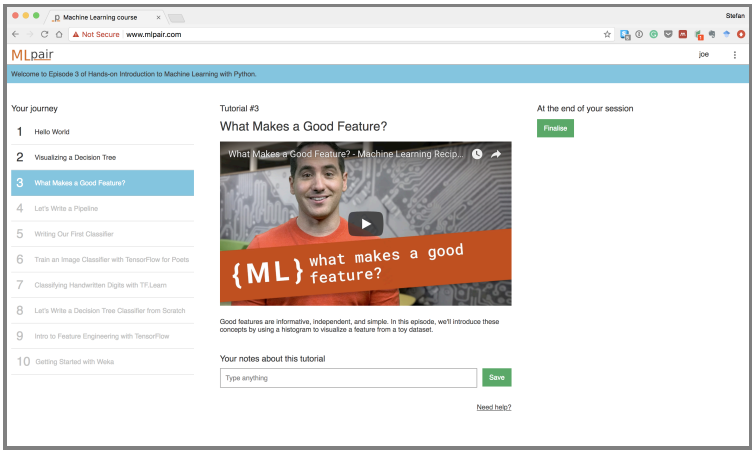

Figure 7: Minimalistic interface for a multi-part video tutorial

ANALYSIS

At the time of submitting this report, semi-structured interviews are being conducted with participants, supported by summaries and visualisations of log data. Quantitative analysis will start as soon as the last pair has finished the course or stopped studying.

RESULTS

While the study is ongoing it would be premature to elaborate on preliminary findings. Quantitative results are not available yet. However, log data and participant interviews have already shown substantial support for the notion that studying face-to-face pairs is indeed a desirable, feasible, and viable option for many self-determined learners. So far, most of the interviewees emphasised that having a study partner was essential for them to stay motivated and continue despite difficult content and confusing error messages. Many said that they would have given up, had it not been for their pair who made them feel accountable and committed to a time schedule. Compared to MOOCs, very few participants disengaged prematurely. Pairs were found to be remarkably self-sufficient. Despite the large number of technical problems (e.g. installation, code errors, version conflicts, etc.) that pairs described in their notes and interviews, the researcher received very few direct help requests.

While some participants brought their own study partner (mostly colleagues or friends, occasionally people in the same household) most participants preferred to be paired up by the researcher, rather than asking friends, colleagues, etc. whether they would be interested in studying together. A variety of reasons were mentioned, including fear of rejection and social norms. One participant explained that finding people with similar interest was the easy part, e.g. through meetup.com: *"You can go onto that, there's lots of people there."* However, making the transition to actually studying together was described as an obstacle: *"It would be very difficult […] Do you want to do something together? […] You'd probably have to build up a relationship with an individual before you even ask that sort of question. It's almost like, you know, do you want to hang out with me? […] I suppose there would have to be an intermediary sort of situation that draws people into it that are already thinking that they want to pair up with other people."*

IMPLICATIONS FOR X5GON

The preliminary findings support the desirability, feasibility and viability of pair studying in self-determined adults, while raising questions regarding scalability and sustainability. Two key challenges were identified where recommender systems could potentially have an impact: (a) matchmaking between strangers with known common study interest; (b) awareness of common interests among potential study partners.

Regarding the matchmaking, it is worth noting that in this study, the recruiting and match-making were performed by a researcher, using an official UCL email address. Presumably, the status of the university may have contributed to a high degree of a-priori trust in the process and the pairing. Moreover, the entrance barrier to the course was relatively high (compared to e.g. MOOCs), since all participants had to go through an elaborate sign-up process, including a 6-page consent form and short preliminary interview. In combination, these factors may have partially contributed to the high initial retention rate and participants' confidence in being paired. One might speculate to what extent the same attitudes would likely occur if the process was automated, e.g. if there was a website that offered "study buddy" recommendations as a service. Opinions among the interviewees have been less consistent in this regard. Aspects of trust and screening procedures are certainly among the factors to take into account when thinking about the design of systems that could scale this approach to thousands of learners.

The other potential challenge for X5GON is that any two people (e.g. friends or colleagues) are usually not aware of the full range of interests and learning needs that they share in common. As a consequence, a substantial number of opportunities is lost among people who would potentially make great study buddies. Solutions to this problem would involve user modelling, data visualisation, and interface design.

5. FRAME TAXONOMY

As a combined result of our literature reviews and empirical research, the fourth important outcome of WP6 has been a structured overview of OER use cases that are potentially relevant to X5GON. We call it the FRAME taxonomy, since the identified use cases revolve around Finding, Recommending, Assessing, Managing, and Engaging (FRAME).

The FRAME taxonomy is empirically grounded and has been reviewed by education experts. As a conceptual framework, it can guide the evaluation of user interfaces and systems, including the outcomes of other WPs.

Furthermore, as a creative tool, it can support designers in envisioning novel use scenarios, by selectively combining the components (F, R, A, M, E) and mapping them onto entities, such as the learner, teachers, peers, AI, etc. Thanks to its systematic nature, flexibility and ease of use, FRAME has also been helpful in evaluating early-stage project ideas, and in sketching a research roadmap for WP6 in year 1 and beyond.

CONCLUSIONS AND FUTURE WORK

In year 1 WP6 has contributed to X5GON a broad range of relevant insights regarding the effective design and evaluation of systems and interfaces for learning with OER.

A series of studies was conducted which logically progressed from observation in the wild, to participatory design with learners, and finally exploration of novel use cases. Key outcomes are:

1. a set of guidelines for how (not) to present OER recommendations to learners
2. a range of empirically evaluated interface designs
3. opportunities for supporting pairs
4. the Journey metaphor
5. the FRAME taxonomy

The concept of the Journey, which resulted from in-depth design and evaluation with real learners in the wild, is a powerful research tool. It describes how learners traverse an open education landscape, how they experience it, and what they gain from it. Whereas "learning pathways" (Henning et al. 2014) essentially describe sequence of content - which may be seen as stepping stones within the Journey (or dots and arrows on a map) - the Journey itself includes the *interactions* that put the content to use, bring it to life, make it useful to the learner.

To paraphrase Dillenbourg (1999), interactions activate cognitive mechanisms. Collaborative interactions activate richer, and higher-level cognitive mechanisms. Collaboration fits well into the Journey framework, since learners can share a Journey together. As our preliminary findings have shown, they can propel each other forward in unexpected ways, given the right type of support.

Whether learners collaborate or study individually, keeping one's focus on the Journey implies capturing the ups and downs, breakthroughs and setbacks that a learner experiences over time. For researchers, it means detecting the subtle practicalities that can make or break a learner's progress, achievement, enjoyment and confidence at any given moment. For designers, it means leveraging, navigating, and reshaping these practicalities, in order to enable a worthwhile learning experience.

Keeping a robust focus on the Journey will become increasingly important in year 2, as we will extend our activities to formal learning settings, such as universities (working with lecturers and OER repositories) and schools (designing with teachers). While these institutions are of central importance to education, they are also notorious for their entrenched structures (regarding time, space, processes, systems, regulations, policies, licences, responsibilities, etc.). These can easily become the main centre of attention, once their rigidity threatens to impede, slow down, complicate or threaten the feasibility of an innovative effort, as countless school and university-based projects testify (e.g. Moher et al. 2005). Focusing on the Journey (while it may not necessarily prevent the obstacles or the need to deal with them) will stabilise the researchers' focus and priorities on the learning experience. In the best case, the Journey approach ensures that workarounds are never to the detriment of the learner.

When doing research with providers of education, there is a risk of the research accidentally becoming too provider-centric. For instance, MOOCs typically focus on evaluating their success through largely measuring completion rates based on log data. While such online data can be informative, it does not take into account other 'off-platform' learning activities (Veletsianos et al. 2016), such as the learners' knowledge before starting the course, what other online resources they use in parallel, and where they continue to study after disengaging from the course. In other words, this type of research is best described as course-centric or provider-centric, whereas a truly learner-centric analysis would aim to look at the entire Journey and follow the learner over time (across providers), in order to get a rounded picture and know what kind of support they need, when, where, how and why. It is worth noting that the notion of Cross-Provider research is a relatively nascent movement in open education. The Journey gives X5GON a head-start in this regard.

Similarly, when designing with teachers, the Journey can help us distinguish between the teacher's needs and the learner's needs (and ideally optimise for both), rather than the teacher-centric sides taking over disproportionately. It can also help us analyse the teacher's needs and actions in the context of their ultimate objective which is (or should be) to cause improvements in the learners' experience, whether it is through better personalised content, recommended activities, awareness of peers, etc.

By the same principle, when designing with content, the Journey can help us distinguish between content-centric definitions of success and learner-centric ones. The former have traditionally been expressed by total number of clicks/buyers, etc. More advanced definitions of success (and "quality") are being elaborated in WP1 which have far more potential to take into account individual learners and their Journeys.

In order to develop our learner-centric approach, our efforts in year 1 have mainly focused on learning that happens in an open context, independent of the constraints of formal education. We explicitly focused on self-determined, self-motivated adult learners. The main benefit of these efforts has been a deep and detailed understanding of what learning with OER implies, culminating in our concept of the Journey. Other benefits are:

1. The findings and tools devised in this context can directly benefit learners across institutions and providers, which is a key goal of X5GON.
2. Many of our findings will likely generalise to institutional settings.
3. The process of generalising from journeys to institutional settings is likely to inspire novel solutions that are less obvious when looking at institutions first.

In year 2, we will extend our focus to institutional contexts, while maintaining a human-centred, in-the-wild research approach. Further design and evaluation with university lecturers and students are in planning for year 2 and 3.

REFERENCES

Dillenbourg, P. (1999). What do you mean by collaborative learning. In Collaborative learning: Cognitive and computational approaches (pp. 1–16). New York: Elsevier Science.

Drachsler, H., Verbert, K., Santos, O. C., & Manouselis, N. (2015). Panorama of Recommender Systems to Support Learning. In Recommender Systems Handbook (pp. 421–451).

Green, P., & Wei-Haas, L. (1985). The Rapid Development of User Interfaces: Experience with the Wizard of OZ Method. Proceedings of the Human Factors Society Annual Meeting, 29(5), 470–474.

Moher, T., Hussain, S., Halter, T., & Kilb, D. (2005). RoomQuake: embedding dynamic phenomena within the physical space of an elementary school classroom. In *CHI '05 extended abstracts* (pp. 1665–1668).

Nagappan, N., Williams, L., Wiebe, E., Miller, C., Balik, S., Ferzli, M., & Petlick, J. (2003). Pair Learning: With an Eye Toward Future Success (pp. 185–198). Springer, Berlin, Heidelberg.

Platt, C. A., & Yu, N. (2014). Virtually the Same?: Student Perceptions of the Equivalence of Online Classes to Face-to-Face Classes. MERLOT Journal of Online Learning and Teaching, 10(3).

Plonka, L., Sharp, H., van der Linden, J., & Dittrich, Y. (2015). Knowledge transfer in pair programming: An in-depth analysis. International Journal of Human-Computer Studies, 73, 66–78.

Rogers, Y., & Marshall, P. (2017). Research in the Wild. Synthesis Lectures on Human-Centered Informatics, 10(3), i-97.

Veletsianos, G., Reich, J., & Pasquini, L. A. (2016). The Life Between Big Data Log Events. AERA Open, 2(3), 233285841665700.

Yeomans, M., & Reich, J. (2017). Planning prompts increase and forecast course completion in massive open online courses. In Proceedings of the Seventh International Learning Analytics & Knowledge Conference on - LAK '17 (pp. 464–473). New York, New York, USA: ACM Press.

Zhao, B., Xu, S., Lin, S., Luo, X., & Duan, L. (2016). A new visual navigation system for exploring biomedical Open Educational Resource (OER) videos. Journal of the American Medical Informatics Association, 23(e1), e34–e41.

APPENDIX

A: PUBLISHED RESEARCH PAPER

Kreitmayer, S., Rogers, Y., Yilmaz, E., Shawe-Taylor, J. (2018). Design in the Wild: Interfacing the OER learning journey. In *Proceedings of the 2018 British HCI Conference on - British HCI '18*. Belfast, United Kingdom.

Design in the Wild: Interfacing the OER learning journey

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Open Educational Resources (OERs) such as talks, lectures, texts, slideshows, and online activities, offer much potential for people to study a broad range of topics. However, the choice among millions of OERs can be overwhelming and many learners give up on their goals prematurely. Our ongoing research aims to help self-directed learners study effectively and enjoyably by providing a personalized route through appropriately prioritized OERs. However, there are many aspects that can be considered including motivation, getting lost, determining whether to continue, and what resource to look at next. How can we begin to design an interface that can support these? To this end, we describe our iterative 'design in the wild' approach, showing how it helped us to determine how to operationalise and support these aspects and, in doing so, provide us with a way of assessing the overall learning experience.

Open Education Resources (OERs); Learner-centric design; Iterative design.

1. INTRODUCTION

Adult learners have a diversity of prior skills and knowledge, together with preferences for how they want to learn. Such individual needs have been recognized by MOOC research in recent attempts to make them more adaptive. For example, features that have been added to enable more personalisation included course-specific features, such as intelligent tutoring systems [1], recommender systems [4], and A/B testing [6]. However, it is difficult to know how effective these approaches are as they typically focus on evaluating their success through largely measuring completion rates based on log data. While such online data can be informative, it does not take into account other 'off-platform' learning activities [5], such as the learners' knowledge before starting the MOOC course, what other online resources they use in parallel, and importantly the actual experience of learning. How much do students enjoy the course, what do they get out of it? How can these aspects be more extensively taken into account alongside what learning activities can be logged, in order to inform the next generation of self-directed learning - OERs - that are now becoming more mainstream?

Open Educational Resources (OER) provide a new opportunity to create personalised learning pathways for each learner, by connecting resources of various sizes, types, and origins. OERs may include MOOCs as well as smaller units, such as tutorials, books, lectures, etc and fragments thereof. With AI-based recommender systems beginning to outperform human recommendations, there is great potential for designing systems that analyse someone's long-term learning history in order to infer their knowledge and preferences and give informed recommendations regarding what to study next [2]. By allowing the learner to change paths and adapting continuously, this approach promises more flexibility for self-determined learners to take ownership of their journey. At the same time, it is far from obvious to what extent people's learning habits and preferences transfer naturally to the unfamiliar context of personalised learning. For instance, how will the abundance of choice of learning materials affect planning, engagement, sense of progress and achievement, reflection, and perseverance? How can peer interaction be orchestrated when no two learners' journeys are the same? How will people handle moments of getting sidetracked, stuck, overwhelmed, distracted, etc in this novel kind of environment? Will their usual strategies suffice or will new strategies emerge? What measures of success and support are appropriate in this context? In the following we describe our research approach.

2. AIMS

The aims of our ongoing research are:

- to collect empirical evidence of how learners use OER recommendations in the wild, their needs and expectations;
- establish appropriate learner-centric definitions of success and progress;
- inform the design of user interfaces and learning platforms around OER recommender systems.

3. METHODOLOGY

When determining how to design an effective, efficient and satisfying learning experience, we decided to focus on the experience of real learners under real conditions, rather than assumed scenarios or personas. To begin, we designed a minimalistic web interface, based on the results of initial interviews suggesting that learners need to (1) find OERs, (2) preview and compare search results, and (3) keep track of selected resources over days and weeks. Many interviewees said they were happy with the results from Google search but expressed frustration about having too many browser tabs open, which made it difficult to preview, compare and keep track of things over time and across devices. Consequently, our initial design started with a Google search for a popular topic, in this case "Introduction to machine learning". We selected a number of resources, and decided how best to structure and present these at the interface and how they should adapt to the user. The details of the initial design are presented later.

The reasons for choosing Machine Learning (ML) as a topic included the practical benefit of having domain expertise represented in our team. Furthermore, ML is practically applicable and of high relevance to the general public, formal education and professional training. It is a fast-changing knowledge domain: new OERs are published every day and courses can quickly become outdated.

4. DESIGN IN THE WILD

The participants were recruited based on their expressed interest in an introduction to ML. Rather than just ask them to use our system, we asked them to explicitly help us iterate and evolve our OER system in a real world context. 8 participants (5 male, 3 female, age 23-57) were invited to use the interface for as long as they found it useful, in their free time, using their own laptop or smartphone. They were also asked to provide feedback during a weekly interview. These were directed towards building an in-depth understanding of the learner's experience over time (including usability but also getting stuck, sidetracked, etc, see introduction) and towards informing design changes that address the learners' explicitly stated needs.

One-on-one sessions with participants have constituted the primary data source. Also taken into account was the extent to which the participants used the interface for collecting resources and taking notes. In addition, feedback from 3 experts in the area was elicited at various stages. This 'design in the wild' iteration process took place over two months. Below we describe the initial design of the interface and how it evolved.

Initial design
The initial OER design presented users with 37 manually selected, ML-related OER recommendations, including several online courses, articles, podcasts, tutorials, meetup groups, etc. We decided on a small number to begin with, in order to be flexible in case of any need for manual processing. We also took inspiration from familiar websites like Netflix and Amazon, that people are very familiar with using, to present the items, as horizontal icon-based lists, categorised by media type and other criteria, such as "Because you are interested in learning Python". By selecting an item, users could see more information, take notes and mark the item as started or completed. Two dedicated lists allowed learners to easily find started and completed items again. Basic functionality for overall note-taking and diary was also provided.

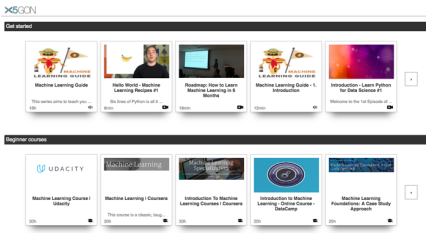

Figure 1: *Resources arranged by category.*

"Bookmarks" instead of "started"
In response to user feedback, the categories "started" and "completed" were renamed as "bookmarks" and "archive", in order to better apply to certain types of resources, such as meetups, short videos, and articles intended for continuous reference. This seemingly minor change highlighted the potential for journeys to be made open-ended.

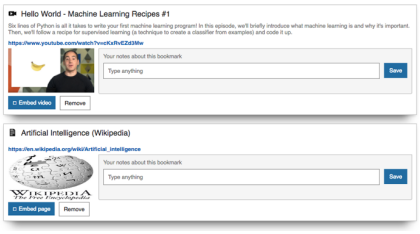

Figure 2: *Two bookmarked OERs including the title, description, URL, image, and a field for taking notes.*

Support for journeys
As their collections of OERs they had selected for viewing grew over the weeks, several participants expressed a need to organise their bookmarked resources into meaningful groups. Different designs were considered and tested with participants,

including "tags", "folders", "projects", "problems" (perceived as sounding too negative), "workspaces" (too static), and "journeys". The latter was found most appropriate by the majority of participants, as it matched best how they perceived what they were doing when interacting with the OERs. A journey can be short or long, focused or exploratory, completable or open-ended. Moreover, the idea of inviting others to join a journey was perceived as compelling and intuitive. When creating a new journey, the user is required to give it a name. Surprisingly, this feature was also used as a planning tool by one participant who created multiple journeys at once, like a todo-list of subtopics to study.

Peer involvement
Several participants suggested the possibility to share a journey, or multiple journeys, with other people. To get an indication of the real demand for such a feature, it was implemented as a mockup and participants were asked whether they would use it in practice and if so, what for and how. A variety of reasons were expressed. For instance, one participant suggested *"to have a real person check in on my progress once in a while - as opposed to automatic email reminders, because those I just ignore"*. Another participant said: *"Just to have someone who is also trying to achieve the same thing [...] that would be motivating."* Three participants said that they could imagine inviting their friends, partners, fellow university students, etc who are also keen to learn about the topic, but not necessarily strangers. Overall, participants expressed considerable interest, mostly in regard to increasing their own motivation and perseverance. Conversely, one participant suggested that by sharing her bookmarks she could help other learners. Finally, two participants expressed that they would probably prefer to study alone, at least initially or most of the time.

Need for previews
To avoid opening too many browser tabs, four participants asked for a more convenient way to preview OERs. Because in our case OERs are represented as URLs of web pages, we experimented with embedding the target web pages in our interface in small boxes (HTML iframes). Surprisingly, the result was found quite usable with many target websites, including Wikipedia and websites that appeared in a mobile-friendly version. However, a considerable number of popular websites showed nothing but blank space in response to being embedded, indicating that this solution would not easily generalise. A variety of alternatives are currently being considered, including screenshots, extracted features and services that provide page previews.

Definitions of progress
One participants suggested that journeys could indicate the learner's progress in some form, *"[...] to know how close you are to completion"*. However, when asked where and how they would like this information displayed, difficulties became apparent. Concerns were raised that the size of a journey is rarely knowable in advance and may vary as new things are discovered. Moreover, some journeys may be open-ended. Further questions were raised regarding appropriate metrics, e.g. number of resources, time investment, level of understanding or types of engagement. One participant suggested: *"maybe you specify progress in terms of a feeling."*

5. OBSERVED USE OF OER

Participants were interested in a variety of media types, including online courses. However, choosing between courses was generally found to be difficult. Given the time investment involved in trying out a course, none of the participants tried out more than two courses and some participants settled for a suboptimal choice. For instance, one participant was content with their course except that they found the programming examples to use an older version of the programming language (Python). The question was raised whether our system could be used to find alternative examples that also matched the course lectures but were more up to date.

Participants' reflections on the importance of following a recommended OER from beginning to end were mixed. For the most part, our findings indicated that self-directed learners care very little about completing or not completing a MOOC or other OER. What mattered more to them was using their time efficiently. In the words of one participant, who said that she generally avoided MOOCs for this reason: *"I tend to avoid learning things that I wouldn't immediately apply in one of my projects, because then they don't stick and I would have to learn them again. I would probably watch a video to get an introduction but then I use Google to look up very specific problems that I need to solve."* Another participant explained: *"[...] like in a supermarket, you're not expected to buy everything. It's OK to leave some things on the shelf. Or with a textbook, sometimes you want to read the whole thing and sometimes you only care about a specific chapter."*

The participants agreed that our prototype OER interface was functional, usable and attractive. Some participants reported using it less frequently after a target website had drawn them away from it. They kept on that site. For instance: *"I found this Udacity course through the interface. Now most days I go directly to Udacity, rather than going through the interface, because it's faster. But occasionally I come back here to take notes."* Similar cases were reported where participants found themselves being drawn to playlists on YouTube for

extended periods. While this switching to other sites makes it harder to keep track of what learners are doing online, it was not seen as a problem for their learning experience as long as the content was relevant. The tendency to go to other sites, however, does raise questions about how we bring them back and how they sit with our accompanying personalised learning resources.

As a result of the comments and feedback made by the participants we were able to reflect upon how small changes at the interface would impact upon the higher level pedagogical goals we hoped to foster. Below we discuss the results of our 'design in the wild' approach with respect to our aims.

6. DISCUSSION

Our ongoing design and in-depth evaluation with real users produced a number of insights that we acted upon in changing aspects of the interface. Making these changes with a live audience enabled us to get iterative feedback on the fly - providing us with a way of testing the new features and discovering how they impacted on the learning experience. For example, the concept of "journey" suggested by the participants to describe what they were doing, was found to be useful for us as an analytical tool to describe the experience and self-perception of self-directed learners using OER recommendations. While the notion of "learning pathways" as used in [2] represents a content-centric view on a series of resources, the "journey" is the experiential counterpart, supporting a complementary, learner-centric view.

At a more general level, we identified 3 areas when considering the next iteration of the interface design: peers, previews, and progress. By these are meant: (1) leveraging peer involvement to support learners' motivation, perseverance and help-seeking, (2) enabling learners to efficiently preview OERs of diverse media types, (3) helping learners reflect on and manage their progress. Our next steps require operationalising these in terms of the learner journey and to be able to implement these at the interface.

Another future direction is to consider how much of the interface to leave open for learners to choose from available OERs and how much to scaffold through using automated recommendation. Given the ever increasing number of resources for learners to choose from, leaving certain things unfinished might be preferable. An implication for design is that learners might value an interface that helps them mix and match different resources and parts thereof.

Our next steps also will be to address how to design aspects of an interface that can help with supporting learners' strategies for dealing with obstacles and impasses - such as getting stuck, side-tracked, overwhelmed, or distracted. Recent MOOC research has begun to recognise these issues [3] and insights gained in this context could in some cases transfer to self-directed OER journeys as well.

7. CONCLUSIONS

Our 'design in the wild' approach has enabled us to iteratively design a user interface for OER recommendations that adopts as its central metaphor - the learner journey. Using the "journey" as our primary conceptual unit of analysis, also enabled us to begin to consider how to design functionality that can support learner engagement and reflection. We have also found through this process that small changes at the interface can enable us to explore more generally what impacts they can have on learning at large.

8. ACKNOWLEDGMENTS

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9. REFERENCES

[1]Aleven, V., Baker, R., Blomberg, N., Andres, J., Sewall, J., Wang, Y., Popescu, O. (2017). Integrating MOOCs and Intelligent Tutoring Systems: edX, GIFT, and CTAT. In Proceedings of the 5th Annual Generalized Intelligent Framework for Tutoring (GIFT).

[2]Henning, P., Heberle, F., Streicher, A., Zielinski, A., Swertz, C., Bock, J., Zander, S. (2014). Personalized Web Learning: Merging Open Educational Resources into Adaptive Courses for Higher Education. UMAP Workshops.

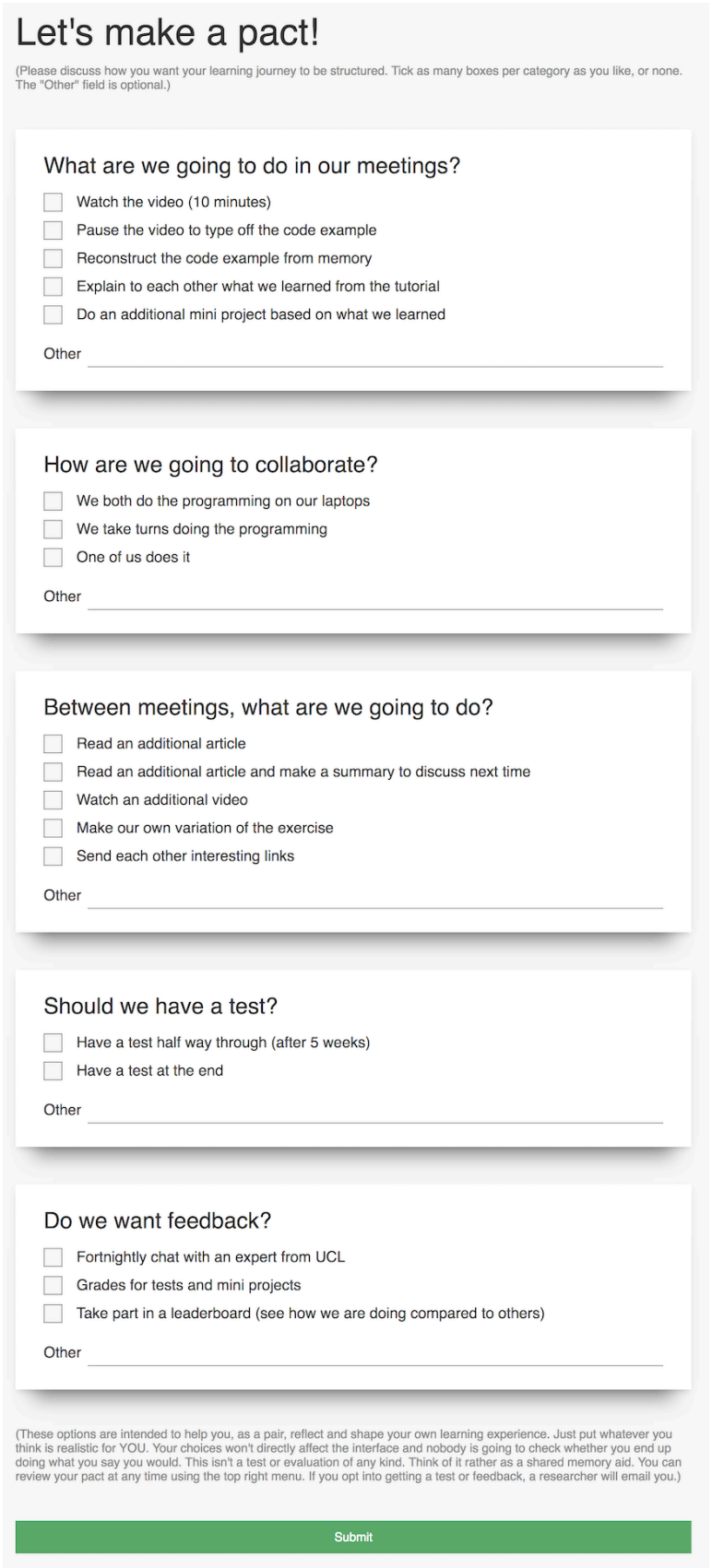
[3]Kizilcec, R., Pérez-Sanagustín, M., Maldonado, J. (2016). Recommending Self-Regulated Learning Strategies Does Not Improve Performance in a MOOC. In Proceedings of the Third (2016) ACM Conf. on Learning @ Scale - L@S '16, 101–104.

[4]Pardos, Z., Tang, S., Davis, D., Le, C. (2017). Enabling Real-Time Adaptivity in MOOCs with a Personalized Next-Step Recommendation Framework. In Proc. of the Fourth (2017) ACM Conf. on Learning @ Scale - L@S '17, 23–32.

[5]Veletsianos, G., Reich, J., and Pasquini, L. (2016). The Life Between Big Data Log Events. AERA Open 2, 3 (2016), 1–10.

[6]Williams, J., Rafferty, A., Maldonado, S., Ang, A., Tingley, D., Kim, J. (2017). MOOClets. In Proc. of the Fourth (2017) ACM Conference on Learning @ Scale - L@S '17, 287–290.

B: PACT QUESTIONNAIRE



Let's make a pact!

(Please discuss how you want your learning journey to be structured. Tick as many boxes per category as you like, or none. The "Other" field is optional.)

What are we going to do in our meetings?

- [ ] Watch the video (10 minutes)
- [ ] Pause the video to type off the code example
- [ ] Reconstruct the code example from memory
- [ ] Explain to each other what we learned from the tutorial
- [ ] Do an additional mini project based on what we learned

Other _____

How are we going to collaborate?

- [ ] We both do the programming on our laptops
- [ ] We take turns doing the programming
- [ ] One of us does it

Other _____

Between meetings, what are we going to do?

- [ ] Read an additional article
- [ ] Read an additional article and make a summary to discuss next time
- [ ] Watch an additional video
- [ ] Make our own variation of the exercise
- [ ] Send each other interesting links

Other _____

Should we have a test?

- [ ] Have a test half way through (after 5 weeks)
- [ ] Have a test at the end

Other _____

Do we want feedback?

- [ ] Fortnightly chat with an expert from UCL
- [ ] Grades for tests and mini projects
- [ ] Take part in a leaderboard (see how we are doing compared to others)

Other _____

(These options are intended to help you, as a pair, reflect and shape your own learning experience. Just put whatever you think is realistic for YOU. Your choices won't directly affect the interface and nobody is going to check whether you end up doing what you say you would. This isn't a test or evaluation of any kind. Think of it rather as a shared memory aid. You can review your pact at any time using the top right menu. If you opt into getting a test or feedback, a researcher will email you.)

Submit