

Supporting urban change

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Supporting urban change: using a MOOC to facilitate attitudinal learning and participation in smart cities

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Abstract

Smart cities try to use technology and data to improve the efficiency of city services, to address societal challenges and to improve collaboration between citizens and government. Driving such social change requires a deep socio-ecological transition with both organisations and individual's lifestyles needing to change. This has led to an increasing recognition of the need for education to empower people to play a more active role within smart city initiatives. This paper examines our use of a MOOC as a tool to facilitate attitudinal learning around the topic of smart cities and to explore whether the learners engage in local smart city activities. A mixed methods research design was employed, collecting data via an online survey that was completed by 202 learners and through in-depth interviews with 8 of those learners. The results show that learners' perceived high levels of attitudinal learning on the topic of smart cities across four categories of learning outcomes (general, cognitive, affective and behavioural). Our findings also contribute to an understanding of the types of post-course activities learners participate in and their experiences of trying to apply what they learnt if they participated in local smart city activities. We conclude by providing new insights into how to design for learning to support social change in the context of a MOOC.

Keywords:

Distance education and telelearning; learning communities; lifelong learning; evaluation methodologies

1. Introduction

Cities face great challenges from rapid urbanisation, climate change and increasing pressures on services such as transport, housing and healthcare (United Nations, 2014). Smart cities use technology and data to improve the efficiency of city services, to reduce resource consumption and costs, to improve collaboration between citizens and government and to address societal challenges. (Börjesson Rivera, Eriksson, & Wangel, 2015; Hollands, 2008; Nam & Pardo, 2011; Shapiro, 2006; Van Waart, Mulder, & de Bont, 2015). As the smart city concept matures, it is evolving from being technology focused towards a more citizen-centric concept that seeks to address quality of life and the sustainability of cities using technology as an enabler (Marsal-Llacuna & Segal, 2017; Nesta, Saunders & Baeck, 2015). Meeting societal challenges will require a deep socio-ecological transition within cities with changes in urban development, governmental structures and individual's lifestyles (Mulder, 2014). Driving such a social change requires changes in attitudes and there is a need to

engage and empower citizens to participate within smart cities by providing opportunities for learning, community-based innovation and active citizenship (Mulder, 2014; Rizzo, 2015).

Education systems can be used to address the challenges global communities face, by transforming values, attitudes and behaviour patterns to actuate social change (Sharma & Monterio, 2016). Various definitions of social change exist, but one that captures its key features is a 'broad umbrella to encompass a range of typical social and civic outcomes from increased awareness and understanding, to attitudinal change, to increased civic participation, the building of public will, to policy change that corrects injustice' (Animating Democracy, 2018). According to Mezirow's theory of transformational learning, education that allows learners to go through a process of critical reflection, leads to a transformation in their thinking (Mezirow, 1997). Critical to this is distorting dilemmas, experiences that encourage learners to reconsider their beliefs by critically reflecting on their own views and those of others through discourse.

Given the way MOOCs are designed, they could provide an effective tool for facilitating citizen learning and participation in smart cities. MOOCs widen access to education as they are open, have no prerequisites or commitment, and attract a large global audience with diverse backgrounds and attitudes (Barak, Watted, & Haick, 2016). They offer learners an opportunity to take ownership of their education, by deciding how they want to participate, what they want from a course and by providing a space where individuals can reflect, act and link their practice to broader democracy (Carver and Harrison, 2013). Policy makers view MOOCs as having important policy implications for sustainable development; they increase access to high quality education and connect people who share the same interests so that citizens are able to reach out to new groups, generate new ideas, projects or interpersonal engagements (Patru & Balaji, 2016).

This study examines the use of a MOOC to facilitate attitudinal learning around the topic of smart cities and explores the post-course activities learners participate in and their experiences of trying to apply what they learnt if they engaged in local smart city activities. Our study uses the Smart Cities MOOC, a course written by two of the authors of this paper as part of a collaborative smart city initiative. The course aim is to provide a global learning resource for citizens to explore the role of technology and data in cities, and to learn how they can participate in the creation of smart cities (Anonymous, 2016). The MOOC is hosted on the FutureLearn platform which employs a social constructivist pedagogy that is based on social learning through commenting and discussion, provoking conversations and marking learner progress (Ferguson, Clow, Beale, Cooper, Morris, Bayne et al., 2015). The course design was informed by a learning design approach which recognises the importance of the situated aspects of a student's learning experience, and sees expertise as developing through engaging with the knowledge, applying it, playing with it, and transforming it (Galley, 2018).

The origins of learning design can be traced back to the instructional design research of the 1940s (Reiser, 2001), but it is distinct from the field of instructional design which is concerned with finding efficient ways of facilitating the acquisition of knowledge and draws on cognitivist learning theories (Galley, 2018). Learning design draws upon socio-cultural perspectives which emphasise the importance of the learner's experience and sees expertise as developing through learners taking 'a legitimate role in the ongoing activities of a [learning] community and gradually moving to fuller participation' (Barab, Evans & Baek, 2004, p.199). Research evaluating the learning design of MOOCs and learner perspectives of their effectiveness is still at an early stage (Olazabalaga, Garrido & Ruiz, 2016). Whilst changing learners' attitudes is a core element of education, research addressing how to design for attitudinal learning is also limited and the literature related to MOOCs focuses on instructional design (Enger & Lajimodiere, 2011; Watson et al., 2017). The lack of research is in part

due to the hesitancy of researchers to claim cause-and-effect between the design of learning and attitude, as there may be other causes (Simonson & Maushak, 1996; Watson, Watson, Yu, Alamri & Mueller, 2017).

Attitude is an individuals' psychological evaluation about an object and is widely considered to consist of three key components; the cognitive component comprised of belief or knowledge about the object, the affective component comprised of feeling about the object and the behavioural component comprised of actions taken towards the object (Kamradt & Kamradt, 1999; Simonson, 1979; Vogel & Wänke, 2016; Watson, Kim & Watson, 2016; Zimbardo & Ebbesen, 1970). An attitude about an object is stable when the three components of attitude are closely aligned or in balance. The most common approach to designing learning to change attitudes is through the creation of cognitive dissonance, which aims to create a tension within an individual's beliefs, by presenting new information to the learner (Bodenhausen & Gawronski, 2013). To create dissonance within the affective component, strategies typically aim to emotionally arouse learners, whilst the behavioural component can be impacted by asking learners to perform a behaviour inconsistent with their existing behaviour (Kamradt & Kamradt, 1999; Simonson, 1979).

Recent studies have explored the potential of using MOOCs to support attitudinal learning in socio-scientific issues, those that have a basis in science and a potentially large impact on society (Ratcliffe & Grace, 2003). Watson, Kim & Watson (2016) developed an online survey that measures MOOC learners' perception of attitudinal learning across four areas (general learning, cognitive learning, affective learning and behavioural learning). They found statistically significant differences in relation to learners' perceptions of attitudinal learning based on their reasons for enrolling in the MOOC on Animal Behaviour and Welfare (Watson, Kim & Watson, 2016). Woori et al. (2016) compared learners' perceptions of attitudinal change between three MOOCs (Human Trafficking, US Food System and Animal Behaviour and Welfare) using an attitudinal learning survey and reported high perceptions of attitudinal learning across all courses and explored the impact of different instructional methods. These studies indicate the potential of MOOCs to be utilised to educate the public regarding socio-scientific topics and in doing so help to shape public attitudes which can contribute to social change.

Some MOOCs specifically attempt to create social change by supporting citizen participation within the issues they teach about. For example, the World Bank MOOC "Citizen Engagement: A Game Changer for Development" (World Bank Group, 2018) and "Bridging the Dementia Divide: supporting people living with Dementia" (Robertshaw & Cross, 2016). However, little research has attempted to evaluate MOOCs with this purpose. One study explored whether MOOCs supported employability by undertaking an online survey and interviews with learners who had been motivated to take the courses for reasons related to financial limitations and/or employment reasons (Dillahunt, Ng, Fiesta & Wang, 2016). It concluded that whilst learners were optimistic about the potential to improve employability, there was limited evidence of employment mobility arising from studying MOOCs.

Our study builds upon the studies mentioned above, further developing a method of evaluating learners' perceptions of attitudinal learning in MOOCs and applying it to the Smart Cities MOOC. It also seeks to better understand how MOOCs might be effective in supporting citizen participation in smart cities. We examined the types of activities learners engaged in after studying the MOOC and where they were involved in local smart city activities we explored their MOOC experiences and how they applied the knowledge gained. The research forms part of the evaluation stage of the learning design of the Smart Cities MOOC and hence the learners' experiences feed into the course revisions.

Our findings also provide insights for other course designers on how to design learning to support social change.

The following section describes the study methods, including the research purpose and design, the research setting and data collection and analysis. The results section includes three sub-sections, each one provides an answer to one of the research questions. The discussion section outlines the significance of the research findings, makes suggestions for improving the MOOC design and highlights the research limitations. The conclusion summarises the key findings.

2. Methods

2.1 Research purpose and design

The goals of the study are to examine learners' perceptions of attitudinal learning after studying a MOOC on smart cities and to explore the post-course activities they participate in and their experiences of trying to apply what they learnt if they engaged in local smart city activities. We define the following research questions:

- 1) What are the learners' perceptions of their attitudinal learning (general, cognitive, affective, and behavioural learning) after studying the MOOC?
- 2) What type of smart city related activities do learners participate in after studying the MOOC?
- 3) What was the MOOC experience for learners who went on to participate in local smart city activities, and how did they apply the knowledge gained from the MOOC?

This study employed a sequential explanatory mixed methods research design consisting of an online survey followed by in-depth interviews. The use of mixed methods in MOOC research has been relatively low, but it should help to reduce the weaknesses of qualitative and quantitative research design and provide a more comprehensive understanding of the MOOC phenomenon (Bozkurt, Keskin & de Waard, 2016). Institutional research ethics approval was obtained prior to conducting the study. Learners gave consent before participating in the survey and interviews, and where comments from the MOOC have been used permission was provided by learners.

2.2. Research setting

The research involved participants from the Smart Cities MOOC, a 6 week course which is delivered on the FutureLearn platform in English. The learning objectives of the Smart Cities MOOC are that by the end of the course learners should be able to (1) Describe different approaches to smart city design and delivery; (2) Co-create a smart cities project in their community using a range of tools and techniques; and (3) Share and discuss their views on smart cities as part of a global learning community. Each week is composed of distinct teaching elements, called steps, which are article, video, audio, quiz, poll, activity or discussion steps.

The 6 weeks of the MOOC cover 1) Introduction to smart cities, 2) Smart citizens, 3) Infrastructure, technology and data, 4) Enterprise and innovation, 5) Leadership and strategy and 6) Measurement and learning (Anonymous et al., 2016). The course was designed to enable learners to reflect on their learning about smart cities concepts, to consider how they are relevant to their own urban area, to share their views with other learners, and it encourages them to explore if there are any smart city activities where they live and provides them with the tools and techniques to co-create a project within their own community. It includes smart city case studies from cities around the world, presenting a variety of views and perspectives on smart city topics and related issues such as privacy, leadership, citizen engagement and ethics.

There were four presentations of the MOOC between September 2015 and August 2016. The number of people who registered for the course was 23,355 and 11,104 of these became *learners*; these are people who study at least one step of the course. The number of learners who were classed as *fully participating*, completing at least 50% of the available steps, was 1,850. At the start and end of the Smart Cities MOOC participants were sent a standard pre and post course survey (Anonymous, 2016). The number of learners who completed the pre course survey was 2107 and 359 completed the post course survey across the 4 presentations. Of this total who completed a pre or post course survey, 1181 individuals indicated they would be happy to participate in further research related to the MOOC.

The Smart Cities MOOC research survey was sent to the 1181 people via email in October 2016 and 202 people (17%) completed the survey by November 2016. The email explained the aims of the study, how data would be collected, stored and used, and that by submitting the survey they would be providing consent. Participation in the survey was voluntary and participants could withdraw their data from the study. We also asked survey respondents if they would be willing to participate in a further interview and if so to provide their contact details.

2.3. Data collection and analysis

Both quantitative and qualitative data was collected via the online MOOC research survey which comprised a combination of Likert type scale, multiple choice and open questions delivered via the SurveyMonkey platform. The survey included questions on learners' motivations to study the course, perceptions of attitudinal learning, experiences of the course, activities they had undertaken after studying the course and demographic information. To avoid response bias, the online survey was anonymous, we ensured the questions were short and clear, avoided leading questions and put the demographic questions at the end of the survey.

The number of learners who completed the online survey was 202 and 190 of them provided the optional demographic data. The gender ratio was 57% male, 42% female and 1% preferred not to say. Their age range was fairly evenly distributed across the age categories; 26-35 years (16.3%), 36-45 years (18.8%), 46-55 years (22.8%), 56-65 years (14.4%) and over 65 years (14.4%), with smaller proportion (6.4%) between 16-25 years. Those responding lived in 47 countries, with the majority from the UK (40%), Spain (5.8%), India (4.7%), Italy (4.2%), Canada (3.2%), Ukraine (2.6%), Colombia (2.6%), Netherlands (2.6%), USA (2.1%), Romania (2.1%), France (2.1%) and Australia (2.1%). English was the first spoken language for half of the respondents. Most of the learners were highly educated; 88% already had a University degree or higher qualification, 65% were in full or part-time employment and 17% were retired. The demographic profile of the survey participants is typical of the wider learners who complete the pre course survey for the Smart Cities MOOC (Anonymous, 2016).

To examine Research Question 1 (What are the learners' perceptions of their attitudinal learning [general, cognitive, affective, and behavioural learning] after studying the MOOC?) data was collected from the attitudinal learning questions included in the survey, which are shown in Table 2 in the results section. The questions were adapted from the 'attitudinal learning survey' designed by Watson et al. (2016) which aims to measure perceptions of attitudinal learning in four areas (general learning, cognitive learning, affective learning and behavioural learning). Participants were asked to rate attitudinal learning items using a 5-point Likert scale, where the scale points are levels of agreement with the statements (1. strongly disagree, 2. disagree, 3. neither agree or disagree, 4. agree 5. strongly agree). Quantitative data analysis of the survey data was performed using SPSS statistical software. The reliability of the attitudinal learning survey questions was calculated using

Cronbach's alpha, which should be above 0.70 for high reliability (Nunnally, 1978). Cronbach's alpha of the total attitudinal learning survey was 0.88 and for the general learning, cognitive learning, affective learning and behavioural learning scales it was 0.66, 0.75, 0.66 and 0.81 respectively (n=202). A range of descriptive statistics (mean, minimum, maximum, standard deviation and standard error) were calculated related to attitudinal learning outcomes as shown in Table 2. Here it should be noted that we have treated data collected on an ordinal scale (where the scale points are levels of agreement with a statement) as if it were on an interval scale to allow comparison with values presented in Woori et al. (2016), who also took this approach.

To examine Research Question 2 (What type of smart city related activities do learners participate in after studying the MOOC?) quantitative data was collected from a question in the online survey which asked about the types of smart city activities learners reported participating in after studying the course. They were asked to tick statements that applied to them from 14 options (shown in Table 3). Qualitative data was also collected through an open ended question that asked 'tell us more about the smart cities activities you are undertaking since the course' and there were 69 responses which were reviewed individually and key themes identified.

To examine Research Question 3 (What was the MOOC experience for learners who went on to participate in local smart city activities, and how did they apply the knowledge gained from the MOOC?) we selected the data of the 33 people who ticked the option 'I have participated in smart city/community activities within my local area'. They were located globally; in the UK (n=12), Spain (n=2), Netherlands (n=2) and individual learners in Argentina, Australia, Brazil, Canada, Colombia, India, Israel, Italy, Philippines, Poland, Portugal, Romania, Singapore, Syria, Ukraine, United States and Venezuela. Of these 33 people, 14 of them provided contact details. We contacted all 14 by email to invite them to participate in a Skype interview, 8 responded and were interviewed after they had completed a consent form.

Table 1: Interview participants

	Gender	Age category	Country	Profession
P1	Male	36-45	UK	Smart cities consultant running small company developing smart technology solutions
P2	Female	46-55	Romania	Freelance educator in arts/theatre working on projects with schools and communities
P3	Female	46-55	UK	Works in family print media company which publishes free newspapers for city and involved in community groups
P4	Female	36-45	UK	Founder of social enterprise that provides affordable items of furniture to people on low-incomes and offers local recycling
P5	Male	56-65	Israel	Coach working with an education charity on a MOOCHub project which sets up groups of people to study MOOCs together
P6	Male	46-55	India	Real estate consultant working on smart cities and sustainability projects
P7	Male	36-45	USA	Self-employed IT consultant developing smart city applications alongside existing work and in voluntary capacity
P8	Male	56-65	UK	Assistant Chief Executive of Local Authority involved in smart city funding bids

Table 1 shows the attributes of the 8 learners who were interviewed, their names and organisations are excluded due to privacy concerns. The interviews lasted 40-60 minutes and were conducted using Skype, which offered the ability to interview learners in different locations around the world. While one participant was from a developing country, we believe conducting the interviews in

English may have been a barrier to some people participating. Semi-structured interviews were used to explore the findings from the online survey in more detail and this also allowed new concepts and ideas to arise during the interviews. The questions covered the learner's experience of smart cities prior to studying the course, the smart city activities they were involved in, who else was involved, how they were funded, what they hoped to achieve from the activities, what elements of the MOOC were helpful, how the MOOC could be improved and what other learning resources and support they were using. The interviews were audio recorded, manually transcribed by the interviewer and the transcripts were then checked by the interviewees. We recognised there can be response bias with interviews, including participants' willingness to please. The use of semi-structured interviews, rather than unstructured, helps to mitigate against this bias and conducting the interview via skype can reduce interviewer effects, as it is more difficult to read facial expressions and take cues from this.

Analysis of the interview transcripts was undertaken by the research team, which included the course authors and facilitators. NVivo software was used for coding the transcripts and an inductive coding process was used to examine the meanings embedded within the data sets (Corbin & Straus, 2008). This process was led by the first author who is an expert in smart cities and the lead author of the MOOC. A line by line analysis was undertaken in which concepts were identified and labelled within the data. The codes were subsequently categorised into emerging themes, provisional codes were updated based on discussion with the other authors until agreement was reached. No codes existed prior to the analysis, they were created through constant comparison of the data. Internal consistency was not measured statistically due to the small number of interviews. The key themes identified are discussed in Section 3.3.

3. Results

3.1. Attitudinal learning as a result of studying the MOOC

Through the online MOOC research survey we sought to address the first research question to measure the learners' perception of their attitudinal learning around smart cities having studied the MOOC. Table 2 shows statistical information about learners' perceptions of attitudinal learning across the four categories (general learning, cognitive learning, affective learning and behavioural learning). The mean values indicate the level of agreement with the statements from 1 = strongly disagree through to 5 = strongly agree.

Table 2: Descriptive statistics of attitudinal learning outcomes after studying the MOOC

	n	Mean	Min	Max	SD	SE
General learning						
G1 - I enjoyed the MOOC	202	4.21	1.00	5.00	0.74	0.05
G2 - I found the learning activities in the MOOC interesting, stimulating and engaging	202	4.20	1.00	5.00	0.73	0.05
G3 - My perspective towards smart cities has changed as a result of this MOOC	202	3.69	1.00	5.00	0.93	0.07
<i>General Learning total</i>	202	12.11	3.00	15.00	1.86	0.13
Cognitive learning						
C1 - I am more informed and knowledgeable about smart cities as a result of this MOOC	202	4.32	1.00	5.00	0.71	0.05
C2 - I am inclined to consider multiple perspectives around smart cities as a result of this MOOC	202	4.11	1.00	5.00	0.75	0.05
C3 - I agree with the perspective presented by the MOOC about smart cities	202	3.85	1.00	5.00	0.70	0.05

<i>Cognitive learning total</i>	202	12.28	3.00	15.00	1.77	0.12
<u>Affective learning</u>						
A1 - My feelings about smart cities changed as result of this MOOC	202	3.37	1.00	5.00	0.97	0.07
A2 - I feel more confident that my opinion about smart cities is an informed one as a result of this MOOC	202	4.09	1.00	5.00	0.71	0.05
A3 - I feel more engaged with activities related to smart cities as a result of this MOOC	202	3.86	1.00	5.00	0.85	0.06
<i>Affective learning total</i>	202	11.32	3.00	15.00	1.96	0.14
<u>Behavioural learning</u>						
B1 - I have plans to participate in further activities related to smart cities as a result of this MOOC	202	3.78	1.00	5.00	0.92	0.06
B2 - I plan to encourage others to participate in activities related to smart cities as a result of this MOOC	202	3.76	1.00	5.00	0.87	0.06
<i>Behavioural learning total</i>	202	7.54	2.00	10.00	1.64	0.12

The total mean score for the learners' perceptions of general learning was 12.11, for cognitive learning 12.28 and affective learning 11.32, which are scored out of 15.00 and can therefore be considered high. Learners' also perceived their behavioural learning as high at 7.54, scored out of 10.00. These values are comparable with the values reported in the study by Woori et al. (2016) that argued attitudinal learning had occurred in learners studying three MOOCs, where the number of survey participants was 746 and the total mean scores were 12.52 for general learning, 12.74 for cognitive learning, 11.77 for affective learning and 7.09 for behavioural learning.

In terms of general learning, the majority of learners reported that they enjoyed the Smart Cities MOOC (M=4.21), found the activities interesting, stimulating and engaging (M=4.20) and felt their perspective towards the topic had changed as a result of studying the MOOC (M=3.69). The perceived cognitive learning impact of the course was also high; with the majority of learners reporting they felt more informed and knowledgeable about the topic (M=4.32), were inclined to consider multiple perspectives (M=4.11) and were in agreement with the perspective presented by the course (M=3.69). This was also supported by the post course survey results (n=359), where learners were then asked to rate their subject knowledge having completed the MOOC; 65% said 'I know a lot more about this subject now', 38% said 'I know a little more about this subject now' and 3% selected 'My knowledge of this subject has not changed'. Observations from learners' comments posted in the course also show they valued the fact the course materials and discussions introduced them to different perspectives on smart cities, which led them to reflect on their own views on the topic:

"A very interesting course. I particularly enjoyed reading, thinking about and discussing the various different perspectives, views and ideas of the participants, especially those whose viewpoint is very different from my own. In my experience I learn much more from those with whom I disagree, because even if they don't change my views, at least they make me think about them" [Jackie Pullman]

"This has been a very engaging course which has introduced me to a lot of new ideas. Various parts of the course have caused me to question my views and this has resulted in new perspectives" [Dave Hall]

In terms of affective learning, the majority of learners reported that after studying the course they felt confident their opinion about smart cities was an informed one (M=4.09) and they felt more engaged with smart city activities (M=3.86). Learners reported a medium level of agreement (M=3.37) that their feelings about smart cities had changed as a result of studying of the course. This

result is consistent with the findings in Watson et al. (2016) who report a medium level of agreement ($M = 3.38$) for the question around how learners' feelings had changed after studying a human trafficking MOOC. In that course a large proportion of learners had enrolled on their course with existing views of the topic. In the Smart Cities MOOC a significant number of learners were new to the topic, as indicated by the post course survey question 'How much did you know about the subject of this course when you started?', to which 43% of the learners ($n=359$) responded little or nothing.

Perceived behaviour learning outcomes were also high; many of the learners reported they had plans to participate in further activities related to smart cities ($M=3.78$) and to encourage others to participate in related activities ($M=3.76$).

3.2. Smart city related activities learners participate in after studying the MOOC

Our second research question sought to understand the type of smart city related activities learners participated in after studying the MOOC. The online research survey asked learners to select the activities they had participated in since studying the course. The number of learners who selected at least one option was 179 (89% of survey respondents) and the activities they reported participating in are shown in Table 3.

Table 3: Activities learners undertook after studying the MOOC

Post course activities	n	% of survey respondents
I have looked at related materials e.g. books, online articles, blogs	111	55
I have shared what I learnt with others	91	45
I am researching the subject area further	81	40
I am using what I learned in my work or voluntary work	63	31
I am using what I learned in my studies	61	31
I have signed up for another free course in this subject area	53	26
I have researched opportunities to work in the field of smart cities	42	21
I have participated in smart city / community activities within my local area	33	16
I have met with other people interested in the subject offline	31	15
I have continued developing my smart cities project	28	14
I have used what I learnt for the purpose of teaching others	23	11
I have participated in online activities related to the subject area	20	10
I am involved in the development of another smart cities project	18	9
I have signed up for a paid course in this subject area	4	2

Table 3 shows that looking at related materials (55%), sharing what I learnt with others (45%) and researching the topic further (40%) were the most popular activities. Around a third of learners (31%) were using what they had learnt in their work, voluntary work or studies. A quarter had signed up for another free course in this subject area but very few learners (2%) had signed up for a paid course. 16% said they were participating in smart city activities in their local area and 15% had met with others offline who were also interested in smart cities, whilst 14% of learners had continued to develop the smart city project they started in the course and 9% were involved in the development of another project.

An open ended question asked learners to 'tell us more about the smart cities activities you are undertaking since the course' and there were 69 responses (34%). Some learners provided further details on the activities they had previously reported they were doing, such as sharing what they learnt with others, researching the subject further and taking another free course. The remaining

responses revealed that learners were participating in smart city activities across a broad spectrum of areas such as technology (n=6), education (n=5), communication (n=4), sustainability (n=3), transport (n=2), public safety (n=2), open data (n=2), international development (n=2), language (n=1), health (n=1), resilience (n=1), lighting (n=1) and standards (n=1). They reported these activities were being led by a variety of organisations; business (n=11), community group (n=10), local authority (n=8) and a University (n=1). Several were involved in partnership projects:

"I am involving in the Project of Fiep's Observatories called "Curitiba 2035" which is following project of Curitiba 2030. This project involve different actors from Curitiba and its main goal is to develop a Roadmap and establish the objectives for each select area of Smart Cities concept."

"Edinburgh Council is a member of the Scottish Cities Alliance. The SCA has recently published a Smart Cities Blueprint and work is developing for the four goals. My learning from the Smart Cities MOOC is proving helpful."

3.3. Learners who participate in local smart city activities and their experiences of the MOOC

Our third research question sought to understand the MOOC experience for learners who went on to participate in local smart city activities and how they applied the knowledge gained from the MOOC. Of the 179 learners who had participated in follow-on activities after studying the MOOC, 33 indicated they had been involved in smart city/community activities in their local area. We interviewed 8 of these learners and their attributes are shown in Table 1.

Half the interviewees (P1, P6, P7, P8) said they had some knowledge and experience of smart cities before studying the MOOC, as they were all involved in smart city projects through their work. These learners said they had studied the course to broaden their knowledge of the subject, to learn about different approaches to smart cities and to further develop their views on the topic. They were using what they had learnt to adopt new approaches to involving citizens and local municipalities in their projects. For example P1 joined the MOOC to see if it would be useful as a business support tool: *"I provide smart city consultancy to cities around the world. I wanted to be confident in pointing people towards the course when they ask me how they should get a grounding in what smart cities are"*. Alongside his work he was trying to establish smart city activities where he lived *"I have taken on the defacto leadership from a bottom-up perspective trying to do things like get citizen responses to questionnaires and work out what people actually want to do"*. P7 was an IT developer *"focusing on healthcare technology"* working with a university, hospital, seniors and care givers in New York. He was also a volunteer with the coastguard *"we are working on emergency preparedness... potentially some sort of internal app that gets everyone connected"*. P8 worked on public policy in a UK municipality and was interested in how smart cities *"is going to help the citizens in my area live their lives differently"*.

The other interviewees (P2, P3, P4, P5) had no prior knowledge of smart cities before studying the MOOC and said they signed up to learn what smart cities are, to learn about different approaches and to formulate a view on the topic. Having completed the course they had all started to integrate what they had learnt into their work and community activities. For example P2 worked in arts education in Bucharest and said using what she had learnt to teach children in her city about sustainable development through cultural activities including *"workshops for the museum they are funded by the parents or by the schools"*. For P3 studying a MOOC appealed as *"it is impossible for me to access formal education due to needing to work and look after a family full time"*. She had started to develop a project idea *"to create an online language learning app"*. P4 studied the course alongside developing a project idea to submit to OurMK, a smart cities citizen innovation

competition in Milton Keynes. P5 brought together 57 people in Hadera in Israel to study the course as a group, from the local municipality, university, businesses, local residents and social activists. *"The goal was to finish the course and create many smart city projects. We finished with around 25 people and created 6 projects"*. They had 10 meetings alongside the MOOC and said *"every group member studies the materials online at home. They are then processed and practised in the setting of the group meetings. The group worked together, translating materials for members of the group who were less familiar with English"*. They held a workshop after the course, which the CEO of the local municipality and mayor attended, to share their project ideas.

With regard to the course design, six of the interviewees mentioned that the MOOC had given them a well-structured overview of smart cities. P1 said *"it gave me a framework for how to begin to work with a city where there is in particular not a lot of direction"*. P8 found the structured overview and case studies in the MOOC *"gave some sort of contextualisation to some of the disparate bits and pieces that I had picked up on things that we were tangentially or centrally involved in. That was really helpful, as it gave more of a sense of how things fitted and what was smart city issues"*.

Five mentioned they liked the citizen centred focus of the course materials and six said that the city case studies (videos and articles) had widened their knowledge of how technology and data was already being used within urban areas to address societal issues and how it would be relevant to where they lived. For example P7 said he liked the course as it *"focussed on the human centric aspect of Smart Cities. It wasn't just about the technology, it was all about what are people using it for"* and he said *"I really like the different use cases that you had provided because I didn't know about all the different avenues and things that one can use technology for"*.

Six mentioned they liked the interactive nature of the course and the discussion steps were highlighted as an effective element of the course design which helped them engage with other learners' perspectives and to reflect on their own views. P2 said *"I made some comments and I always read the comments... I had a deep satisfaction when I said to myself well I understand this. It's not my expertise but I understand and the fact that I can comment is a good thing for me"*. Three mentioned they liked the use of Padlet (an online board embedded within some of the MOOC discussion steps for learners to post text, pictures and website links) as a method to crowdsource information about smart city activities and views from around the world. Half the interviewees had used this tool to share examples from their communities. P8 found the discussion steps helpful *"the questions I found very good for actually sitting me down and rethinking"*.

In terms of their experiences of trying to apply their learning within local smart city activities, securing funding and human resources were common challenges mentioned. P4 had secured funding to do market research around her smart city project idea on furniture reuse, *"we got around £3000 in total and we visited 11 low income areas in Milton Keynes on consecutive days in an electric van and we popped up a shop"*. However resourcing her project was still a challenge *"I have some volunteers but we're struggling in the resource area. With a social enterprise it's really hard to get it off the ground as you are starting with nothing"*. With P3, her project to develop a language learning app had stalled, *"the main difficulty that I hit was trying to get a group together to sustain enough to be able to do that on a very regular basis. That plus the University lecturer that was going to help me with the curriculum suddenly ran out of funding"*. For the group in Israel, P5 said there was enthusiasm around the fact the project had brought together a diverse range of people who realised they already had connections within the city, which they could build upon through projects. However, the MOOCHub dissolved due to a lack of funding and it is not clear if the project ideas were implemented.

Another common challenge was working with local municipalities, including changes in political control, the lack of awareness of smart city approaches among managers or politicians. P1 said the local municipality *"has no overall control politically, they talk a lot about having smart city goals but in reality they don't understand what the term smart cities means and they certainly don't have anyone with any political power to make things happen"*. P3 said *"we had a change of council at the same time as the elections ... from what I can gather from the actual growth of Plymouth as a smart city, it took a little delay because of that change"*. P8 said elected political *"members, many of whom are even older than I am, don't really see that there is a new way of thinking that we as public servants need to get on-board with and that actually there is a lot of potential to engage people in developing that"*. P6 was a consultant working with four municipalities in Bangalore to develop their understanding of smart cities and assisting them to submit proposals to India's Smart City Challenge (Government of India, 2018). He said *"the local municipal bodies they have no idea what smart cities are...politicians think the control of the developments will go out of their hands... So that's where making them understand where they actually fit in the whole scheme is a very difficult thing because they have their own set, fixed mind set"*. He felt the MOOC would be very helpful in India for engineers and local officials but it would need to be translated and adapted to the local cultural context. *"We need to build in some local examples for them. I have a sense that if we are talking about Songdo, Rio de Janeiro or Milton Keynes, they won't be able to relate themselves to them because there is already a culture there, both infrastructure and citizen behaviour wise, which is difficult to associate with and relate with our culture here"*.

4. Discussion

Our first research question sought to measure and analyse learners' perceptions of their attitudinal learning having studied the MOOC. The majority of learners agreed with the survey statements that they found the MOOC stimulating and engaging and they felt more informed and knowledgeable about smart cities having completed it. They reported high levels of attitudinal learning across the four categories (general learning, cognitive learning, affective learning and behavioural learning), which is consistent with values reported in other studies exploring attitudinal learning in MOOCs (Watson, Kim & Watson, 2016). Comments posted in the MOOC suggested they valued the fact the course materials and other learners' comments encouraged them to reconsider their views.

We also wanted to understand the type of smart city related activities learners participated in after studying the MOOC (Research Question 2). A high proportion of the learners (89%) reported they were participating in at least one smart city activity after studying the course. Popular activities were looking at related materials, researching the subject further and using what they learnt in work, voluntary work or in their studies. Nearly half were sharing what they learnt with others but only 16% were involved in smart city activities within their local area. The focus of the activities covered a broad spectrum of sectors, including technology, education, communication and sustainability, with activities mainly led by business, community groups or a local authority.

The third research question looked at learners involved in local smart city activities, exploring their experiences of the course and whether they had used what they learnt in the MOOC to support those activities. The 8 people we interviewed were from diverse, international backgrounds, working in a variety of sectors, but what they had in common was they each contributed to their local community. Half already worked in smart city related jobs and the other half were new to the topic. The interviewees highlighted the structure of the course, the human-centred focus, the city case studies and the discussion steps were particularly effective elements of the course design. They also liked the interactive nature of the course, in particular the discussion steps and the reflective questions. In terms of their experiences of trying to apply their learning within local smart city

activities, securing funding and human resources were common challenges mentioned when developing local smart city projects. As was working with local municipalities, including the lack of awareness of smart city approaches among managers or politicians and changes in political control.

The city in Israel was interesting as it had brought together a diverse group of people to study the Smart Cities MOOC together, with the aim of creating smart city projects in a simultaneous process of 'doing' while 'learning'. Multi-stakeholder collaboration, involving local government, research organisations, technology providers, community organisations and citizens, is seen as central to smart city development (Angelidou, 2014; Van Waart, Mulder & de Bont, 2015). Whilst the city was successful at creating multi-stakeholder project ideas, shared with the local Mayor and CEO of the municipality, there was no funding to sustain the network and their activities beyond the course. It is interesting that the challenge of working with local municipalities, experienced on an international scale, parallel those experienced within the local citizen innovation work of the smart cities initiative which developed the MOOC (Anonymous et al., 2018). This suggests that these experiences are entrenched in the way that cities are organised and that while citizen-led activities can achieve change, they are limited by the political and economic systems cities operate under.

Transformative learning is required to effect social change and therefore learning design plays an important role in the effectiveness of education with this aim. Our study results showed that the majority of learners who participated in the survey found the Smart Cities MOOC an effective learning environment which introduced them to new content and ideas about smart cities. They mentioned engaging with the course content, in particular they enjoyed reading and watching the city case studies as they helped them to understand how smart city approaches could be relevant to their communities. Comments posted in the MOOC suggest that for some learners reading and posting on discussion steps helps them to connect with other learners' views and to reflect on their own. This suggests that the Smart Cities MOOC can be effective at supporting attitudinal learning and it also provides opportunities for critical reflection. However for transformative learning to occur, learners also need to be provided with opportunities that allow them to act (Mezirow, 1997). Our results suggest that whilst the majority of MOOC learners who completed the survey integrated what they learnt into existing activities, such as work and study, only a small proportion went on to actively participate in local smart city activities and when they did they faced a number of barriers. To sustain civic participation and innovation requires ongoing support and resources at a city level which appeared to be lacking in many of the cities where the learners were based.

We also recognise that whilst the aim of the Smart Cities MOOC is to support citizens to engage in smart city initiatives, a critical perspective is that such initiatives try to make people fit with technological requirements of smart cities rather than empowering them to participate. To move MOOCs beyond uni-directional transmission of content, educational designers encourage dialogical learning design (Mathiesen, Nedergaard & Nørgård, 2016). When developing the course we were careful to design learning activities that encourage democratic dialogue, critical reflection and encouraged the integration of knowledge within the shared learning community of course facilitators and learners, rather than designing a MOOC where the focus was on instructing knowledge to learners through course materials which conveyed the educators' opinions. This fits well with the social constructivist pedagogy of the FutureLearn platform which encourages learning through conversations and even when learners don't comment, they still have the opportunity to read others comments. It could therefore be the case that having learnt about smart cities and formed their own opinions, some learners choose not to participate in local smart city activities, perhaps due to ethical and privacy concerns or the fact that was not their purpose for studying the course.

People are motivated to join MOOCs for wide variety reasons, they come from diverse backgrounds and they have different expectations of what they want from a course (Milligan, Littlejohn & Hood, 2016). Our aim was to create a short course for global citizens to learn how they can participate in smart cities. To support more people to engage in smart cities at the city or community level, we could redesign the course and put a greater emphasis on areas in which the learners said they faced barriers, for example focusing on how to work with local municipalities and politicians. We could also change the target audience to local municipalities and how they can support citizens to get involved. However there are likely to be significant cultural differences in how to approach such issues within different countries and many of our learners are new to the subject. An alternative approach to increase the social impact of the MOOC would be to work more closely with city or country level smart city initiatives to encourage them to use it as part of their local engagement strategies. They could promote it through local networks and establish study groups (country or city specific). FutureLearn have added an option to set up study groups within a MOOC but this could also be done outside the course. The MOOC is covered by a Creative Commons Licence and hence much of it can be reused, adapted and customised. Local policymakers could adapt the course materials to address language and cultural barriers and include local case studies. The Israel MOOCHub translated the course materials, to make them more accessible for non-English speakers, and the Alba Iulia Smart City Team in Romania are now translating them and adding local material for use in their citizen smart city training. However policymakers need to consider how they will support such activities beyond the lifetime of the course, for example linking into local democratic processes that support civic participation, if their aim is to build local capacity for social change.

We recognise our study has some limitations. 202 MOOC learners were surveyed and 8 of these were interviewed in depth, so this is a small sample compared to the number of people who studied the MOOC during the 4 presentations ($n=11,104$). The sample is also self-selecting and therefore likely to be representative of learners who are highly motivated and self-directed. Also the Cronbach's alpha values for the general and affective learning sections of the attitudinal learning survey were slightly less than 0.70, which indicate moderate reliability and that improvements could be made to the survey design. The majority of people who study MOOCs are well-educated and already have access to higher education, so this is a barrier to social change if MOOCs are not optimally inclusive and accessible (Patru & Balaji, 2016). Learners also require access to a good internet connection and digital literacy skills. These can be particular issues for developing countries, although UNESCO do recommend that policymakers in developing countries re-use and adapt MOOCs as part of their national education strategies and use them alongside other forms of education (Patru & Balaji, 2016).

The attitudinal learning survey developed by Watson et al. (2016) provided a useful starting point to assess learners' perceptions of attitudinal learning at scale, but we felt the results it provided are high-level and of limited use as a method of evaluating the effectiveness of a MOOC to support attitudinal learning when used in isolation. Adding additional questions to the online survey, undertaking in-depth interviews, and supplementing this with data from the post course survey and learners' comments in the MOOC, provided us with much richer insights about learners' attitudinal learning. It also allowed us to explore their learning experiences and how they applied what they learnt if they got involved in local activities after the course. We have therefore developed a more comprehensive method of evaluating attitudinal learning from a MOOC and gained insights into how to improve the learning design of a MOOC with the aim to support citizen participation in smart cities.

5. Conclusions

This study examined learners' perceptions of attitudinal learning after studying a Smart Cities MOOC and sought to understand whether learners engage in smart city related activities after the course and their learning experiences. MOOC learners reported high levels of attitudinal learning and said they use what they have learnt in work, voluntary work and study. However, only a small number were actively seeking to engage in smart city activities within their cities and they faced barriers often due to a lack of support from their local municipality or resources. Our findings provide some evidence that a MOOC can be a useful tool to support attitudinal learning around smart cities as it brings together a diverse group of people and provides a learning environment in which to scaffold knowledge as the community learn together, with opportunities for critical reflection through the discussions. However when designing courses with the aim that the learning can be transformative and engage citizens in urban change, there needs to be consideration of how the educational resources can be aligned to opportunities at a local level that would support learners to transform their learning into action. This could also provide opportunities to work with city policy makers to address the barriers which prevent some people from accessing MOOCs, such as language, cultural relevance and digital literacy, and help to build capacity for social change.

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