# Scaffolding Self-learning in MOOCs

*Israel Gutiérrez-Rojas, Carlos Alario-Hoyos, Mar Pérez-Sanagustín, Derick Leony, Carlos Delgado-Kloos*

*Department of Telematic Engineering, Universidad Carlos III de Madrid, Av. Universidad, 30, 28911, Leganés (Madrid), Spain*

***Abstract:*** *MOOCs are considered an affordable alternative to higher education and vocational training, as students can complement their studies on particular topics related to their professional development and hobbies, generally free of charge. Nevertheless, not everyone can benefit equally from MOOCs. Due to the scarce personalized guidance that can be provided by MOOC teachers, it is much more likely that people lacking study skills and work habits drop out of MOOCs, contributing to increase the educational gap between those more and less educated. This paper presents the first steps towards a tool called MyLearningMentor, which is designed to guide and advise MOOC participants with less study know-how in the delicate task of facing MOOCs. MyLearningMentor aims to turn less experienced students into self-learners, helping them to plan the MOOCs as they enroll, and proposing tips and actions to achieve their successful completion.*

## Introduction

MOOCs (Massive Open Online Courses) are a recent hit in online learning, and are positioned as an alternative to traditional higher education courses (Yuan & Powell 2013). The most successful initiatives in the MOOC area, such as Coursera, edX, Udacity, FutureLearn or MiríadaX are receiving strong attention from the media (Pappano 2012). MOOCs have brought a revolution to the education sector in a short time, opening up opportunities for new pedagogies (Martin 2012) and business models (Kolowich 2012), enabling thousands of students access to free, high quality education.

This free access makes it possible for people all around the world to register in MOOCs (Mackness et al. 2010). Despite varied social backgrounds, most MOOC participants have similar profiles regarding age and literacy. Several studies point out that most MOOC participants are workers aged between 25 and 40 years old that have a Bachelor's Degree, Master's Degree or PhD (Alario-Hoyos et al. 2013, Balch 2013). Learners with this profile have developed study skills, especially in face-to-face and blended instruction, as well as work habits. It is therefore easier for these learners to take advantage of the online instruction provided in MOOCs, updating their knowledge or covering new topics related to their professional career and/or personal interests.

However, the affordable education provided by MOOCs can also be seen as a chance for those who did not complete their studies and need a shift in their careers due to the current socio-economic context (Shen 2013), either because the sector in which they work is losing competitiveness as compared to other growing sectors, or because they are unemployed (Mourshed et al. 2013). As an example, Alario-Hoyos et al. (2013) reports 22% of unemployed participants in a MOOC on educational technologies taught in Spanish, with 59% of participants from Spain, a country that in December 2013 faced an unemployment rate of over 26%.

Those most affected by high unemployment rates are generally non-qualified people for whom accessing Higher education is a major challenge. This problem causes a growing educational gap between qualified and non-qualified workers, further hindering the latter's access to the labor market. For this reason, and in line with authors such as Sharples et al. (2013) and Shen (2013), we believe that MOOCs are a great opportunity to complement not only Higher education, but also vocational training, and to reach less experienced learners, who now have the opportunity to receive free, high-quality training. Aligned with this idea, major MOOC initiatives like Coursera are already offering courses that may be useful for this alternative student profile. As an example, the Tecnológico de Monterrey delivers a course on 'Continuity and development of the family business' (https://www.coursera.org/course/empresafamiliar), while the University of Florida offers a course on 'Sustainable Agricultural Land Management' (https://www.coursera.org/course/sustainableag). Transversal skills such as language proficiency may also be useful to help train less educated people, particularly in multilingual contexts such as Europe.

Nevertheless, facing an online course without having developed study skills and work habits can be frustrating and lead to early drop outs (Sharples et al. 2013). This situation is particularly aggravated in MOOCs due to the lack of support from teachers, who cannot respond to all learners' requests for advice (Downes 2010). Some authors go even further, suggesting institutions to discourage students who have no study habits from participating in MOOCs, and encourage them to take only blended or face-to-face courses (Beasley 2013); although these courses usually have significant costs associated. In the balance between education and economy there is a need for solutions that instill confidence and self-learning abil-

ity for those with no experience in online learning, so that they are able to follow the MOOC pace and learn whatever interests them. Such solutions could help reduce early drop outs from less experienced learners, and eventually the educational gap between trained and untrained people.

This paper presents the results of a research study that drives the requirements and preliminary design of a software application to help less experienced people take advantage of MOOCs. This application is called MyLearningMentor, and aims to scaffold self-learning in MOOCs and improve learners' performance by providing personalized planning, tips and hints for time management, study habits and teamwork, and a meeting point for people who need help to keep pace with the MOOC and need to know who can offer them support (mentors). Although MyLearningMentor is not exclusive for MOOCs, it is expected to have greater impact on them due to the lack of support from teachers and the large number of people that are currently joining these courses. MyLearningMentor is a first step towards understanding the role of massive online education for less educated people.

The next section of this paper deals with onto overall research methodology, and then the problem statement and initial hypothesis are established. The requirements of an application that addresses the problem statement are discussed immediately after. We then examine the design of MyLearningMentor, an application that meets the identified requirements, including architecture and user interface. Afterwards we discuss the potential impact of the application and the next steps related to this research work.

## Methodology

Given the pragmatic purpose of this project and its application in a real-world setting, this project follows a 'design-based research methodology' as described in Wang and Hannafin (2005). This research methodology is characterized by an iterative process in which the goal is to produce artifacts quickly to be validated and used as the input for the next iteration. It is noteworthy that in design-based research the concrete research objectives are likely to evolve as the project moves forward.

Accordingly, this work starts by defining the research problem statement and the initial hypothesis. Once the existence of the research problem has been established, the initial requirements of a solution to addresses this problem are summarized; in this case, the solution proposed is a software application. After analyzing the extracted requirements, a mockup of the application is developed to validate whether the collected requirements can be implemented. Mockups (or wireframes) are one of the most popular techniques for agile prototyping, and are accepted in multiple software development areas to attain direct information from end-users (Budde et al. 1992). The application proposed in this paper addresses learners' needs and it is convenient to work first with simple and visual prototypes (like mockups) in order to detect whether learners' requirements are met.

A mockup of the application is the first step towards its implementation. This implementation will follow an agile software development approach (Highsmith & Cockburn, 2001). An agile development approach is aligned to design-based research, sharing such concepts as continuous and quick iterations and refinement.

## Problem statement and initial hypothesis

This work starts with the formulation of the research problem: how to give support to less experienced learners in MOOCs. Although target learners in this research problem are inexperienced in online learning and particularly in MOOCs, the results of this work are expected to be useful for more experienced learners willing to improve their performance and self-learning skills when enrolling in MOOCs.

The initial hypothesis related to the research problem is the lack of study skills and work habits of less experienced MOOC learners, e.g. a proper place to study, a regular study schedule or the ability to solve problems in groups. In order to validate the existence of the identified hypothetical problems, 41 second-year Higher education students were surveyed through a Likert-5 about their study skills and work habits. This is a representative sample of students since they have considerable experience in face-to-face and blended learning, but have little experience in online education.

The survey results returned clear indicators about the choice of an appropriate workplace (more than 83% of students agreed or completely agreed that they usually studied in the same place and that it was quiet and well-lit) and the importance of distraction-free study (only 22% of them were in disagreement or complete disagreement that they studied away from distractions). Nevertheless, a lack of awareness of teamwork was also detected, as only 12% of learners agreed or completely agreed that they usually studied with colleagues, while 7% of them stated that they normally employed the course forum to solve questions. There was also a generalized disorder when planning their study time, as most students needed to reorganize their schedule several times per week. Teamwork and a good organization of study time are essential skills when facing online courses. Most surveyed students recognized major difficulties in participating in online courses (only 22% of them could follow their courses without major problems), and only a small fraction of them had managed to complete an entire online course (15%).

These results are interesting because even though the demographic consisted of Higher education students, they lacked the study skills and work habits for online education. If this also occurs with university students, it is envisaged that the problem will worsen when dealing with people that have a lower level of literacy. All in all, the survey results corroborated the existence of the research problem, and also served to extract a series of requirements for the design of an application that tackles this problem.

## Requirements analysis

Before designing and developing an application that helps less experienced learners take advantage of MOOCs, the requirements that such applications should implement must be clearly stated. Table 1 summarizes these requirements, which are discussed throughout this section.

| Identifier | Requirement |
|---|---|
| Req1 | Distributed as a mobile application |
| Req2 | Customizable to different student profiles |
| Req3 | Include an adaptable daily planner |
| Req4 | Rely on crowdsourced information |
| Req5 | Provide tips and hints to make the most of MOOCs |
| Req6 | Serve as a meeting point with volunteer mentors. |

The first requirement (Req1) is that the application must be distributed as a mobile application. This requirement is justified insofar as most MOOC participants are typically aged between 25 and 40 (Balch 2013), and most people in this age group have incorporated mobile devices in their daily lives (GoGulf 2012, Nielsen 2012). This argument was confirmed through the aforementioned questionnaire, according to which most surveyed learners had incorporated smartphones in their daily routines, employing them for instance to consult their class schedule. In addition, people carry mobile devices with them all the time, and so can receive notification of planning and work habits even when not in front of a PC or laptop.

The second requirement (Req2) is that the application must be customizable to different profiles. Participants' profiles in MOOCs can be very diverse, comprising workers, students and the unemployed (Alario-Hoyos et al. 2013). They commit to differing study times, have different aims for their participation and can be registered for several courses at the same time. The survey handed out to Higher education students revealed that there was considerable heterogeneity regarding schedules and the number of study hours per week.

The third requirement (Req3) is that the application must include an automatic daily planner listing which MOOC-related tasks learners need to accomplish. This planner must be adaptable to different student profiles (see Req2) and take previous performance into account. It must integrate information about the specific tasks learners need to carry out and gauge their estimated workload so that more efficient planning can be scheduled. The survey handed out to Higher education students highlights the need for an adaptable daily planner since most of them reported the need for reorganizing their study hours several times per week.

The fourth requirement (Req4) is that the application must rely on crowdsourced information about MOOCs from the user community. In most cases the overall information about MOOCs, such as the start and end dates or the average workload per week can be collected from the web, but detailed information about the number of concrete tasks that must be performed and when their deadlines fall is not always easy to harvest automatically. In addition, this kind of detailed information is sensitive to changes and needs to be updated regularly. For these reasons, learners themselves will use the application for adding and curating the information related to the MOOCs they are following, and therefore receive a more accurate daily study plan (see Req3), customized to their profiles (Req2).

The fifth requirement (Req5) is that the application must provide tips and hints so that less experienced learners can make the most of their MOOCs. These tips and hints should cover different aspects related to study skills and work habits, such as what to do after failing several test questions or recommendations for reviewing peer activities. These tips will also stress the social dimension of MOOCs as this is a key issue to avoid early drop outs, e.g. reminding students to check the course forum, or to rely on peers using social tools when there are problems.

Finally, the sixth requirement (Req6) is that the application must be a meeting point for less experienced learners and volunteer mentors, or people with more experience in MOOCs that wish to spend their free time selflessly helping their peers. Those people that receive support from mentors typically achieve higher performance and are able to deal with more complex problems (Malgrem 2010). Despite the importance of mentoring, only 7% of the surveyed higher education students agreed or completely agreed that they usually had somebody to help them plan their study.

## MyLearningMentor

This section presents MyLearningMentor, an application that aims to help students with little experience in online learning take advantage of MOOCs. This application has been designed to meet the requirements identified in pre-

vious sections. First, the architectural design of the application is presented. Second, mockups of the interface serve to illustrate how users will interact with the application.

## Architectural design

MyLearningMentor follows a client-server architectural model as described in Figure 1. This decision stems from two requirements: making the application available to the users through their mobile devices (Req1), and crowdsourcing information about MOOCs (Req4). The former requirement indicates that users access the system with their mobile phones or tablets, which play the role of the client. In order to take advantage of most of the functionalities available in a smartphone (e.g. the use of notifications related to work habits, Req4), a native application is more appropriate than a web application. The latter requirement implies the need to have a server that provides access to crowdsourced information.

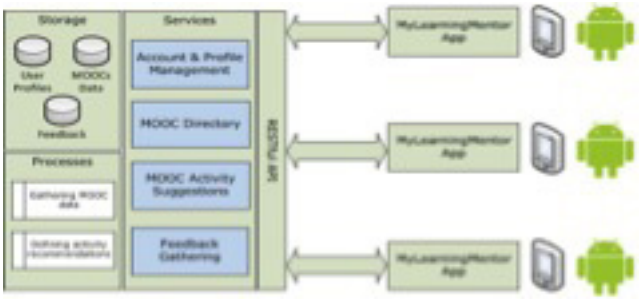


*Figure 1. Diagram of MyLearningMentor architecture with the server on the left and the client on the right.*

The server centralizes the storage of information, the execution of processes that affect the adaptive daily planner and the provision of services to be used by mobile clients. The information to be stored includes 'user profiles' (Req2), 'MOOCs data' (Req4) and 'feedback' provided by learners that indicates their progress in the courses (Req3 and Req5).

Two processes are executed periodically on the server side. The first process is 'gathering MOOCs data' from a set of platforms, including characteristics such as course duration, recommended weekly dedicated study time, and activity type (Req4). The second process consists of 'defining activity recommendations' for the adaptive daily planner (Req2, Req3 and Req5) based on learners' profiles and MOOC data.

The server includes a service layer for mobile clients to interact with the databases and processes. The 'Account & Profile Management service' administers and authenticates user accounts. The 'MOOC Directory service' provides course information collated from major MOOC platforms and handles additional MOOC data submitted by users. The 'MOOC Activity Suggestions service' provides tips and hints to be displayed in a daily adaptive planner for learners. The final service, 'Feedback Gathering', collects and processes comments from learners' progress within the MOOCs that they are enrolled in. The whole server-side architecture will offer a RESTful API, so that several clients (mobile, web) can be supported.

## Interface design

This section presents a mockup of MyLearningMentor. This mockup is a first prototype design and takes into consideration the requirements identified in the previous section. The mockup has been created using Balsamiq, an application for developing interactive mockups easily and quickly. Balsamiq mockups can be used to check whether the key ideas behind an application meet target user needs or to communicate with the stakeholders involved in the development process. Further, mockups can be easily modified in real time while users interact with them.

To address the first requirement (Req1), the mockup simulates a mobile application. As with any mobile application, the user will download it from the corresponding application store (App Store, Google Play...) and install it on his/her personal device. Once installed, the application requests that the user register. There are two different ways to register: quickly, where users can re-use their credentials from Google, Facebook or Twitter accounts, and manually, where users manually complete the information required: name, surname, age, e-mail address and password (Figures 2a and 2b).

The first time the user logs into the application, the system asks him/her to adde further detail to his/her profile, such as whether (s)he works/is unemployed/is a student and his/her availability (e.g. number of available hours to study per week). This profile information is related to the second requirement (Req2), and is employed by the application to customize some of its functionalities according to different student profiles (Figure 2c).

*Figure 2. Screenshots of MyLearningMentor. From left to right: (a) Log in screen, (b) User profile screen, and (c) User study preferences screen.*

As a third step, the user is forwarded to the MOOC selector page (Figure 3a). On this page, the user can select the MOOCs (s)he wishes to follow and then click the 'Join the course!' button to be redirected to the course website. If the user does not find the course (s)he wishes to join, MyLearningMentor will offer the option of 'Adding a New Course' not registered in the current list. This option asks the user to introduce information related to a new course, such as a title, amount of hours required, number of lessons, dedication needs, types of activities to accomplish, the platform where the MOOC is hosted and a link to the course website or knowledge area. All the information uploaded by the user is directly added to the MOOCs database in the application so that other learners can find the course when using the system (Req4). In this way, the application benefits from 'the power of the crowd' to extend the MOOCs' database (Figure 3b).

The application includes a 'Tips List' (Req5) that can be directly accessed from the daily planner. This tips list includes practical advice about self-learning, particularized for the MOOC context. These tips range from recommendations about how and where to study to strategies for organizing and planning work, as well as mechanisms for being more productive. Tips are updated dependent on user profiles and their performance as the courses move forward (Figure 4c). The tips list also includes the 'Ask for a Colleague Mentor' button, which users can click to send an e-mail to a mailing list of registered mentors, enabling them to arrange meetings with colleagues, collaborate and advance together in the MOOCs (Req6). Further communication between MyLearningMentor users and mentors are out-of-scope of this application.


*Figure 3. Screenshots of MyLearningMentor. From left to right: (a) Course selector screen, and (b) the form to fill in when users want to join a new course.*


*Figure 4. Screenshots of MyLearningMentor. From left to right: (a) the Daily Plan screen, (b) the calendar indicating the tasks distributed in a month, and (c) the tips list screen.*

After choosing a course, the user is redirected to the 'Daily Planner'. This daily planner is presented as a daily list of tasks that workload learners must dedicate to the MOOCs they are enrolled in (Req3) (Figure 4a). How generic or specific the information about these tasks is depends on previously-collected data (either automatically or from the community). Users can mark these tasks as finished after completing them in the MOOCs. It is noteworthy that MyLearningMentor does not intend to integrate the MOOC activities, and so users need to go to the course website to complete them. The Daily Planner is proposed according to learners' profiles and the characteristics of the courses selected. Mobile telephone alerts complement this planner, occurring to indicate the learner's MOOC work schedule. At the end of the week users are asked to complete a brief survey indicating more information about the kind of activities completed, whether the scheduling for the activities was suitable or not, and whether they are happy with their performance. Planning for the following week is modified according to previous weekly results. The application also includes a monthly calendar where users can visualize their tasks in advance (Figure 4b). These planning functionalities are expected to overcome students' organizational weaknesses identified by the survey.

## Discussion and next steps

The survey employed to demonstrate the initial hypothesis concerning the research problem as presented in this paper served to identify the lack of study skills and work habits as a significant factor, hindering the successful completion of MOOCs by less experienced learners. MyLearningMentor addresses this by providing personalized planning and tips aimed at helping less experienced learners make the most of MOOCs by scaffolding self-learning. However, this work is still at an early stage and needs to be implemented and evaluated with real MOOCs.

The tips provided by MyLearningMentor include common strategies for time management particularized for MOOC context. Examples of time management strategies are: having regular study periods, taking short breaks, alternating subjects and prioritizing tasks (Dembo, 2004). Although some authors claim that there is no correlation between awareness of time management strategies and learning success (Jung, 2007), there is a general agreement in the community that metacognitive self-regulation correlates with learners' achievement and course completion (Puspitasari, 2012). Nevertheless, the usefulness

of the tips provided by MyLearningMentor, as well as the effect of the suggested time management strategies on metacognitive self-regulation in MOOCs are aspects that need to be researched further.

The analysis of study skills and work habits in those students that have successfully completed different MOOCs can enrich planning and advice provided by MyLearningMentor, resulting in specific study guidelines for each particular MOOC and generic guidelines for specific domains. Even though MyLearningMentor targets MOOC participants that lack study skills and work habits, it needs to be researched further to see if it can be useful for other kinds of learners and in other contexts, such as blended learning scenarios (e.g. freshmen and University students that have not yet developed study skills) or other online contexts that are not necessarily MOOCs (e.g. ALISON, Canvas, MIT OpenCourseWare, etc.).

MyLearningMentor aims to prepare less educated people to face the MOOC challenge, and eventually reduce the attrition rates of those who cannot keep up with MOOCs. This is a first step towards the ultimate goal of shrinking the gap between qualified and non-qualified people. Nevertheless it requires further research on how to promote the use of MOOCs for vocational learning rather than as a complement for higher education. Moreover, the study advice and activity planning provided by MyLearningMentor can also serve to interiorize work strategies and improve productivity in the workplace. Thanks to MyLearningMentor, people can reflect on their current work habits and incorporate the tips and planning provided by the application into their daily routine. All in all, MyLearningMentor can enhance future experiences of users both in learning and work settings.

Steps in the near future include the continued implementation of MyLearningMentor following an agile software development methodology. As a preliminary step, the current mockup will be reviewed by target users. A fully functional application will be implemented afterwards, taking into account the feedback collected from target users; this application will be distributed using current mobile app marketplaces such as Google Play Store and iOS App Store. Evaluation experiments will ascertain whether MyLearningMentor facilitates the development of study skills and work habits in less experienced learners, and whether target users have the discipline to use this application regularly.

Future work will also include the development of functionality for synchronous communication with mentors via MyLearningMentor. These mentors will be volunteers who wish to share their experiences of MOOCs in general or of the actual MOOCs that MyLearningMentor users are registered in. Another line of work is the integration of MOOC recommenders (e.g. moocrank, see Gutiérrez-Rojas et al. 2014) in MyLearningMentor, enabling users to discover and receive recommendations of which MOOCs suit their learning profile. Finally, MyLearningMentor is expected to be offered by MOOC providers as a way to increase student and teacher awareness, as well as the completion rates of their courses.

## Acknowledgements

This work has been funded by the Spanish Ministry of Economy and Competitiveness Project TIN2011-28308-C03-01, the Regional Government of Madrid project S2009/TIC-1650, and the postdoctoral fellowship Alianza 4 Universidades. Prof. Carlos Delgado-Kloos wishes to acknowledge support from Fundación Caja Madrid to visit Harvard University and MIT in the academic year 2012/13. He also thanks numerous people from MIT, Harvard and edX for fruitful conversations carried out during this research stay.

## References

Alario-Hoyos, C., Pérez-Sanagustín, M., Delgado-Kloos, C., Parada-Gélvez, H.A., Muñoz-Organero, M. & Rodríguez-de-las-Heras, A. (2013). Analysing the impact of built-in and external Social Tools in a MOOC on Educational Technologies. Proceedings of the 8th European Conference on Technology Enhanced Learning, EC-TEL 2013, Springer, LNCS 8095, 5-18, Paphos, Cyprus, September 2013.

Balch, T. (2013). MOOC Student Demographics (Spring 2013). The augmented Trader. Retrieved December 2013 http://augmentedtrader.wordpress.com/2013/01/27/mooc-student-demographics

Beasley, R.L. (2013). Don't Follow the Crowd. Inside Higher Ed. Retrieved December 2013 http://insidehighered.com/views/2013/04/09/essay-online-learning-strategies-black-colleges

Budde, R. (1992). Prototyping: An Approach to Evolutionary System Development. Springer.

Dembo, M.H. (2004). Motivation and Learning Strategies for College Success: A Self-Management Approach. Lawrence Erlbaum Associates.

Downes, S. (2010). The Role of the Educator. Huffington Post Education, Retrieved December 2013 http://huffingtonpost.com/stephen-downes/the-role-of-the-educator_b_790937.html

Highsmith, J. & Cockburn, A. (2001). Agile software development: the business innovation. IEEE Computer Society, 34, 9, 120-127.

GoGulf (2012). Smartphone Users Around the World – Statistics and Facts [Infographic]. Go-Gulf, Retrieved December 2013 http://go-gulf.com/blog/smartphone.

Gutiérrez-Rojas, I., Leony, D., Alario-Hoyos, C., Pérez-Sanagustín, M. & Delgado-Kloos, C. (2014). Towards an Outcome-based Discovery and Recommendation of MOOCs using moocrank. Accepted for the Second European Stakeholders Summit, eMOOCs 2014, Lausanne, Switzerland, February 2014.

Kolowich, S. (2012). How will MOOCs make Money? Inside Higher Ed. Retrieved December 2013 http://insidehighered.com/news/2012/06/11/experts-speculate-possible-business-models-mooc-providers

Jung, M. (2008). The Effects of Integrating Time Management Skills Into a Blended Distance Learning Course. University of Southern California, PhD Thesis.

Mackness, J., Mak, S. & Williams, R. (2010). The Ideals and Reality of Participating in a MOOC. Proceedings of the 7th International Conference on Networked Learning, 266-274, Aalborg, Denmark, May 2010.

Malgrem, R.D., Ottino, J.M. & Amaral, L.M. (2010). The role of mentorship in protégé performance. Nature, 465, 1, 622-626.

Martin, F.G. (2012). Will Massive Open Online Courses Change How We Teach? Communications of the ACM, 55, 8, 26-28.

Mourshed, M., Farrell, D. & Barton, D. (2013). Education to Employment: Designing a System that Works, McKinsey Center for Government, McKinsey&Company. Retrieved December 2013 http://mckinseyonsociety.com/downloads/reports/Education/Education-to-Employment_FINAL.pdf

Nielsen (2012). Survey New U.S. Smartphone Growth by Age and Income, Nielsen, Retrieved December 2013 http://nielsen.com/us/en/newswire/2012/survey-new-u-s-smartphone-growth-by-age-and-income.html

Pappano, L. (2012). The year of the MOOC. The New York Times, Retrieved December 2013 http://nytimes.com/2012/11/04/education/edlife/massive-open-online-courses-are-multiplying-at-a-rapid-pace.html

Puspitasari, K. (2012). The Effects of Learning Strategy Intervention and Study Time Management Intervention on Students' Self-Regulated Learning, Achievement, and Course Completion in a Distance Education Learning Environment. The Florida State University, PhD Thesis.

Sharples, M., McAndrew, P., Weller, M., Ferguson, R., FitzGerald, E., Hirst, T. & Gaved, M. (2013). Innovating Pedagogy 2013, Open University Innovation Report 2. Milton Keynes: The Open University.

Shen, C. (2013). Announcing the Launch of the Open Education Alliance. Udacity Blog, Retrieved December 2013 http://blog.udacity.com/2013/09/announcing-launch-of-open-education.html

Yuan, L. & Powell, S. (2013). MOOCs and disruptive innovation: Implications for Higher Education. eLearning Papers, In-depth, 33, 2, 1-7.

Wang, F. & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. Educational Technology Research and Development, 53(4), 5-23.