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Conscientious Behaviour, Flexibility and Learning in Massive Open On-Line Courses

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Abstract

Since 2011 the growth in Massive Open Online Courses (MOOCs) has been so enormous that, according to the Economist magazine, “the ivory towers of academia have been shaken to their foundations” (2013). One proposed benefit of MOOCs is that they allow considerable flexibility in organizing learning. At the same time, there is evidence that learning is associated with conscientiousness (O’Connor and Paunonen, 2007), especially planning, self-discipline and organization. This may be even more important in flexible courses than in traditional learning. This study explored the impact of conscientious behavior in a MOOC on student completion. Data from 27,993 students on a course was analyzed (including only those who watched at least one lecture and/or submitted at least one assignment). Students engaging with the course at roughly the same time every week were regarded as showing planning and self-discipline (high conscientiousness) and an index of regularity was developed. The association of this regularity with course completion was assessed. The results showed a moderately strong and highly significant association (chi-square = 1205.4 (5), $p < .001$), Cramer’s $V = .324$. This suggests the flexibility of MOOCs may be of most benefit to those with conscientious study practices. The development of tools which help students to plan and develop conscientious practices may well aid student completion and learning in MOOCs.

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1. Introduction

Massive Open Online Courses (MOOCs) have been one of the major developments in higher education over the last three years. From the time that the first truly massive course was launched in Stanford in 2011, higher education has seen the foundation of a number of different providers of MOOCs including Udacity, Coursera, and

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EdX. In December 2013, Coursera alone was able to boast of 549 courses, provided by 107 leading universities, and over 5 million student registrations. MOOCs were originally announced as the death knell for the lecture (Koller, 2011) and it was no surprise that, in July 2013, the Economist magazine reported, “Since the launch early last year of Udacity and Coursera, two Silicon Valley start-ups offering free education through MOOCs, massive open online courses, the ivory towers of academia have been shaken to their foundations”. One of the defining features of MOOCs is that they are intended to be flexible, catering for people who do not have the time, money or freedom to attend traditional higher education. Coursera, for example, describes itself as enabling people to “learn without limits” and highlights that it is designed for those who are busy with many demands on their time (Coursera, 2013). Daphne Koller, one of the founders of Coursera has highlighted that, “the flexibility that students have with online courses allows them to complete assignments at a time and place that is more convenient to their lifestyle” (Levi, 2013). Yet, it is open to ask if learners are always equipped to manage the flexibility and openness that MOOCs provide. In particular the way in which a person plans and organises themselves (the personality trait called conscientiousness) is likely to have an impact on their learning (O’Connor and Paunonen, 2007). While traditional higher education provides considerable structure for the learner (in the form of timetables and clear deadlines), MOOCs allow much greater flexibility. This may be a challenge for learners, as much as a benefit. In this study we sought to explore the impact of conscientiousness on completion rates in a MOOC called ‘Introduction to Computer Programming in SCALA’ offered by the École polytechnique fédérale de Lausanne (EPFL) in 2012. While personality traits like conscientiousness are often measured using self-report scales, the record of learner activities gathered within a MOOC allowed us to look at students’ actual actions (rather than their self-report of what they would normally do). Students who typically watched videos on the same day each week were regarded as showing evidence of planning and self-discipline (two aspects of conscientiousness). The association of this measure of conscientiousness with completion of the MOOC was assessed.

2. Context of the Research

2.1. Massive Open Online Courses

Although the term MOOC existed previously, the first really Massive Open Online Courses were delivered from Stanford University as recently as 2011, when three computer science courses delivered on an open on-line platform attracted 300,000 registrations (Koller, 2011). Almost immediately there were claims that MOOCs would revolutionize higher education, and would ultimately replace most universities as we know them today (Schuman, 2013). The New York Times declared 2012 to be “the year of the MOOC”. MOOCs come in many forms, but typically they offer short video lectures, combined with quizzes and exercises which give the learner opportunities to get feedback on their progress. They also use social media tools such as forums to allow learners to interact with each other and to support each other’s learning. There is typically no rigid timetable – videos and other materials are made accessible on a regular (usually weekly) basis and students are encouraged to follow them regularly, but they remain accessible during the course period and so someone can follow the course ‘out of step’ with other participants. The flexibility of the platform is seen as a major bonus, allowing people who would not otherwise be able to take a course to access it through a MOOC. Yet, very quickly, questions were asked about the high drop-out rates from MOOCs. Clow (2013) identified that this rate is something of the order of 80%-90% and uses the metaphor of ‘funnel of participation’ to conceptualize the steep drop-off in activity. The number of people who are aware of the course is greater than the number who registers for it. The number of people who register is higher than the number who watches the first video. The number that undertakes exercises and participates in community interaction is lower still. The number who completes the course is lower again. For some this steep drop off rate is not a significant problem. Lukeš (2012) identifies that, while one of the first MOOCs (the Stanford Artificial Intelligence course) had a drop of rate of 85%, this still left 23,000 people completing the course – 10,000 more than the total number of students actually enrolled in Stanford at the time. Yet, many of the almost 140,000 people who dropped out of this course undoubtedly invested time and energy in the course. With the added scale of MOOCs must come an added responsibility not to waste students’ time. It is worth, therefore asking, what features are associated with increased likelihood of completion of a MOOC. MOOCs can help to answer this question. As Koller (2011) has noted, the online format provides a window on what works: “Online technology can capture every

click... This mass of data is an invaluable resource for understanding the learning process and figuring out which strategies really serve students best”.

2.2. *Conscientiousness*

One factor that seems likely to be associated with course completion is conscientiousness, a personality trait that has been found to be associated with attainment in higher education settings (O'Connor and Paunonen, 2007). Personality is described as “relatively stable, enduring and important aspects of the self” (Maltby et al., 2007, p. 9). Conscientiousness therefore describes people’s dispositions to act in different aspects of their life (not just in learning) and is regarded as being relatively stable over time. Conscientiousness includes features like organization, self-discipline, thoroughness and reliability (Costa & McCrae, 1985; Goldberg, 1993). Conscientiousness has been found in numerous studies to be associated with attainment in higher education. O'Connor and Paunonen reviewed over 20 empirical studies of personality and attainment in higher education and found that conscientiousness was the personality factor that is most consistently linked to academic success in higher education (O'Connor & Paunonen, 2007, p. 974). Of 30 correlations reported, 20 reported significant positive correlations between conscientiousness and attainment, ranging in scale from $r=.13$ to $r=.40$. They found a mean correlation between conscientiousness and academic attainment of $r = .24$. Conscientiousness is closely linked to the cognitive construct of metacognition (Batteson, Tormey and Ritchie, 2104). Metacognition refers to a person’s thinking about their thinking and it includes elements of planning, monitoring and reviewing one’s own learning (Flavell 1999; Schraw and Dennison 1994). As the aspect of conscientiousness most closely related to learning, it is interesting to note that there is some evidence that metacognition can be learned. Hattie for example, (2009, p. 188-9) has summarized the findings from over 800 different meta-analyses on learning and concluded that the impact of teaching meta-cognitive strategies to pupils on learning was $d=0.69$, as compared to an average effect size of $d=0.40$ for all educational interventions. This suggests that metacognitive strategies can be learned, and that learning them has a positive impact on attainment. Veenman (2011) has provided guidance, based on a review of evidence, as to how metacognition can effectively be taught. Typically conscientiousness is assessed through personality inventories (Costa & McCrae, 1985; Goldberg et al., 2006). Metacognition is also often measured using self-report tools (Schraw and Dennison 1994; Pintrich et al., 1991). These are questionnaires in which a person indicates the degree to which they agree with a given statement which describes themselves (sample statements for a typical conscientiousness scale include ‘I am always prepared’, ‘I get chores done right away’, and ‘I make plans and stick to them’). As Roberts et al. (2001, p. 200) have argued (in relation to Emotional Intelligence), “self-report scales rely on a person’s self-understanding, if the self-reports are inaccurate, these measures yield information concerning only the person’s self-perception”. Although they make this point in the context of Emotional Intelligence, it equally applies in the context of personality. Arising from this, it is useful to ask, if conscientiousness or metacognition – as measured through observations of learning practices that shows evidence of planning, organization, self-discipline and reliability – has an impact on dropout rates in MOOC courses. If so, and given the evidence that metacognitive practices can be learned, this clearly has implications for how we support those who take MOOCs.

3. **Research Methodology**

The research involved participants on the ‘Introduction to Programming in SCALA’ course offered by Martin Odersky, of EPFL, in 2012, on the Coursera platform.

3.1. *Participants*

The total number of registered participants in the course was 50,335, however many of those were people who registered but did not engage in any meaningful activity in the course. Although such registrations are often included in discussions of MOOCs dropout rates, including these in the analysis is effectively meaningless (like regarding those who looked in through the back of a lecture theatre once as being the same as those who came in, and sat through a lecture). The number of participants who watched at least one lecture video and submitted at least

one assignment was 29,950. These were taken as the effective course participants. Of these, data on completion/dropout was identifiable for 27,993 students. This was taken as the data set for analysis.

3.2. Measures

Completion/ Dropout: The course included seven assignments, but students were made aware after five weeks that they could pass the course if they had scored sufficiently well on five of the seven assignments. Therefore:

- Students were regarded as *completing* the course if (a) they had submitted all of the seven required assignments or (b) they had submitted assignments for at least the first five weeks and had also watched at least six weeks of lecture videos (n= 10,398).
- Students were regarded as *dropping out* of the course if (a) they had submitted fewer than five assignments, or (b) they submitted five assignments but did not watch at least six weeks of lecture videos (n= 17,595).
- Students who (a) watched videos in all weeks but submitted no assignments, and (b) students who submitted five assignments but watched only five weeks of videos were removed from the analysis (n=1,957).

Conscientious/ Irregular: Those participants who typically watched or downloaded a video on the same day every week were regarded as showing evidence of planning, organization, self-discipline and reliability (i.e., conscientiousness). The modal day on which a person first watched a week's videos was identified (in the case of bi-modal or multi modal distributions, a single mode was chosen). An index of regularity was calculated, based on how often a person deviated from that modal day such that the most regular (those who always watched the video on the same day) scored 1, and those who had no identifiable modal day (i.e. they watched videos on a range of different days) scored 0, with others scoring between 0 and 1.

Using this method, 58.9% of participants had a score of 0. A score of 0 could indicate that they watched videos on a wide range of different days (sometimes on a Monday, sometimes a Wednesday, sometimes a Saturday, and so on), or it could indicate that they did not watch many of the videos as a result of dropping out. This means it is questionable to use a 0 score as an independent variable to explain drop out (since drop out makes a 0 score more likely). For this reason, in the analysis that follows, we have paid most attention to students with a regularity score above 0 (n=11,502) (these participants have watched two or more weeks of videos with at least two weeks of videos having been watched or downloaded on the same weekday). Notwithstanding this exclusion, however, it is worth noting that it was possible to complete the course with a regularity score of 0 (9.1% of those with a regularity score of 0 completed the course, a total of 1,493 participants). It should also be noted that a number of alternative scoring methods were also explored. Both more and less tightly defined regularity indices were calculated, with the mode being defined based on a 12-hour window (more narrowly defined), and a 48-hour window (less narrowly defined). Alternative analyses were also carried out allowing participants to have one or two deviations from the modal video watching day. The patterns as described in this paper remained the same across all these conditions. For ease of reading, only a single condition is reported on here (the mode identified in terms of a 1-day window).

3.3. Procedure

The course data was retrieved from the Coursera platform and then uploaded to a MySQL database server. Data was cleaned and relevant fields were extracted using SQL queries. During data cleaning it became apparent that multiple versions of some videos had been made available due to video updates to fix bugs or errors. These multiple IDs were mapped so that the each of the multiple versions of a given video were treated as the same. The data was extracted and then analyzed in Excel, 'R' and SPSS.

4. Findings

Table 1 shows the rate of completion of the course. In total 37.1% of those who watched at least one lecture and submitted one assignment completed the course. This is much higher than the reported 10% completion rate (e.g. Clow, 2013), as a result of having excluded 'casual observers' from the analysis.

Table 1. Rate of course completion by regularity score

| | Index of regularity score | | | | | | Total |
|-------------------------|---------------------------|------|------|------|------|------|-------|
| | 0 | .286 | .429 | .571 | .714 | .857 | |
| Completed course | 9.1 | 65.0 | 86.3 | 94.1 | 97.2 | 98.7 | 37.1 |
| Did not complete course | 90.9 | 35.0 | 13.7 | 5.9 | 2.8 | 1.3 | 62.9 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Total (number) | 16491 | 6065 | 2707 | 1291 | 818 | 627 | 27933 |

Note: 3 participants with a regularity score of 1 have been excluded due to their small numbers

There is a clear association evident in the table between regularity score and completion, even when those with a regularity score of 0 are excluded. Those who are more regular in their study habits (i.e. score closer to 1) are more likely to complete the course than those who are less regular (score closer to 0). This can also be seen in Figure 1, below.

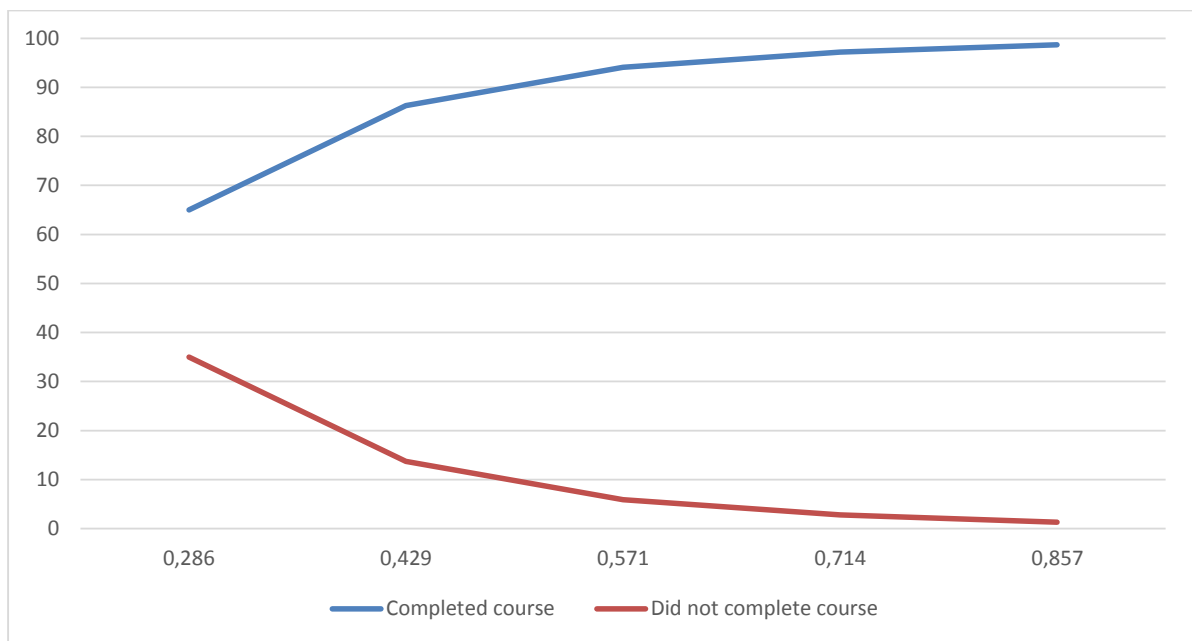


Fig. 1. Rate of course completion (in percent) by regularity score (zero scores excluded)

As one would expect based on this data, and based on the large data set, the association between regularity score and course completion was found to be significant even when those with a regularity score of 0 were excluded (chi-square = 1205.4 (5), $p < .001$). When those with a regularity score of 0 are excluded, Cramer's $V = .324$, indicating a moderate to large association. Needless to say, the association appears far stronger when those with a regularity score of 0 are included (Cramer's $V = .719$, indicating a very strong association), however the weaknesses with this measure have been identified above.

5. Discussion and Conclusions

It is a very short time since MOOCs were heralded as sounding the death knell for the traditional lecture and as signalling the future of higher education (e.g., Koller, 2011). More recently the gloss has appeared to come off of

these hyperbolic claims, and Sebastian Thrun, founder of Udacity and one of the teachers of the original Stanford MOOCs that attracted 300,000 registrations, has since argued that the low completion rates makes MOOCs a “lousy product” (Chafkin, 2013). These low completion rates are a product of having inflated the number of initial participants by including all ‘registrations’ as being real. As we outlined in section 3.1, of the total number of registrations for the SCALA course, only about two-thirds actually watched a video and completed a learning task/assignment. Of this group, 37.1% completed the course. We would contend that this is a much more realistic account of completion rates. It is notable that this completion rate is also much closer to completion rates in many traditional university settings. In France, where, like in MOOCs, there is little selection before entry, it has been estimated that almost half of students do not complete their first year of studies in higher education, rising to an estimated 80% in the case of medical students (Pilkington, 2012, p. 43). Viewed in this way, MOOC completion rates are not so disastrous and, if they are a “lousy product”, they are only as lousy as much traditional university teaching. If MOOCs are not as bad as recent bad press suggests, they are also not as flexible as previous good press claimed. The flexibility of MOOCs has been acclaimed as one of its hallmarks, with people being able to study and learn without having to change their lifestyles. Thrun’s original Stanford MOOC, for example, has been characterised as being accessible to “young men dodging mortar attacks in Afghanistan, [and] single mothers struggling to support their children in the United States” (Chafkin, 2013). But the evidence presented here challenges these assertions. We found that those who tended to first watch videos on the same day each week were more likely to complete the course than those who first watched the videos on a range of different days. In other words, those who were less ‘flexible’ in their approach – those who exhibited signs of having planned for learning and of having stuck to that plan – were more likely to have completed the course. To put this in numerical terms, only 9.1% of those who did not have a regular day for first watching the videos (regularity score of 0) completed the course, as compared to over 90% of those with a regularity score of .57 or higher. On the other hand, it is also interesting to note those with a regularity score of .57 have a rate of completion almost as high as those with a regularity score of .86. In other words, ‘perfect’ regularity is not required for successful MOOC completion – high completion rates are also found among those who show some, limited, flexibility. Thrun’s answer to the problem of low completion rates has been to argue that MOOCs are not suited to many learners. An alternative approach would be to see if MOOCs could help people to develop the kind of planning behaviour and self-discipline that is associated with success. Conscientiousness in educational settings - metacognitive strategies – can be thought of as involving planning, monitoring, de-bugging and reviewing practices (Flavell 1999; Schraw and Dennison 1994). MOOCs already provide people with regular feedback on their progress which can be used for self-monitoring purposes. There is no technological barrier preventing MOOCs from expanding upon this to also provide opportunities to plan for learning, to reflect on their plan, and to review their performance at the end. In doing so, MOOCs might not just help people learn, they might also help them learn how to learn.

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References

- Batteson, T., Tormey, R. & Ritchie, T. (2014). Approaches to learning, metacognition and personality; an exploratory and confirmatory factor analysis, *Procedia – Social and Behavioural Science*, 116, 2561-2567.
- Chafkin, M. (2013). Udacity’s Sebastian Thrun, godfather of free online education, changes course, *Fast Company* 14 November 2013. (url: <http://www.fastcompany.com/3021473/udacity-sebastian-thrun-uphill-climb>) (accessed: 12 December 2013)
- Clow, Doug (2013). MOOCs and the funnel of participation. In: *Third Conference on Learning Analytics and Knowledge* (LAK 2013), 8-12 April 2013, Leuven, Belgium.
- Costa, P. T., & McCrae, R. R. (1985). *The NEO Personality Inventory Manual*: Odessa, FL: Psychological Assessment Resources.
- Coursera (2013) Our vision. (url: <https://www.coursera.org/about>) (accessed: 2 December 2013)
- Flavell, J. H. (1999). Cognitive Development: Children’s Knowledge about the Mind, *Annual Review of Psychology*, 50, 21-45.
- Goldberg, L. R. (1993). The structure of phenotypic personality traits, *American Psychologist*, 48, 26-34.
- Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. C. (2006). The International Personality Item Pool and the future of public-domain personality measures. *Journal of Research in Personality*, 40, 84-96.

- Koller, D. (2011). Death Knell for the Lecture: Technology as a Passport to Personalized Education, *The New York Times*, 5 December 2011 (url: http://www.nytimes.com/2011/12/06/science/daphne-koller-technology-as-a-passport-to-personalized-education.html?pagewanted=all&_r=0) (accessed: 2 December 2013)
- Levi, B. (2013). MOOCs change academic playing field, *The Leader (Elmhurst College)*, 8 November 2013 (url: <http://ecleader.org/2013/11/08/moocs-change-academic-playing-field/>) (accessed: 2 December 2013).
- Lukeš, D. (2012). MOOC motivations and magnitudes: Reflection on the MOOC experience vs the MOOC drop out, *Researchity – Exploring Open Research and Open Education*, 18 August 2012 (url: <http://researchity.net/2012/08/18/mooc-motivations-and-magnitudes/>) (accessed 2 December 2013).
- Maltby, J., Day, L., & Macaskill, A. (2007). *Personality, Individual Differences and Intelligence*. (2nd ed.). London: Prentice Hall.
- O'Connor, M. C., & Paunonen, S. V. (2007). Big Five personality predictors of post-secondary academic performance. *Personality and Individual Differences* 43, 971-990.
- Pilkington, M. (2012). The French evolution: France and the Europeanisation of higher education, *Journal of Higher Education Policy and Management*, 34, 39-50.
- Pintrich, P., Smith, D.A.F., Garcia, T. & McKeachie, W.J. (1991). *A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ)*. Ann Arbor: The University of Michigan (url: <http://files.eric.ed.gov/fulltext/ED338122.pdf>) (accessed: 2 December 2013).
- Roberts, R.D., Zeidner, M., & Matthews, G. (2001). Does emotional intelligence meet the traditional standards for an intelligence, some new data and conclusions, *Emotion*, 1, 196-231
- Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19, 460-475.
- Schuman, R. (2013). The King of MOOCs abdicates the throne, *Slate*, 19 November 2013 (url: http://www.slate.com/articles/life/education/2013/11/sebastian_thrun_and_udacity_distance_learning_is_unsuccessful_for_most_students.html) (accessed: 2 December 2013)
- The Economist (2013) The attack of the MOOCs, *The Economist*, 20 July 2013 (url: <http://www.economist.com/news/business/21582001-army-new-online-courses-scaring-wits-out-traditional-universities-can-they>), (accessed: 2 December 2013).
- Veenman, M.V.J. (2011). Learning to self-monitor and self-regulate. In R.E. Mayer and P.A. Alexander (Eds.), *Handbook of Research on Learning and Instruction* (pp. 197-218). New York:Routledge.