

Can we afford it?

The cybernetic determinants for pedagogical models in MOOCs

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Building on existing research this paper claims that the FutureLearn platform does not have the necessary affordances to support social learning at scale and presents qualitative and quantitative results of an intervention designed to enable discovery and engagement based on affinity. This intervention is also used as a lens through which to examine wider sociomaterial factors and novel pedagogical methods are suggested which place greater value on community approaches to learning.

Cybernetics; affordances; MOOC platforms; social learning

I. INTRODUCTION

MOOCs are wholly online courses with large cohorts of learners. Their scale has necessitated an independent study model that is in stark contrast to the more accepted socio-constructivist approaches to learning [1], with discussion forums added as an ‘appendage’ rather than a key part of the learning design [2]. That is not to say social features are not utilised, rather that the levels of participation are not proportionate with the levels of interactive writing [3] which is associated with learning [4]. Kizilcec et al. [5] conclude that social activity in MOOCs is highly associated with completion of courses and make the case that platform designers should build features that promote pro-social behaviour.

This paper frames the problem as one of information and participation overload [6] and demonstrates that a systems design or cybernetic analysis, like has been previously done on institutional VLEs can reveal what behaviours are encouraged by the platform and how features should be extended to scaffold a more social learning experience. Specifically, Britain and Liber’s cybernetic analysis of VLE platforms suggest that to encourage a sociocultural pedagogical model (the conversational framework [7]), and taking Ashby’s viable system’s model [8], platforms (as the controller) need to encourage variety across the following dimensions: resource negotiation, adaptation, self-organisation, monitoring and individualisation [9].

The design paradigm of stigmergy [10], [11] can be used as a framework to guide the development of platform affordances such that the activities of large groups (swarm intelligence) can be divided into coordination, cooperation and collaboration and can be appraised according to how

well they encourage or prevent the aforementioned dimensions.

This paper analyses a new feature which use visualisation to coordinate peer production and encourage variety across resource negotiation, individualization and self-organisation. It does this by affording learners new learning strategies for both reading and interacting with others and suggests methods in which the platform could be extended further to encourage cooperative behaviours. This is in line with existing ideas of learning design which connect the cybernetic qualities of a platform with teaching activities [12]–[15] and is a current gap in research concerning the pedagogy of MOOCs. The suggested methodology for development of new affordances is design based research as it is grounded in theory yet allows for iteration based in the naturalistic setting [16].

II. COMMENT DISCOVERY TOOL

This paper tracks the development of a plugin developed for the FutureLearn platform which visualises all the learner comments into an interactive wordcloud. Learners can use this tool as a filtering mechanism and also as an implicit cognitive scaffold.

The choice of visualization and aggregation technologies (d3.js, nltk) was made because the platform was considered deficient in terms of discovery, therefore self-directed learning [17], [18]. The FutureLearn platform has features for making comments on every page, which is intended to create conversations that can be “free-flowing around the immediate content” [19]. It also divides course materials into sequential pages or ‘steps’ which learners are encouraged to ‘mark complete’. This may encourage comments that are more relevant to specific course content and reduce the barriers to making a comment, but another consequence of this is that learners are not incentivised to look back unless they receive a notification that someone has replied to their comment. Discovery of comments that align with affinity is limited to reading the ‘stream’ of comments on each page at the time of viewing, which excludes comments not-yet-written (by learners behind them) and also comments which are further down the stream than is practical to read (information overload).

In summary, the design may encourage writing relevant comments, but they become fragmented across steps and

most likely visible to learners within a similar timeframe as the commenter. The new plugin aggregates all comments and visualises them by word frequency into a wordcloud, linked from a step at the end of the weekly sequence. Learners can click on words to view and also link directly to comments which include those words. A new wordcloud of the filtered corpus is also displayed, which creates possibilities for further reading, replying, and also making conceptual linkages by viewing related terms in a new and previously unavailable form.

The plugin is called the Comment Discovery Tool (CDT) as has been deployed across 8 MOOCs with a combined total of 18230 learners and 31621 conversations. The courses were analysed using quantitative and qualitative methods. The quantitative measures compare overt social activity (i.e. contributions to the comment corpus) with courses that did not use the CDT, taking into account dimensions of conversation length, turn taking and unique contributors to a conversation, which measures the take-up of new possibilities for writing. A survey instrument is also quantitatively analysed (n=308) which correlates learner preferences with perceptions of the affordances, cognitive outcomes and overall evaluation. This helps develop an understanding of how reading strategies can be altered with the new affordances, which is excluded from the purely high-level quantitative analysis above. A further qualitative analysis builds on this and takes the free text comments from the platform itself (n=590), analysing them according to sentiment, learning value, perception of affordance and overall evaluation.

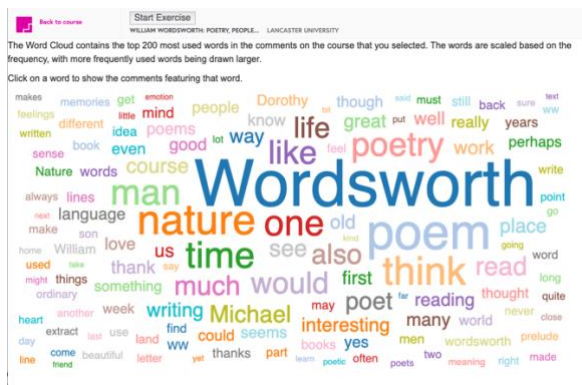


Figure 1. The Comment Discovery Tool visualizing all the comments in a FutureLearn MOOC

III. METHODOLOGY

Design Based Research (DBR) is a relatively new technique in educational research that attempts to bridge the gap between theory and practice. Ann Brown states that DBR is engineering “interventions that not only work by recognizable standards, but are also based on theoretical descriptions that delineate why they work, and thus render them reliable and repeatable” [16]. Interventions should be based in theory and occur in naturalistic settings, to ensure that the differences observed are meaningful. Indeed, experimental designs that look at the learner, the

environment or the learning activity in isolation will inevitably lead to an incomplete understanding of the full context. Due to the design being an engineered intervention, it should be subjected to iteration and modification, with an understanding that real-world practice entails a certain ‘messiness’ not seen in laboratory settings [20].

As described above, this paper adopts a 3-tiered approach to analysis of the intervention: 1. a high level quantitative analysis of social activity; 2. a survey instrument to correlate learner preferences with behaviours; 3. a qualitative analysis of free text comments which uses the CDT as a mechanism for discussing wider sociomaterial aspects of learning at scale, factors which can be accounted for in future iterative cycles of DBR.

The high level quantitative analysis extends Chua et al’s [21] categories for FutureLearn comments onto whole conversational units to create a taxonomy of ‘conversation types’ based on unique contributors and turn taking in a conversation [22], [23]. These are used as proxies for diversity and collaboration which is important when framing learning as sociocultural and importantly stem from the material affordances or cybernetic qualities of the platform, in line with the central claims of this paper.

The turn taking dimension categorises all conversations into 4 heuristic types based on their development within the initiation, response, feedback (IRF) method [24], [25]: Lone (no reply or self replies), QA (no ‘further’ replies/ 2nd replies to a thread), Limited Social (further replies limited to initiator) and Extended Social (any conversation with ‘further’ replies by initiator or respondents).

The unique contributor dimension also creates 4 types: Lone (1 member), ‘Watercooler’ (2 members), ‘Cocktail Party’ (3-9 members), ‘Conference’ (10-19 members). These categories represent the actual data collected but could be extended further if there were more than 20 members of a conversational unit.

An ANOVA analysis is also conducted to determine statistical significance of length and unique members. This presents the following research questions:

- Does the CDT have a statistically significant impact on the length and unique members of conversations?
- Does the CDT affect the types of conversations on the platform?

The results of these research questions have been previously published as preliminary findings [22] and this paper extends on these results by adding further quantitative and qualitative analysis to deepen understanding on how platform affordances affect learning experiences.

The survey instrument asks 15 questions to discover correlation between learning preferences, cognitive development and behaviours related to learning. That is to say relating the value learners placed on the social learning affordances with whether the CDT (as a new affordance) helps to form conceptual linkages or encourage further commenting and interaction behaviours. The results were analysed using a Spearman’s rho coefficient, which is a measure of the strength of monotonic relationships between paired data where 1 would be a perfect positive correlation, 0.6 would be considered strong and 0.4 would be considered

moderate [26]. The research question for this level of analysis is:

- What are the relationships between learning preferences, experiences, perceived affordances and evaluation of the CDT as a means to develop thinking?

Finally, learners were encouraged to write a short comment on the CDT page in the course and a total of 590 comments were analysed for sentiment, overall evaluation, perceived learning value, perception of affordances, scaffolding in the course structure and feature suggestions. This analysis intends to use the CDT as a mechanism for discussing factors affecting the wider sociomaterial context as well as tangible suggestions for further development of the technology. The final research question is:

- How does the CDT affect the overall experience of learning at scale?

IV. RESULTS

A. Does the CDT have a statistically significant impact on the length and unique members of conversations?

257239 conversations were analysed. An ANOVA analysis showed that the unique learners variable was significant, $F(1, 257239)=496.265, p=0.00$, and also that the conversation length variable was significant, $F(1, 257239)=601.703, p=0.00$. Cohen’s d scores were also calculated for a measurement of impact, and generated a score of 0.15 for unique learners, 0.12 for conversation length.

TABLE I. DESCRIPTIVE STATISTICS

	Courses (n=35)	N	M	SD
Unique Learners	no CDT	225618	1.33	0.80
	CDT	31621	1.46	0.91
Conversation Length	no CDT	225618	1.48	1.43
	CDT	31621	1.67	1.70

B. Does the CDT affect the types of conversations on the platform?

These breakdowns of conversations by type (according to the heuristic measures explained above) demonstrate that courses with the CDT have a larger proportion of the heuristic groupings associated with higher levels of social constructivist learning: ‘extended social’ conversations, conversations with more members, and fewer lone conversations

TABLE II. PERCENTAGE OF CONVERSATIONS IN EACH HEURISTIC GROUPING

		No CDT	CDT
Social dimension	Lone	78.15	71.06
	Q&A	14.93	19.53
	Limited Social	3.29	3.88
	Extended Social	3.63	5.53
Unique participants	Lone	78.15	71.06
	Watercooler	15.08	19.16

Cocktail Party	6.75	9.76
Conference	0.02	0.02

C. What are the relationships between learning preferences, experiences, perceived affordances and evaluation of the CDT as a means to develop thinking?

The survey asked learners how important the discussion features are to learning, and there was a moderate correlation between those who valued these features and the extent to which the CDT helped develop thinking, discover new conversations and commenting more (0.34-0.35), which are theoretically based indicators of successful learning. This result indicates that those who value the discussion forum also perceive the inbuilt limitations of the platform (that it restricts access to certain posts) and appreciate the affordances that the CDT brings (that it opens up a new method of using social features based around affinity and discovery).

In this phase of design based research, there is a limitation in that many learners only experience the tool once in the first week and that the CDT is framed as a ‘tool’ or technology. This is for pragmatic reasons: the technology is new so was ‘rolled out’ carefully with consideration for the risks associated with any introduction of a production level system. However, the survey reveals that there is also a moderate to good correlation (0.39-0.48) between number of times the CDT was used and reported cognitive outcomes such as developed thinking, and also desired behaviours such as commenting more. This supports a claim that the CDT could be integrated at the end of every week, planned into the formal learning design and framed in terms of a reflective or investigative learning activity [13].

Amongst those highly engaged with the CDT activity (those who used it most frequently), it is interesting that of the correlations of cognitive outcomes and desired behaviours, further opportunities for commenting (0.354) correlates less than simply discovering new conversations (0.431), which indicates that there are more learners using the tool as a reading strategy rather than those who view it as an opportunity to write. This finding may go some way to explaining why there is only a moderate impact in terms of measuring changes to overt contributions, as in the higher-level quantitative analysis.

The strongest correlations were between users who perceived the affordances of discovery and conceptual linkage and the amount to which is helped develop thinking (0.7-0.72) which indicates that when the designed affordances are perceived, there is a strong link with cognitive development through the increase in opportunities for interactions or exposure to diverse viewpoints, and this is supported by sociocultural learning theory [25], [27].

The weakest correlations (weak but still positive) are between both learning preferences for social learning or perception of the affordances and discovering new people (0.2), indicating that it is the exposure to diverse opinions which are valued rather than the connecting with users who posted them. This can be seen as a reformulation of the finding above about the tool’s affordances being more strongly related to reading strategies. That is to say, learners

do not join MOOCs specifically to network with new people, but they see a great deal of value in others' contributions. In this sense the MOOC is not a space of social networking, but it requires a mass of individuals in order to generate enough content such that each individual can find value in the 'swarm'. In this sense, the theoretical framing and design of the tool on stigmergic principles which take advantage of the weak tie connections and coordination of peer production is coherent with users' experiences.

This is also a confirmation that creating affordances which increase the exposure of diversity of opinions is considered useful in the FutureLearn platform, and that simply taking a 'learning analytics' perspective on quantifying participation does account for the vicarious learning strategies employed by many learners, and the high participation but low interactive writing results [3] cannot be understood without consideration of the fragmentation of discussion posts specifically created by the latent cybernetic qualities of the FutureLearn platform.

D. How does the CDT affect the overall experience of learning at scale?

Learners left a total of 590 comments on the CDT step. 245 were positive, and 105 of these comments were negative, although 83 negative comments cited technical problems with access to the tool. The remainder were neutral.

A frequent negative/ non-technical problem comment was that "many of those words are pretty mundane, directing us to random comments". Other comments suggested "the activity could be more clearly thought out" and that "the instructions were [not] entirely clear" indicating that the instructions on the page could be improved and relates to the finding above strongly linking perception of the designed affordances with cognitive outcomes.

However, learners who did positively engage with the activity found it a "really great way of personalizing the exploration", and that it "picked up on comments which pre- or post- dated [my own comments]" or "I rarely look at comments older than those shown on the first page of comments" which confirms the original cybernetic analysis of the platform that it doesn't encourage resource negotiation, individualization and self-organisation, important factors when developing a platform for supporting sociocultural learning. These comments also demonstrate that the new affordances increase variety along these dimensions and learners who recognize this are able to improve their learning experience. Indeed, many learners comments that the "would like to see the feature used across all FutureLearn courses" (i.e. not just the ones involved in this study).

A wider issue of time emerged from this analysis and learners reported that they "could spend hours reading different threads"; this was negative for learners who wanted to quickly achieve completion as they saw the exercise as a "distraction" or a "time-waster", but positive for learners learned how to operate the tool in order to efficiently discover relevant content. This raises the issue of the 'ticking clock' as an invisible aspect of the sociomaterial context –

FutureLearn MOOCs are only available for free for a limited time, and some learners were acutely aware of this, whilst others enjoyed the ability to personalise their experiences. Further qualitative data needs to follow up on this factor, in order to link the perceptions of time, the appraisal of the CDT and the motivations for learning. It is hypothesized that learners who are motivated intrinsically (out of interest for the subject) rather than to extrinsically (for example to achieve completion as a professional development exercise) or who have paid for an 'upgrade' and unlimited access are more likely to appraise the CDT positively and appreciate the new affordances because of their differing perceptions of time. The CDT exercise is not intended to be completed quickly, rather supports 'slower' reflective learning activities and creating opportunities for serendipitous encounters.

In terms of supporting cognitive change, some learners who perceived the affordances reported that the tool helped them make conceptual linkages: "for me it triggered thoughts on what I have read and [made me want] to re-read the passages again" or that "it can direct me towards understanding a certain aspect". However, fewer learners reported perceiving this affordance, as the conceptual scaffolding is 'implicit', meaning that the epistemic implications of seeing an aggregated view of all comments is not explicitly referenced in the instructions.

Throughout all the qualitative analysis, more comments support the finding of the survey data: that learners do not use the tool to connect with other learners (as people), rather to expose themselves to a diversity of viewpoints, which is a reflection of the fact that many learners do not comment at all, and adopt a vicarious learning strategy. That is not to say the affordances of the CDT are less useful for this end, moreover that an analysis from the point of view of learning analytics does not reflect this as it only measures overt contributions rather than examining these wider sociomaterial factors.

The challenge for the future iterations of DBR are to scaffold the CDT in such a way to realize the benefits to more people (and quicker to prevent disengagement), which may involve modelling use-cases: "It's value will derive from the clarity of investigative questions/ enquiries which provide the rationale for selecting particular words from which to generate fresh clouds which may either offer answers or provide leads for further enquiry". Clearly the instructions on the step need to more closely match this learner's analysis.

V. CONCLUSION

A cybernetic analysis of MOOC platforms is useful for providing avenues for pedagogical development, in that it is able to identify dimensions of variety and provide a framework for analyzing how these behaviours are supported within platform affordances. This project has demonstrated a new method for analysing large quantities of conversational data in order to make a comparative analysis of changes brought about by the introduction of a technical intervention, and also used this to frame wider analysis on the experience of learning at scale. The results show that the intervention is able to increase levels of overt sociality and that the main

benefits of the tool are in increasing opportunities for interaction and also vicarious learning strategies.

In order to extend these benefits to the wider MOOC audience, it is suggested that greater use case modelling is included in the instructions for use to reduce time spent learning how to make best use of the tool, and that the tool is introduced into courses more frequently, and as a specific learning exercise, rather than as a technological intervention, which may reduce the wariness that many learners feel towards new technology. The exercise should be designed as an investigative learning activity to emphasise the “clarity of the line of investigative questions” as the most important factor.

In order to reduce the number of “irrelevant words” and to extend the activity into a cooperative groupwork exercise, modelling social behavior by suggesting learners use hashtags throughout the whole course will allow learners to self-define the main topics of interest, as and when it is relevant (i.e. when writing comments relevant to a single piece of content on a ‘step’). This in turn can be filtered by the tool and MOOC pedagogy can be enhanced from one mainly based around acquisition to one grounded in community and the ‘swarm intelligence’ of thousands of learners who contribute to the ‘funds of knowledge’.

MOOC interactions are completely mediated online, and this project has demonstrated that analyzing the platform through a cybernetic lens allows for the identification of gaps in the affordances which mediate these interactions, and provides a foundation for designing learning activities which extend from the toolset itself and alter the whole learning design of the course.

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