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Sophie C. Ward^a & Jan H.F. Meyer^a

^a School of Education, Durham University, Durham, UK

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Metalearning capacity and threshold concept engagement

Sophie C. Ward* and Jan H.F. Meyer

School of Education, Durham University, Durham, UK

This study aims to further our understanding of metalearning activity through the analysis of qualitative data gathered from 370 first-year microeconomics students in three UK universities. The students were asked to produce undirected reflective essays in response to a personal ‘learning profile’ generated before, and after, the teaching of a threshold concept. The purpose was to compare the capacity and/or inclination of students studying threshold concepts to write about their learning in a manner that conveys an understanding of the self, and sense of control, in the associated process. Findings are first, that as a posited benefit of the metalearning experience a majority of students demonstrate an increased level of control over their learning of threshold concepts, and second that the metalearning activity may provide the basis for study support intervention, tailored to the individual student’s needs as identified in their self-reported learning profile and reflective essay.

Keywords: metalearning; threshold concepts; reflective essays; study support

Introduction

This study aims to further our understanding of metalearning activity through the analysis of qualitative data gathered from 370 first-year microeconomics students in three UK universities. The students were asked to write reflective essays in response to a personal ‘learning profile’, generated by Meyer’s (2004) Reflections on Learning Inventory (RoLI), before and after the learning of a threshold concept. The purpose of the present study is to discover the extent to which students’ reflective essays display evidence of developed/developing metalearning capacity when studying threshold concepts; the ‘troublesome knowledge’ that must be understood by students in order for them to think like a subject specialist (Meyer & Land, 2006, p. 4). The RoLI is designed to assist in the development of students’ metalearning capacity; defined as the individual’s *awareness* of learning in a given context and *control* of learning in that context (Biggs, 1985). Previous research has demonstrated that students that engage with the RoLI are better able to regulate their learning and become more confident as learners (Meyer, Ward, & Latreille, 2009; Lindblom-Ylänne, 2004), making the RoLI of potential benefit to students who are about to embark on the study of threshold concepts. The counter-intuitive, conceptually challenging nature of many threshold concepts means that students often find them difficult to acquire (Meyer & Land, 2006), yet when a student *does* acquire a threshold concept, the ideas and procedures of a subject that previously seemed alien to them begin to make sense (Davies, 2006, p. 74). For example, *opportunity cost* captures the idea that choices can be compared, and that every choice means rejecting

*Corresponding author. Email: s.c.ward@durham.ac.uk

alternatives, and by grasping this concept students begin to move beyond looking at immediate consequences, and even just monetary costs, towards a more abstract way of thinking (Meyer & Shanahan, 2006, p. 102). Helping first-year undergraduates to take control of their learning of microeconomic threshold concepts therefore has a particular transformative significance compared with learning in a more general sense of the discipline (for a detailed discussion of threshold concepts in economics, see Davies & Mangan, 2007).

The data in the present study take the form of reflective essays about learning, written by students in response to an individualised 'learning profile' produced via the online completion of the RoLI. The RoLI introduces the 'awareness' aspect of metalearning by asking students to respond to 80 statements concerned with their beliefs about learning and study practices in a specific context and then presenting them with a summary of what they have disclosed in the form of a bar chart containing 16 ranked observables: they literally construct a learning profile of themselves, and a non-evaluative guide explains what the observables in the profile represent conceptually (for a sample profile, see www.rolisps.com). The learning profile is thus a stimulus: it provides a reflection of 'the self as student' in a chosen context, and is intended to create sufficient self-awareness to provoke further reflection, which may refer to the 'control' aspect of metalearning capacity (Meyer, 2004). As such, the RoLI offers students an opportunity to engage in what Kember et al. (1999, p. 23) describe as a 'perspective transformation'. According to Kember et al.:

To undergo a perspective transformation it is necessary to recognise that many of our actions are governed by a set of beliefs and values which have been almost unconsciously assimilated from the particular environment. (Kember et al., 1999, p. 23)

The students' essays therefore represent an opportunity for them to reflect upon the RoLI's disclosure of what may have been both un-interrogated assumptions about what constitutes good learning and unconscious habits of learning, and the metalearning activity (i.e. completing the RoLI and writing an essay) may thereby enable students to begin to transform their perspective on learning.

Data collection

In autumn 2007 data were gathered from 370 first-year microeconomics students in three UK universities. These universities vary in their entry requirements; degree structure; proportion of mature students and proportion of overseas students, and while it is inevitable that across such diverse cohorts there will be variety in response to the complexity of threshold concepts, the focus of interest in this study is the development of individuals' self-reported learning engagement with, rather than their relative intellectual mastery of, threshold concepts. All participants were volunteers embarking on their first semester at university, and as such the data may be said to reflect the views of undergraduates interested in their own learning. Almost 40% of students enrolled on first-year microeconomics across the three universities agreed to take part.

Data collection took place at the beginning and towards the end of a one-semester (13 week) unit of study, before and after the teaching of a designated threshold concept, and the data gathered from the three universities is identified here in terms of

the particular threshold concept taught at that university: EL (elasticity; $n = 302$); KM (Keynesian model; $n = 47$); OC (opportunity cost; $n = 21$). These threshold concepts were respectively selected by the three universities, and are typical of the conceptually challenging material that must be understood by students in order for them to progress in their chosen discipline.

Two data sets ('A first'; 'B second') were gathered from each of the 370 students. For the 'A' metalearning activity, the students were asked to think about their most recent learning experience (for example school; community college) and to respond to the RoLI's statements (via a Likert-type response format) with that learning experience in mind. The RoLI produces a bar chart (the learning profile) that contains 16 ranked observables that relate to learning engagement (for example, one column is labelled 'Memorising without Understanding'). When read from left to right the profile reveals the students' prevalent learning strategies in decreasing order of emphasis as determined by their responses to the statements. After having completed the RoLI, the students were asked to write a brief (c. 500 words) essay reflecting upon their resultant learning profile. For the 'B' metalearning activity, the students were asked to: think about their learning again, this time in relation to their experience of learning a designated threshold concept; respond to the RoLI's statements with that learning experience in mind; and write a second brief essay reflecting on the resultant learning profile. Both the 'A' and 'B' reflective essays were *undirected* to ensure that the content was an authentic expression of students' reaction to their learning profiles, and the ensuing essays contained a range of descriptions of the profiles, considerations of self-diagnosed issues requiring future action, and other free response comments (for example, the mention of hobbies).

Data analysis

A previous study utilising the RoLI (Ward, Meyer, & Shanahan, 2006) found that first-year microeconomics students who scored less than 50% in their end of year examination had previously produced second ('B') learning profiles that contained one or more of a subgroup of observables conceptually designated as *interference conditions* (i.e. observables which are likely to 'interfere' with deep-level integrative learning¹) in the first five columns; conversely, students that gained 50% or higher had not. In the present study, the 'A' and 'B' learning profiles were therefore categorised as 'good' in the absence of any interference conditions in their five most highly emphasised (ranked) observables, and 'problematic' if one or more of these interference conditions was present.² In order to contrast those students who, according to the changes in their learning profiles, had made improvements in their learning engagement against those who had not, the students in each cohort were partitioned via a four-way tag based on the categorisation of their 'A' and 'B' *profiles*: 'Good first-Good second'; 'Good first-Problematic second'; 'Problematic first-Good second'; 'Problematic first-Problematic second'.

The qualitative data (essays) were categorised using a method based on Marshall and Rossman's (1999) analyst constructed typologies: headings were devised to record each novel statement made by a student, and the subsequent mention of the same phenomenon by another student was tallied under that heading. In this manner, salient issues were made visible. In exploring what might account *in the essays* for the changes in students' self-reported learning (as captured in their profiles' categorisations), the corresponding 'A' and 'B' essays were subjected to a form of *comparative*

analysis (Glaser & Strauss, 1967), with the focus on isolating and interpreting evidence of any *change* between them.

Findings

Table 1 reports the categorisation of the students' profiles for each of the three threshold concepts.

As is shown in Table 1, only 47% (n = 174) of the sample produced 'Good' first profiles, which suggests that most students were exhibiting at least one interference condition in the five most prominent aspects of their generic learning engagement at the start of the semester. In contrast, 66% (n = 244) of students produced a 'Good' second profile, which suggests that a majority of students had developed/were developing levels of metalearning capacity when studying their designated threshold concept. However, just over a third of students appear to have failed to develop their metalearning capacity in the face of the learning of a designated threshold concept. In the light of this finding, we examined the students' reflective essays in order to uncover any difference between the subgroups in terms of their 'perspective transformation' on learning (Kember et al., 1999, p. 23).

The data yielded three conceptually clear examples of noteworthy reflection: the issues of *rote learning*, *fact-based learning*³, and the detailing of study plans. Tables 2 and 3 report, respectively, the percentage of students in each subgroup that reflected upon these issues in their 'A' and 'B' essays.

Table 1. Categorisation of students according to their learning profiles.

Students	Good-Good	Good-Problematic	Problematic-Good	Problematic-Problematic	Total
EL	103	28	86	85	302
KM	24	1	13	9	47
OC	16	2	2	1	21
Total	143	31	101	95	370

Table 2. 'A' essays.

Subgroup	<i>Learning is fact-based (%)</i>	<i>Rote learning (%)</i>	Study plans (%)
Good-Good	4	4	18
Good-Problematic	9	0	12
Problematic-Good	2	10	31
Problematic-Problematic	3	3	12

Table 3. 'B' essays.

Subgroup	<i>Learning is fact-based (%)</i>	<i>Rote learning (%)</i>	Study plans (%)
Good-Good	11	2	16
Good-Problematic	22	9	19
Problematic-Good	7	1	18
Problematic-Problematic	8	14	28

Study plans

As is shown in Table 2, the students in the 'Problematic-Good' subgroup have a far greater tendency than the other students to mention study plans in their 'A' essays, which suggests that these students felt compelled to take action to improve their learning engagement in response to the RoLI's disclosure of their 'problematic' learning engagement at the start of the semester. For example:

'Problematic-Good' OC 5, 'A': I aim to explain what I know and know it before memorising.

'Problematic-Good' KM 18, 'A': I will try to relate the concept to real life, draw diagrams; talk to students.

'Problematic-Good' EL 120, 'A': One thing I do find hard about learning is the chore of, and repetitive nature of revising. However, from this analysis of my learning I will now steer away from just methodically memorising quotes, equations etc. and become more of a kinaesthetic learner and incorporate different ways of learning in order to keep my brain interested and willing to learn new things.

Although the 'Good-Good' students do not demonstrate such a marked tendency as the 'Problematic-Good' students to mention study plans in their 'A' essays (see Table 2), when mentioning study plans they likewise display evidence of the intention to engage in self-regulated, deep-level, integrative learning. For example:

'Good-Good' KM 42, 'A': [I will be] reconstructing and breaking down individual concepts and diagrams, this will enable me to see the theory in different stages... [I will] explain them to others, use journals and the Internet.

Interestingly, the two subgroups that produced 'Problematic' 'B' profiles had the *least* tendency to mention study plans in their 'A' essays, which suggests that the first RoLI exercise failed to stimulate them to take control of their learning. Where study plans *are* mentioned by the 'Good-Problematic' and 'Problematic-Problematic' students, they tend to be vague or amount to little more than a list of basic study skills. For example:

'Good-Problematic' KM 1, 'A': I will need to set a plan whereby I focus on improving my learning style to a level that best helps me to fully progress in the future.

'Good-Problematic' EL 203, 'A': I need to learn by example more, I need to find someone who has an easy time understanding and absorbing the key issues introduced in lectures and try to copy their learning style.

'Good-Problematic' OC 17, 'A': [I will] attend every lecture and tutorial, revise and study.

'Problematic-problematic' KM 3, 'A': I hope to work hard to improve my weakness and also keep working hard to perfect my strengths.

This finding suggests that *how* students respond to the disclosure of their generic learning engagement, as exhibited in their 'A' profiles, plays a role in determining the subsequent quality of their threshold concept learning engagement, as exhibited in their 'B' profiles. Further evidence to support this conjecture is found in the 'B' essays

of the ‘Problematic-Problematic’ students: here, 28% make confused and/or desperate study plans in response to their self-reported problematic learning engagement in the context of the designated threshold concepts (see Table 3). For example:

‘Problematic-Problematic’ KM 4, ‘B’: I will also learn formulas by heart but will not actually understand it to the require depth, meaning that really I will not understand it properly and may not even be able to discuss or explain it correctly.

Having failed to acknowledge or address their ‘problematic’ generic learning engagement, the ‘Problematic-Problematic’ students tend to make a belated recognition of the inadequacy of their learning engagement in the face of the complexity of the designated threshold concepts.

Fact-based learning

When comparing Table 2 with Table 3, it is apparent that all of the subgroups display an *increased* tendency to discuss *fact-based learning* in their ‘B’ essays (Table 3), in spite of this being a recognised interference condition that impedes students’ learning (Meyer, 2004). Most students who discuss fact-based learning in their ‘A’ essays express surprise that the RoLI cautions *against* this perspective on learning. For example: ‘Good-Good’ KM 26, ‘A’ states: ‘I have always thought all of my work is fact-based and it just needs to be learnt and memorised.’ This finding is consistent with Kember’s (2001, p. 217) identification of the ‘didactic/reproductive’ beliefs about learning fostered by schools. However, rather than abandon the belief that learning is primarily about memorising and regurgitating facts, many of the students appear to be *more* convinced that this is the case towards the end of their first semester at university, which suggests that there may be something about microeconomic threshold concepts that is prompting students to hold this belief. For example:

‘Good-Good’ KM 28, ‘B’: One of the more serious areas where I had trouble was to do with the idea of learning being fact-based. In general I do not have this problem, as can be seen in the other results, however when learning the Keynesian model and its theories I felt that a lot of the time I was simply learning things that others had decided was fact and that I did not need to challenge them. This led me not to question what was being learnt and simply accept the facts that I was being told which meant I was not really interacting with the learning process.

Here, the impact of the threshold concept on student KM 28’s ability to take control of his learning is apparent. According to Davies and Mangan (2009), some first-year students of microeconomics think that graphs are direct representations of ‘reality’, rather than models used to make sense of economic processes, and that this belief hinders the development of the students’ ability to think like economists. In spite of expressing confusion over the issue of *fact-based learning*, the student quoted above produced a ‘good’ ‘B’ profile, which suggests that he did not hold this belief strongly enough for it to be a significant interference column in his profile. However, almost a third of the students that produced ‘problematic’ second profiles did score highly on this observable, and cite features of the threshold concepts to justify why learning *should* be viewed as fact-based. For example:

‘Problematic-Problematic’ KM 31, ‘B’: I believe that what I learn from the Keynesian model is based on facts because of how it was dated back into the twentieth century.

‘Good-Problematic’ EL 40, ‘B’: ...whilst studying this topic, I found it extremely difficult to alter my perception of some of the statements such as “learning is fact-based” because elasticity is fact-based.

While the threshold concepts seem to have generated epistemological confusion in the minds of some students, it would appear that for others the perspective transformation that occurred as a result of reflecting upon their ‘A’ learning profile *prevented* them from sliding into erroneous thinking about the designated threshold concept. For example:

‘Good-Good’ OC 1, ‘B’: It was particularly helpful whilst learning about opportunity cost to understand that learning is not just factually based, and that my approach to the questions did not need to be purely factual, and that I did not have to recall specific facts about opportunity cost. I felt I was able to logically think through the questions, and deduce an answer from what I knew about opportunity cost already, and was not struggling to recall a set answer.

‘Good-Good’ KM 45, ‘B’: When learning the Keynesian model I thought it was important to understand that this was just a simple model of what is probably a far more complex idea in the real world. With this in mind I knew this was not just about learning the facts.

‘Problematic-Good’ EL 255, ‘B’: I feel that I have stopped using fact-based knowledge as a learning method and am now focusing on a more deep, overall learning strategy where I am more able to inter-link concepts that I have learnt.

This suggests that the metalearning activity helped these students to take control of their learning by *raising their awareness* of the need to resist viewing threshold concepts as facts to be memorised and regurgitated, rather than theories that must be understood, in spite of the preponderance of graphs and formulas in their study experience.

Rote learning

The third most striking feature of the data was the students’ tendency to discuss *rote learning* in their ‘A’ essays (see Table 2), and in particular the observation that this tendency was found least of all in the ‘Good-Problematic’ subgroup (where it was mentioned by no one). Students in the ‘Good-Good’ and the ‘Problematic-Good’ subgroups tended to credit the RoLI for making them *aware*, both that they engaged in this type of learning and that it is harmful. Although the absence of discussion of rote learning among the ‘Good-Problematic’ subgroup makes it impossible to know how they felt about this issue, this absence is perhaps related to their scepticism over the hazard of conceptualising learning as fact-based and their relative disinclination to make study plans that might address detrimental learning habits. Some of the ‘Good-Problematic’ students mention rote learning in their ‘B’ essays, but here they *justify* its use as a coping mechanism when studying threshold concepts. For example:

‘Good-Problematic’ EL 273, ‘B’: My main weakness was “Memorizing as Rehearsal”...personally I do not see this to be much of a caution. If I am unable to understand material, it is necessary for me to commit it to memory regardless.

This finding is perhaps indicative of the complexity of threshold concepts: in the face of conceptually difficult material, students that have not previously reflected

upon their learning in a manner that might support the development of metalearning capacity may be obliged, in desperation, to simply memorise and regurgitate as much material as possible.

Discussion

According to Kember (2001, p. 217), students who begin higher education with didactic/reproductive beliefs about knowledge and learning can find the process of adjusting to the facilitative/transformational learning environment of university 'difficult and even traumatic'. Kember's observation is particularly worrying when considered in conjunction with Davies' (2006, p. 82) identification of the 'monolithic approach' to the teaching of economics in school and on undergraduate degree programmes, which he claims prompts students to 'reproduce versions of subject knowledge and mimic its application without seeming to grasp the underlying meaning of that knowledge'. The findings of this study demonstrate that, although students entering higher education are *expected* to engage in transformational learning, many of them commence their studies holding counter-productive beliefs about learning that are *entrenched* by the complexities of threshold concepts. Rather than develop learning strategies appropriate for degree-level study, some students appear to cling to didactic/reproductive strategies in the face of 'troublesome knowledge' (Meyer & Land, 2006, p. 4). In particular it would appear that threshold concepts compound the idea, for some students, that economics consists of facts that should be memorised and reproduced, rather than theories amenable to interrogation, which suggests that they may be at risk of failing to develop the economic reasoning necessary for the successful study of economics at degree-level. A previous study by Connolly and Ward (2010) found that the RoLI may provide the basis for study support intervention, tailored to the individual student's needs as identified in their self-reported learning profile and reflective essay, and the metalearning exercise may therefore prove particularly useful in identifying those students at risk of misconstruing graphs and formulas as representations of 'reality' (Davies & Mangan, 2009).

A previous study by Norton, Owens, and Clark (2004) found that a metalearning activity involving the RoLI successfully predicted the academic performance of 8 out of 12 first-year undergraduates. Consistent with this finding, the present study found that the study plans offered in the students' 'A' essays appeared to predict the students' sense of control of the learning of the designated threshold concept, as expressed in their 'B' essays. Students that produced 'Problematic' 'B' profiles tended *not* to have made study plans in their 'A' essays, and these students report unfavourably on their experience of learning the designated threshold concept. For example:

Problematic-problematic' KM 4, 'B': 'I will also learn formulas by heart but will not actually understand it to the required depth, meaning that really I will not understand it properly and may not even be able to discuss or explain it correctly.'

In contrast, the students that produced 'Good' 'B' profiles tended to have made study plans in their 'A' essays that detailed how they intended to take control of the learning of threshold concepts, both in terms of their conceptualisation of the material and practical steps to master that material (for example, discussing lectures with classmates and doing additional reading), and reported favourably on their experience of

learning the designated threshold concept in their 'B' essays. Although we did not measure learning outcomes, the level of anxiety over the learning of the threshold concepts expressed by students that produced 'Problematic' 'B' profiles suggests that the metalearning activity is a useful means of identifying, and supporting, students at risk of academic failure prior to formal assessment.

Overall the findings of the study were encouraging: two thirds of students that took part in the RoLI metalearning exercise wrote about their learning in a manner that demonstrated that they had become aware of their own learning, and had begun to take control of the learning of threshold concepts. These students appeared to have undergone a perspective transformation as a result of reflecting upon the RoLI's disclosure of what were, in some cases, unconscious learning habits and assumptions about what constitutes effective learning. For example:

'Problematic-Good' EL 256, 'B': The results of my first [learning profile] and consequent essay made me think a lot about how I approached learning and the way I learned. The highlighted area for my improvement that most hit a chord, and rightly so, was that to my mind learning was very fact oriented...Previously I would have struggled with the concept of price elasticity (the first time I have come across elasticity), eventually committing it to memory via repetition. Whereas now, after this essay writing process I try to focus on the general concept of elasticity...I feel that this self reflective process has ultimately changed how I learn for the better. Learning is not a chore based around textbooks. In the future I am going to try and develop my learning ability further by reducing repetitive learning styles.

While the metalearning exercise appeared to have empowered most students to take control of their learning, one third of the students produced 'Problematic' 'B' profiles and expressed concern and/or confusion over the learning of their designated threshold concepts in their 'B' essays: the findings of the present study indicate that *how* students reflect upon their 'A' RoLI profile, and in particular the quality of the study plans that they make in response to their 'A' profile, may help tutors identify students at risk of failing to move beyond didactic/reproductive approaches to learning in higher education, and that the RoLI metalearning exercise may therefore play a useful role in undergraduate study support.

Notes

1. Simply put, these conditions represent aspects of learning that conceptually inhibit, rather than support, deep-level, integrative learning. In particular the foregrounding of inhibitive aspects in the presence of supporting aspects of such learning is conceptually problematic. Such 'mixed conditions' have been separately modelled in various empirical studies under the label of *dissonance*.
2. The RoLI domain contains 16 observables, five of which (in terms of high scores) are conceptually designated as interference conditions: detail related process, fragmentation, memorising as rehearsal, fact-based learning, knowledge discrete and factual. For a fuller discussion see Meyer (2004).
3. There are three observables in the RoLI domain that may triangulate in students' minds what is simply referred to here as 'rote learning': memorising as rehearsal, re-reading a text, memorise before understanding.

Notes on contributors

Sophie C. Ward is a PhD student in the School of Education, Durham University, with research interests in creativity and metalearning.

Jan H.F. Meyer is a professor of education, and the director of the Centre for Learning, Teaching, and Research in Higher Education. One of his research interests lies in helping students to develop their metalearning capacity within disciplinary contexts.

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