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Threshold Concepts in the Discipline of Pharmacology - A Preliminary Qualitative Study of Students' Reflective Essays

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Abstract

Purpose: Pharmacology is widely experienced as a difficult to learn discipline. Unfamiliarity with its technical and medical terms, and how pharmacological principles transfer from theory to practice, is especially troublesome. This known state of affairs is even more compounded where English is not the first language of students in question. This study aimed to discern the crucial aspects of health science students' reflections from an Eastern – Mediterranean context on the learning and practice of pharmacology using threshold concept framework.

Methods: 21 students enrolled in the pharmacology component of a four years' undergraduate optometry program were recruited for this study. They were provided with prompts and guidelines to write reflective essays related to their learning – teaching experience of pharmacological concepts and constructs in preparation for clinical practice.

Results: The reflective qualitative accounts were thematically analysed using a recent version of NVivo©. The themes were cross-referenced against two main criteria of threshold concept framework which included *transformation* and *troublesomeness.* The key characteristics that eventuated was transformation - in that students felt they had transformed into students who could learn and master.

Discussion: This study observed that learning process, when accompanied by challenges such as difficulty in understanding 'foreign' concepts and overwhelming content, motivated the students to adopt various strategies that not only aided their understanding of the subject but also transformed them as learners. The key attribute of threshold concept framework that thematically emerged through this study included transformation; in that students felt they had transformed into persons who could learn (and master) pharmacology alongside 'creative' teaching methods and 'working out' individual coping strategies.

Keywords: Pharmacology; Reflection; Reflective essay; Threshold concept; Transformation

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1. Introduction

Pharmacology is considered one of the most difficult subjects of the basic sciences for learners where they lack first-hand information about associated diseases. An inherent challenge in the clinical science curricula is the delivery of pharmacology content where it is often taught in isolation during the early stages of clinical/medical science programmes. Compounding this situation, students are expected to apply this knowledge in the later clinical phases of their courses and programmes.[1] This case is not just restricted to medical sciences curricula but also, observed in allied health science disciplines – such as optometry and nursing. The situation becomes even more challenging in regions (such as the Eastern-Mediterranean region where this study was conducted) where English is not the first language. This fosters a culture of memorization of language and lexical and grammatical nuances which, in turn limits the overall language requirement.[2]

An inadequate command of the English language hampers students' learning and understanding of pharmacological discipline-specific vocabulary and terminology. The generic and trade names of drugs are a particular obstacle. Many students compensate for this deficit through use of rote memorization skills. It often does not facilitate full understanding and, inevitably, confine understanding of pharmacology to a more superficial level. These challenges prompt pharmacology educators to consider more 'immersive' strategies such as graphic medicine and concept animation techniques in order to further foster effective student learning of pharmacology in a more meaningful way.[3]

Taking the above-mentioned barriers into account, they profoundly impact the way that English as a Foreign Language (EFL) affects students understand and interpret the discipline of pharmacology. This not only impacts the substantial shift in the learner's perception of the subject knowledge (epistemic shift) but also the 'new way of seeing and being' (ontological shift). This shift/transformation can manifest as a shift in identity or it may be performance related in the way that an individual behaves.[4] This transformed view signifies how the learner 'thinks' in a discipline or how he or she perceives or experiences particular phenomena within that discipline. The shift in the learner's perspective is simultaneously accompanied by an extension of the use of language. Through this elaboration of the disciplinary discourse, new thinking is brought into existence, expressed, reflected upon and communicated – or at least that is the intention.[5] These traits are consistent with Meyers and Land[6] threshold concept framework which proposes that there are certain discipline-specific ideas that are necessary for student learning to take place at the professional level. A threshold concept, across a range of subject contexts, is presumed to be *transformative, irreversible, integrative, bounded,* and inherently *troublesome* in character.[6] In turn, and under the right conditions, they can facilitate learners to obtain 'mastery' of a subject.

The consensus in the domain of threshold concepts emphasized that a concept must be *transformative* in its attainment to be considered a threshold concept. The change of perspective/viewpoints linked to the threshold concept is considered *irreversible* as it is unlikely to be forgotten by the learner and unlikely to be unlearned. Furthermore, threshold concepts are *integrative* as they enable the learner to discern different aspects of learning through revealing the formally undisclosed interrelatedness of ideas, knowledge and concepts culminating in an 'AHA!' moment. They are often *bounded* as they constitute the demarcation that exists between disciplinary areas thus delineating academic territories.[6] The transformation process can lead learners to a transitional state of liminality, where the thought process oscillates back-and-forth between old and emergent understandings.[7] It is a suspended state in which understanding can reach a form of mimicry devoid of authenticity. However, the journey through the 'tunnel' of liminality helps the learner to awareness of their incomplete understanding and comprehend the 'tenuous' nature of their thought processes.[8] A graphical representation (positive and negative) of the learner journey, through this tunnel of liminality, is illustrated in Fig. 1.

Furthermore, the acquisition of knowledge, according to the threshold concept, may lead the learner to Perkin's[9] identified zone of troublesome knowledge that is conceptually difficult, counterintuitive or alien – as also represented in Table 1.

The facilitation of a learner's encounter with a threshold concept requires a reflective dialogue. Reflection has evolved as a recognized pedagogical tool to reinforce the acquisition of professionalism. Reflective tasks may provide the student with a method through which they can monitor the progress of their thinking and understanding. Reflection has a central role in metacognition as it provides the student with an understanding of what they do and do not comprehend, thus enabling them to articulate their concern.[10]

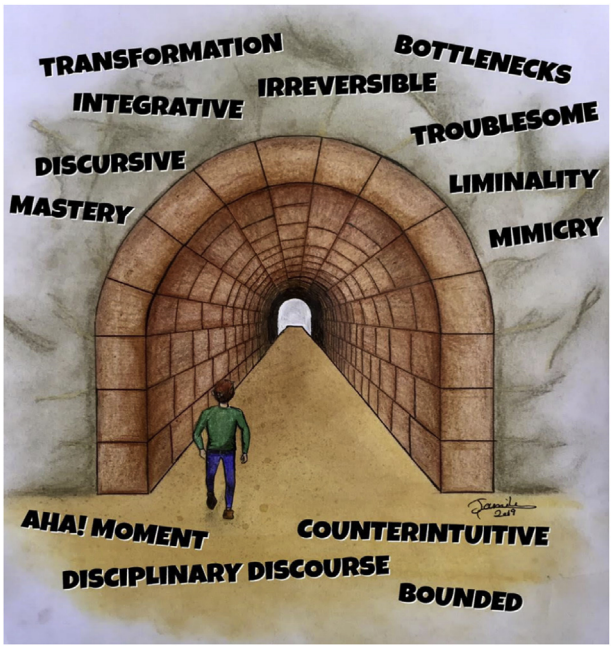

Fig. 1. An illustration of the learner *en route* through to the tunnel of liminality with a portal of understanding in the distance.

Table 1
Determinants of 'troublesome knowledge' by Perkin.[9]

Ritual Knowledge	Routine and meaningless *How we respond when asked 'such-and-such' - the routine task that we perform to get a particular result?*
Inert knowledge	The knowledge that remains 'hidden' until and unless called for by techniques such as brainstorming or quizzes *Words that are understood but not used actively by the learner constitute passive vocabulary.*
Conceptually difficult knowledge	Conceptually difficult knowledge is a mix of understanding and ritual knowledge. Students learn definitions and linked questions as a ritual response - then their interpretations later resurface outside of the classroom.
Alien Knowledge	Alien knowledge is 'foreign' as it comes from a viewpoint that conflicts with the student's own perception of the world. *For instance, early pharmacology students often mistakenly relate the dose of a pill with its efficacy and toxicity believing that pills with more quantity of a drug have stronger effects and are potentially unsafe. However, the quantity of a drug in the dosage form is the function of drug potency but it does not determine its efficacy and toxicity.*
Tacit knowledge	This is the knowledge that remains personal and implicit. It is 'accepted' knowledge even though students often do not know why. *We accept that 'placebo' drugs have a physiological effect on many people – but we do not know why.*
Troublesome Language	Language linked to the academic discipline can attribute to conceptual troublesomeness *In this case, this is the learning of 'foreign concepts' related to pharmacology overall – where a 'foreign language' is also the content*

2. Methods

2.1. Participants and data collection

This study was approved by the institutional research and ethics committee of the College of Health Sciences, University of Buraimi, Sultanate of Oman (Ref No: 0028/REC/2018). Participants for this study were recruited from students enrolled in the pharmacology course of a four-year undergraduate optometry programme. Pharmacology is offered in the third year as two different courses spread across the Fall and

Spring semesters. The number of students registered for these two courses of Pharmacology was 12 and 13 females respectively. All participants were carefully coached as to the nature of the study and tasks they would be involved in. Detailed information regarding the study was shared with the students in advance. Interested candidates were invited to meet the principal investigator to receive further information. Furthermore, they provided their willingness to participate via signed consent before they were inducted into the study. They were allowed to withdraw from the study at any time without penalty. Out of the 25 students registered in the courses, 21 consented to participate. Identified candidates were then requested to remain after their regular pharmacology sessions to record their reflective accounts.

The prompts and the guidelines to write reflective essays were provided to participants as a one-page document. They were then given an option to choose the mode of writing (hand-written or typed) and the majority were opted to go with the hand-written option. Subsequently, all participants were asked to submit their written essays in a 'voting' box kept aside. The following prompts were provided both in English and Arabic as a guide for reflective writing for the purpose of this study:

1 What is the most important concept you have understood in pharmacology that enables you to develop your interest in this subject?
2 What is the most difficult concept you have encountered while learning this subject?
3 Which concept of pharmacology kept your thought process in confusion for a long time?
4 How have you changed since the start of this subject in your preclinical year?
5 Discuss any new approaches to pharmacology learning that you have developed this year.

The software program NVivo© was used to record categories and themes. The reflective accounts of the participants subsequently underwent a qualitative thematic analysis.

2.2. Data analysis

The thematic analysis of the reflective essays was carried out with a theoretical and deductive lens driven by prompts based on the threshold concept framework. This form of analysis tends to offer a more detailed analysis of the data. For this study, a realist method highlighting the experiences, meanings and realities of the participants was used.[11] Familiarity with the data was gained by broadly reading the reflective transcripts and re-reading in more detail afterwards; starting with a line-by-line analysis to firstly code the data. The codes were generated to collate the information provided by the participants into categories based on the similarity of data related to determinants of pharmacology delivery experience. This was appropriate as students with English as a second language (ESL), are more likely to provide information at 'face value' without disguised underlying concepts and assumptions. The next step was to review the themes against the coded extracts and categories as well as the entire data set to generate a thematic map that visually demonstrated how the themes are related to each other. The fifth and final step was to define and name each theme for identification of the results that follow. Member-checking between all researchers assisted the robustness of the analysed data findings.[12]

Two themes emerged from the close analysis of the reflective essays. Sub-themes were noted, but this study wanted to remain as close as possible to the research questions. With reference to thematic analysis, the 'keyness' of a theme is not necessarily determined on quantifiable measure but preferably whether it reveals something important in response to the overall research questions.[11] Therefore, the responses obtained through the reflective essays emerged as two relatively broad but significant themes as answers to the research questions rather than the whole set of prompts. Moreover, the two themes were directly linked to two key characteristics of the adopted threshold concept framework.

3. Results

In keeping with the chosen methodology, the two themes collapsed the codes assigned to the reflective essays. The themes were then examined to determine if any of them met the definition of a threshold concept.

3.1. I was able to learn

This theme reflected that students redefined themselves as someone who could learn pharmacology, and offered examples of what they learned or how that helped. They reflected on their beginning frustrations while trying to learn pharmacology and their sense of 'not making it, in the early stages, as a student'. From this position, they then developed a technique of learning that enabled them to see themselves differently as someone who could learn pharmacology when

presented in a more 'creative' and engaging manner that uses practical examples to link theory to practice. For example, one student felt that by knowing the "group" of the medication, they could figure out the action.

The most important concept for me is to know "This medication belongs to which group." By knowing the group, I can understand the medication easily.

It makes my understanding about disease clearer for me by knowing the drug and for what purpose it is used. Not only in ocular diseases but also systemic diseases and co-morbidities.

Now I know different drugs with their indications.

And if a patient is given the drug by the parenteral route, I know why he/she was given that. I know mydriatics and cycloplegics well which are more related to our field.

The dynamic of the drug gives me the concept of how the drug work in the body; the effect of each drug depends upon the route, receptors, pH and different variables. How does a drug benefit a patient if taken by a correct route? What will be the outcome of treatment if the drug is given by a different route?

I like the mechanism of how the body holds the drugs and how the drugs hold the body.

The concept of therapeutic index encourages me to learn more about the drug, the side effects and clinical uses. This concept gathered many questions in my mind that need to be solved.

As I got new knowledge with perfect clarification from the instructor in each lecture, my vocabulary kept building and this offered me a new perseverance for my studies. It helped me to improve my understanding of pharmacology and now I have become better than what I was early in the pharmacology lectures.

3.2. How I study

Students commonly described their study habits in relation to learning pharmacology in terms of 'transformation of self'. Furthermore, the knowledge gained and the associated student struggle couldn't be rationalised as an 'overnight' epistemological shift. The students were definitely struggling with a large amount of material that they felt they were initially unprepared to learn. Students made flashcards, studied with friends, and invented songs and role-playing games to make the content easier to understand. They also used the drawings and graphic medicine approach adopted by the course instructor to organize their study.

It is easy to learn it if you like it and really want to study it and you can get any grades you want if you try hard enough. Previously I heard and thought it was a very difficult subject, but now it is easy if you do everything that makes it easy and clear.

I overcome these problems by listening to the name of the drugs and chanting along with the teacher during the class. Also, using the help of the diagrammatic story approach of the teacher greatly helped. The drug information can stay inside the mind and is easier to remember.

I have tried many ways for learning pharmacology. I found that when I write each drug and its uses, contraindications, and dosages on a paper or flashcard, it facilitates my learning in a better way.

First, I was in much confusion; how can I remember these many drugs and how can I differentiate between them? By studying every day and by writing and drawing while studying helped me to overcome this confusion.

The new approaches to pharmacology learning included discussion with your friends and do like drama/role play that looks interesting to others.

Thinking through the help of mental charts or mental maps of medicine and use method of linking information through images or symbols facilitated my comprehension and recall of information.

I make a story for the name of the drug and sometimes make song.

4. Discussion

The learning process is as essential as the learning outcomes. It facilitates learners to achieve the intended outcomes successfully by recognising their cognitive efforts and affective engagement during the course of their study. Learners' struggle in various health science disciplines – including pharmacology can influence the development of their disciplinary and professional ways of 'knowing' and 'being'. These disciplinary dimensions and underlying structures can be visualized and understood through the threshold concept

framework amongst others. The visualisation of student's disciplinary ways of 'knowing' and 'being' via a threshold concept lens displays a shift in the identity of the learner, the integration of new verbal and/or mental language specific to the discipline, and a phase of liminality where students shift between previous and emergent understandings of the concept.[13]

A key characteristic of the threshold concept is its transformative capacity in terms of how students redefine themselves (an ontological shift), their perception of their discipline, and their view of what learning and reality are. Transformation is a depiction of transitions that influences the learning process or trajectories. Although these transitions are often uncertain, understanding them is critical. It assumes that the most significant aspect of learning belongs not only to outcomes but also to the process of learning. The growing body of literature on threshold concepts, as a framework, facilitates the inherently developmental nature of these trajectories of learning. The central characteristics of this framework such as 'troublesome,' 'transformative,' 'irreversible,' 'integrative,' and 'bounded help us to understand the complex nature of the learning process.[14] Research conducted by Randall et al.[15] similarly used qualitative thematic analysis of reflective essays with 3rd year paediatric clerks and Collett et al. did similar in the 'softer 'discipline of sociology and psychology using audio diaries.[16] This study is in accordance with those two studies in utilizing the threshold concept framework as a heuristic framework in recognizing the threshold concept as inherent (maybe essential) in the personal and professional development of students' moving from 'novice to expert'.

The reflective essays-based theme of '*I was able to learn*' demonstrates the transformative component of threshold concepts. Under this category, the students acknowledged their transformation as learners to a more in-depth study of pharmacology. For instance, they concurred that the learning of drugs in a group could help them understand the actions and indications of the drugs for different ocular and systemic disorders. Transformation at this level does not only imply the addition of information to the current body of students' knowledge. It also involves a conceptual and ontological shift that leads to change, not simply in what they know, but also in their way of being as part of their subjectivity as highlighted by Meyer & Land.[5]

Furthermore, student difficulties in learning might be linked to the nature of the discipline. Pharmacology has been widely considered/experienced as a difficult to learn discipline because of its complicated nomenclature and difficulty in the application of drug information to actual patient care.[17] The second theme '*How I study*' emphasizes the change in study habits of students with pharmacology, but this could not be categorized as the transformation of the identity or subjectivity. However, it presented another aspect of threshold concept acquisition; that is the student struggle in learning difficult facts and algorithms related to pharmacology – especially in the context of EFL.

Different authors have a different opinion about prioritisation of the key components of concepts during the adoption of the threshold concept. For instance, Land et al.[18] proposed that the threshold concept may be identified as the point at which students experience difficultly. Similarly, the theme of '*How I study*' originated from the difficult nature of the discipline that arose from the sheer volume of reading material related to knowledge acquisition through the retention of drug names, indications, side-effects and contraindications. The trouble understanding pharmacological principles has been linked to a lack of background knowledge about pathological diseases and biochemistry principles. Few of them also admitted 'getting stuck' memorizing and differentiating different types of 'sound alike' or 'look alike' drugs.

The challenging aspects of the discipline-specific learning persuaded the students in this study to adopt various 'adaptive' learning tools and strategies in order to better facilitate their learning process and progress - such as graphs, charts, memorable examples, chants, stories, songs, provision of individualized teaching, promotion of group learning, mechanics of flashcards, etc. This study therefore demonstrated that, despite the complex nature and the challenges associated with pharmacology learning, the transitions that students went through during the supportive learning process facilitates their transformation as a higher-achieving learner.

4.1. Limitations of the study

This study perhaps compromised by the lack of students' English writing skills that resulted in many grammatical inconsistencies and perhaps inability to express their ideas that are initiated in Arabic and then translated into English. On the other hand, it is this cultural context of EFL students, that makes this study unique. Other limitations may be the sequence of courses in which pharmacology is introduced prior to biochemistry, whereas in many other medical schools, pharmacology is built on a knowledge of biochemistry.

In those circumstances, the threshold concepts could likely be different.

4.2. Future research

The replication of this study in a different cultural context would help to establish the universality of the adopted threshold concepts. Moreover, it could facilitate the identification of new threshold concepts that students might come across when learning pharmacology or other 'basic sciences' subjects. The triangulation of reflective dialogues, through in-depth interviews or focus groups, could further assist.

5. Conclusion

This preliminary study provides a qualitative reflective account of students disciplinary learning of pharmacology. The study concludes that pharmacology learning processes, when accompanied by challenges such as difficult to understand concepts and overwhelming content, motivate the students to adopt various strategies that not only facilitate their understanding of the subject but also transform them as learners for future health science disciplines. The key attribute of the threshold concept framework, that thematically emerged through this study included transformation; in that students felt they had transformed into persons who could learn (and master) pharmacology given the appropriate tools and guidance.

In addition, the deeper understanding of student's current way of meaning-making and pragmatic disciplinary learning are useful in designing curricula with developmentally appropriate instruction for pharmacology education. This can facilitate the process of epistemological transformation that is crucial for learners becoming disciplinary experts.

Ethical Approval

Ethical approval has been granted by the institutional research and ethics committee of the College of Health Sciences, University of Buraimi, Oman (25 October 2018, Ref No: 0028/REC/2018).

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References

1. Achike FI. Teaching pharmacology in an innovative medical curriculum: challenges of integration, technology, and future training. *J Clin Pharmacol*. 2010;50(1):6–16. https://doi.org/10.1177/0091270009343697 [published Online First: Epub Date]|.
2. Al-Issa AS, Al-Bulushi AH. English language teaching reform in Sultanate of Oman: the case of theory and practice disparity. *Educ Res Policy Pract*. 2012;11(2):141–176. https://doi.org/10.1007/s10671-011-9110-0 [published Online First: Epub Date]|.
3. Khurshid F, Noushad B, Spanjers IA, Al-Darwashi J. Concept Animation-a potential instructional scaffolding. *MedEdPublish*. 2018;7.
4. Maid B, D'Angelo B. *Threshold concepts: Integrating and applying information literacy and writing instruction. Information literacy: research and collaboration across disciplines*. Fort Collins, CO: WAC Clearinghouse and University Press of Colorado; 2016.
5. Meyer JH, Land R. Threshold concepts and troublesome knowledge (2): epistemological considerations and a conceptual framework for teaching and learning. *High Educ*. 2005;49(3):373–388.
6. Meyer J, Land R. *Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practising within the disciplines*. Citeseer; 2003.
7. Cousin G. *An introduction to threshold concepts: Planet*. 2006.
8. Land R, Rattray J, Vivian P. Learning in the liminal space: a semiotic approach to threshold concepts. *High Educ*. 2014;67(2):199–217.

9. Perkins D. The many faces of constructivism. *Educ Leadersh*. 1999;57(3):6−11.
10. Hyde S, Flatau A, Wilson D. Integrating threshold concepts with reflective practice: discussing a theory-based approach for curriculum refinement in dental education. *Eur J Dent Educ*. 2018;22(4):E687−E697. https://doi.org/10.1111/eje.12380 [published Online First: Epub Date]|.
11. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3(2):77−101. https://doi.org/10.1191/1478088706qp063oa.
12. Harding T, Whitehead D. Analysing data in qualitative research. In: Schneider Z, Whitehead D, LoBiondo-Wood G, Haber J, eds. *Nursing and Midwifery research, methods and Appraisal for Evidence based practice*. 5th ed. Elsevier; 2016:128−138.
13. Nicola-Richmond K, Pépin G, Larkin H, Taylor C. Threshold concepts in higher education: a synthesis of the literature relating to measurement of threshold crossing. *High Educ Res Dev*. 2018;37(1):101−114.
14. Timmermans J. Changing our minds, the developmental potential of threshold concepts. In: Meyer J, Land R, Baillie C, eds. *Threshold concepts and transformational learning*. Rotterdam: Sense Publishers; 2010:3−19.
15. Randall V, Brooks R, Montgomery A, McNally L. Threshold concepts in medical education. *MedEdPublish*. 2018;7.
16. Collett T, Neve H, Steven N. *Using audio diaries to identify threshold concepts in'softer'disciplines: a focus on medical education*. 2017.
17. Alton S. Learning how to learn: Meta-learning strategies for the challenges of learning pharmacology. *Nurse Educ Today*. 2016;38:2−4.
18. Land R, Meyer JH. *Threshold concepts and troublesome knowledge (5): Dynamics of assessment. Threshold concepts and transformational learning*. Brill Sense; 2010:61−79.