

Applying threshold concepts to finance education

Susan Hoadley, Leigh N. Wood, Leonie Tickle and Tim Kyng
Macquarie University, Sydney, Australia

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Abstract

Purpose – The purpose of this paper is to investigate and identify threshold concepts that are the essential conceptual content of finance programmes.

Design/methodology/approach – Conducted in three stages with finance academics and students, the study uses threshold concepts as both a theoretical framework and a research methodology.

Findings – The study identifies ten threshold concepts in finance that are clearly endorsed by finance academics. However, the extent to which students are explicitly aware of the threshold concepts in finance is limited.

Research limitations/implications – As well as informing further research into the design and delivery of finance programmes, the findings of the study inform the use of threshold concepts as a theoretical framework and a research methodology. The study does not explore the bounded, discursive, reconstitutive and liminal aspects of threshold concepts. Implications include the lack of recognition of more modern concepts in finance, and the need for input from industry and related disciplines.

Practical implications – The threshold concepts in finance provide the starting point for finance educators in the design and delivery of finance programmes. In particular, the threshold concepts in finance need to be made more explicit to students.

Social implications – Using the threshold concepts in finance as well as the other findings of this study to inform to finance curriculum design and delivery is likely to achieve better quality educational outcomes for finance students as well as better prepare them for professional finance roles.

Originality/value – The finance curriculum is under researched and for the first time this study identifies the threshold concepts in finance to inform the design of finance programmes.

Keywords Faculty, Threshold concepts, Statistics, Students, Mathematics, Finance curriculum

Paper type Research paper

Introduction

This paper investigates the finance curriculum using threshold concepts as both a theoretical framework and a research methodology. The paper identifies the threshold concepts in finance, providing a base from which educators can construct and discuss with practitioners the essential conceptual content of finance programmes. In addition, the research clarifies the role of interdisciplinary knowledge, primarily mathematics and statistics in finance, and in doing so informs approaches to developing this knowledge within finance programmes.

Finance capabilities are essential in our society and in increasing demand, as indicated by industry trends and significant growth in student numbers. For example, enrolments in the specialist finance degree at one Australian university increased by over 200 per cent from 2002 to 2012, with a nearly 300 per cent increase in international students (Macquarie University, 2012). This demand is predicted to further increase as the finance industry sector increases in size (Deloitte, 2013). This expanding sector offers considerable employment opportunities for the increasing numbers of students who are undertaking finance programmes.

As well as increasing in numbers, finance student cohorts are increasing in diversity as education becomes further globalised and international student numbers increase (Macquarie University, 2012). Prerequisite knowledge requirements have become



more flexible, such as with the shift from “assumed” and “recommended” knowledge in Australia. At the same time, finance programmes have to comply with multiple and multifaceted accreditation requirements, such as the Quality Assurance Agency for Higher Education in the UK, the Australian Securities and Investments Commission Regulatory Guide 146 and the Australian Qualifications Framework, and the US-based Chartered Financial Analyst Institute and Association to Advance Collegiate Schools of Business. Whilst this increased demand, diversity and accreditation are very positive for finance programmes, it is even more essential that they are designed to meet the needs of students, employers and society more generally.

Like many disciplines, finance programmes have developed organically resulting in a curriculum that is overcrowded and lacks coherence. However, research into what should be taught in finance programmes is limited. This is in part due to the fact that finance was and continues to be taught within other disciplines, such as accounting and business. Thus, finance curriculum research tends to either focus on introductory finance rather than an entire finance programme (e.g. Balachandran *et al.*, 2006; Berry and Farragher, 1987; Cooley and Heck, 1996; Gup, 1994; Krishnan *et al.*, 1999) or on preparing students for specific professional roles (e.g. Jackling and Sullivan, 2007 – financial planners; Lakshmi, 2013 – accountants or chief financial officers; Roth *et al.*, 2002 – entrepreneurs).

This study investigates the finance curriculum more broadly than previous research and conceptualises it in new and inspiring ways by identifying the transformational “threshold” concepts (Meyer and Land, 2003) in finance. The premise of threshold concepts is that in any discipline there are a limited number of concepts that are fundamental to mastery in the discipline (Cousin, 2006). “Understanding” a threshold concept involves passing through a conceptual gateway that “permits new and previously inaccessible ways of thinking and practising” (Land *et al.*, 2014, p. 200). Threshold concepts are likely to engage students and involve deep learning because they transform the way students think and view the world. Thus, the identification of the threshold concepts in finance to inform the finance curriculum has the potential to achieve better quality educational outcomes for students as well as better prepare them for professional finance roles.

As originally conceptualised by Meyer and Land (2003), threshold concepts are, or are likely to be, transformative, integrative, irreversible, troublesome and/or bounded. In more recent literature, threshold concepts are increasingly also identified as discursive, reconstitutive and/or liminal (Barradell, 2013; Flanagan, 2015; Land *et al.*, 2014). Due to the interdisciplinary nature of finance and the timing of the research, this study focuses on four of the original characteristics as follows:

- (1) Transformative – occasions a shift in the perception of the subject.
- (2) Integrative – exposes the previously hidden interrelatedness of something.
- (3) Irreversible – unlikely to be forgotten, or will only be unlearned by considerable effort.
- (4) Troublesome – conceptually difficult and/or counter-intuitive (Meyer and Land, 2003).

Cousin (2009) identifies researching threshold concepts as a methodology for researching learning in higher education, involving collaboration with and participation by discipline specialists, educational specialists and learners. This study adopts this methodology, involving finance and educational specialists as researchers and finance specialists and

students as participants, over three stages. In common with other threshold concepts research, data were collected using a range of methods and, as a result, different types of data were collected and analysed using a combination of qualitative and quantitative approaches and techniques. The overall research approach can be described as mixed methods (Johnson and Onwuegbuzie, 2004). This paper synthesises the findings of the three stages in relation to specific finance threshold concepts and also to inform the use of threshold concepts as both a theoretical framework and a research methodology. Separate reports of each stage that explore different aspects of the study are provided in Hoadley *et al.* (2015a, b).

The context of the research is two large finance programmes (a specialist finance degree and a finance major) with a combined cohort of over 2,430 students taught at an Australian university. The programmes have a strong international focus and a significant proportion of the students are international students. In addition, finance academics from institutions in five countries (Australia, Canada, New Zealand, South Africa and the UK) also participated in the research. The research investigates an internationalised finance curriculum and involves international participants and so informs the design of finance programmes to prepare students for employment in the global finance industry.

The paper continues in the following sections with a review of the relevant finance curriculum and threshold concepts literature and then the methodology for the study is outlined. The results are presented and discussed together in a single section covering three areas: threshold concepts in finance, threshold concepts as a theoretical framework and threshold concepts as a research methodology. Finally, overall conclusions are drawn in relation to the study, and directions for future research are identified.

Literature review

Whilst some researchers refer to a body of literature in finance education (Balachandran *et al.*, 2006; Krishnan *et al.*, 1999; Lai *et al.*, 2009) only a limited proportion of this research specifically investigates the finance curriculum; thus, as Lakshmi (2013) states, the area is under researched. Research that does specifically investigate the finance curriculum tend to focus on introductory finance rather than an entire specialist finance programme, or on preparing students for specific professional roles. This is a result of the way finance has evolved from other disciplines. For example, the fact that finance was (and continues to be) taught within accounting programmes that prepare students for the roles of accountants and chief financial officers has led to research into the finance curriculum required to prepare students for those roles. Notably, McWilliams and Pantalone (1994) investigate the entire finance curriculum; however, their research refers to subjects to be included in a finance programme and so the findings are rather broad, for example, investments and international finance.

In addition, previous research into the finance curriculum tends to focus on topics rather than concepts, although there is some inconsistency in the use of the two terms (see Lai *et al.*, 2009) as well as overlap between finance concepts and finance topics in the literature. For example, many concepts identified by Gup (1994) are listed as topics by Cooley and Heck (1996) despite the fact that the latter does make the distinction between concepts and topics.

Interestingly, Gup argues that there is little agreement between executives and academics on the top five concepts in finance beyond present value. Although earlier research into the finance curriculum involved academics and executives as participants

later research has involved students. Krishnan *et al.* (1999) asked students to rank finance topics in order of importance whilst Balachandran *et al.* (2006) and Lai *et al.* (2009) asked students to rank finance concepts identified by Cooley and Heck (1996) in order of importance.

Notwithstanding, the different aims, scope and participants of previous finance curriculum research, there is a significant overlap between the findings. The finance topics and concepts identified in this previous research are summarised as follows:

- capital budgeting (techniques), internal rate of return;
- capital structure;
- capital asset pricing model;
- financial statement analysis, cashflow and financial statements;
- financial institutions and markets, capital markets, investment banking, investments;
- risk and return;
- time value of money, present value, present/future value annuity/single amount;
- valuation, valuation theory, security valuation, valuing stocks/bonds, capital asset pricing model; and
- working capital (management), accounting.

An emphasis on the use of quantitative methods (Finance Learning Standards Working Party Australian Business Deans Council, 2014) has meant that finance has traditionally been considered to involve a significant amount of mathematics (and statistics as a type of mathematics) and indeed the financial services sector has been a major employer of mathematics graduates (Bourner *et al.*, 2009). The role of mathematical modelling in financial services and the importance of understanding mathematical modelling in the context of the use of information systems (which tend to hide mathematical models) is discussed in the work of Bakker and Kent and their colleagues (Bakker *et al.*, 2006; Kent *et al.*, 2007). However, Philippon and Reshef (2012) find that the extent to which finance roles involve mathematics varies, where greater regulation is associated with less mathematics in finance roles and vice versa. Further, behavioural finance, which acknowledges decision biases and non-rational behaviour, considers finance from a different perspective (Frankfurter 2006; Shiller 2006; Statman 2008), with less emphasis on quantitative methods (Coleman 2013).

Previous research specifically on threshold concepts in finance is restricted to the work of Diamond and Smith (2011) in relation to quantitative finance (Diamond, 2014) and business statistics (Diamond, 2011). Diamond and Smith's work on quantitative finance focuses on approaches to teaching threshold concepts, with five concepts suggested as examples: incomplete markets, Ito's lemma, change of measure, risk neutrality, and cointegration analysis. In Diamond (2011), threshold concept theory is used as a framework to understand the nature of the content of the business statistics curriculum to explain surface vs deep learning. Diamond identifies eight examples of business statistics threshold concepts and maps these concepts using the three category framework developed by Davies and Mangan (2007). Whilst this research informs the current research to a certain extent, it is limited in scope to particular specialised sub-sections of the finance curriculum. The current research goes beyond Diamond's research to investigate threshold concepts in finance more broadly.

Given the limited amount of research specifically on threshold concepts in finance and the interdisciplinary nature of finance, with finance still commonly referred to as a sub-field of economics closely related to accounting (Finance Learning Standards Working Party Australian Business Deans Council, 2014) the literature on threshold concepts in economics is relevant to this study. Threshold concept theory was originally developed in relation to economics (Meyer and Land, 2003, 2005, for example) and Davies and Mangan (2005, 2007, 2008) propose a comprehensive range of examples of economics threshold concepts. Davies and Mangan (2007) also propose a three category framework that can be used to understand the threshold concepts in terms of the type of conceptual change they bring about, that is, basic, discipline or procedural. According to Davies and Mangan, basic conceptual change involves replacing common sense, everyday understandings with discipline-specific ways of thinking; discipline conceptual change involves understanding and integrating concepts so that a discipline-specific perspective is developed; and procedural conceptual change is the ability to construct narratives and arguments in a discipline.

In summary, research into the finance curriculum is limited and partial and even more so in relation to threshold concepts in finance. There is literature on the role of mathematics and quantitative methods in finance, with much of the previous research on threshold concepts in finance focused on quantitative methods and business statistics. Given the close relationship between finance and economics, finance threshold concepts are likely to bring about similar types of conceptual change (i.e. basic, discipline and procedural) as identified by Davies and Mangan (2007) in relation to economics threshold concepts.

Methodology

The research was conducted in three stages as follows:

- (1) initial identification of finance threshold concepts by finance academics within the institution;
- (2) verification of finance threshold concepts (identified in first stage) by finance academics beyond the institution and internationally; and
- (3) investigation of the extent to which students are aware of finance threshold concepts.

The three stages involved a range of methods; a combination of focus groups, interviews and questionnaires involving academics and students. Following Cousin's (2009) identification of the benefits of getting discipline specialists together to identify threshold concepts, focus groups were chosen as the most effective way to investigate staff and student perceptions of threshold concepts in finance. Questionnaires enabled the collection of data suitable for more quantitative analysis from finance academics beyond the institution and internationally and also from a greater number of students.

Stage 1

An initial focus group was held with finance academics from within the institution and was attended by nine academics. A brief introduction to threshold concepts was given at the start of the focus group (Cousin, 2009) and the discussion was recorded and transcribed. The transcription was analysed linguistically using bottom-up and top-down approaches. The former involved identifying the nominal groups that represented proposals for threshold concepts in finance, e.g. "short-selling", "market

efficiency". The latter involved using content (ie change of topic) and structural indicators (e.g. "well", "so") to identify distinct sections in the discussion (Halliday and Hasan, 1976; Matthiessen, 2004). The purpose of this was to gain an understanding of the (semantic) content of the entire discussion (Halliday and Matthiessen, 1999).

In addition to the staff focus groups, individual interviews were conducted with three key staff using a semi-structured format (Cousin, 2009). A brief introduction to threshold concepts was given at the start of each interview using a visual stimulus (Cousin, 2009) and the interviewees were asked to consider the threshold concept framework and to make proposals for threshold concepts in finance. Two of the interviews were recorded, transcribed and, as per the staff focus group, the proposals for threshold concepts identified. For the other interview, the interviewee provided a written summary of essential finance concepts.

The proposals for finance threshold concepts arising from the focus group and interviews were reviewed by the researchers individually and then as a group, to remove duplication and categorise them according to the framework developed by Davies and Mangan (2007), that is, basic, discipline and procedural. In addition, the proposals were categorised as finance concepts (e.g. "risk versus return") or statistics concepts (e.g. "expected value").

Stage 2

An extended questionnaire was developed (Hoadley *et al.*, 2015b) and administered online to finance academics at multiple universities in Australia, Canada, New Zealand, South Africa and the UK. In total, 44 responses were received. The questionnaire was used to verify whether the proposals for threshold concepts in finance identified in the first stage are threshold concepts and to investigate the applicability of the transformative, integrative, irreversible and troublesome characteristics of threshold concepts. An introduction to threshold concepts, explaining the four characteristics and using *opportunity cost* as an example from economics was included in the questionnaire. The respondents were asked to nominate five threshold concepts themselves before seeing the proposals from stage 1. The questionnaire was also used to investigate the general applicability of threshold concept theory to curriculum design and learning and teaching in finance.

The questionnaire consisted of mainly closed (including Likert scale) and short answer questions, the responses to which were analysed using quantitative techniques. The main open question was an optional question concerning the usefulness of threshold concept theory, particularly, the 4 characteristics (transformative, integrative, irreversible, troublesome), to learning and teaching in finance. Responses to this question were analysed by identifying the key themes, and also whether the response was positive, negative or neutral overall.

Stage 3

A short questionnaire seeking students' views as to the most important concepts in finance was administered to students at all levels (i.e. first, second, third and fourth year) of the two finance programmes (Hoadley *et al.*, 2015a). This questionnaire was deliberately brief to encourage participation and so the threshold concept framework was not introduced or referred to. The key data collected by this questionnaire was student nominations for the three most important concepts in finance. Around 750 nominations for important concepts in finance were received. The nominations were

categorised by the research team in relation to the findings of the research with finance academics, namely proposed threshold concepts, type of knowledge (Wood *et al.*, 2012) and the role of modelling in finance. The categorisation was initially conducted by one member of the research team and then confirmed by two other members independently. Subsequent meetings were held between the three researchers to discuss and resolve instances where there was initial disagreement. Quantitative techniques were used to summarise and interpret the results of the categorisation process.

Results and discussion

The first sub-section of this section synthesises and discusses the results of all three stage of the study in relation to the identification of threshold concepts in finance by academics and the extent to which students perceive the threshold concepts as important. The second and third sub-sections draw on the results to discuss the use of threshold concepts as a theoretical framework and as a research methodology, respectively.

Threshold concepts in finance

The results of all three stages of the study in relation to threshold concepts in finance are collated in Table I. The first section of Table I shows the ten original proposals for threshold concepts by academics from a single institution (stage 1) that were clearly endorsed by academics from a number of institutions in different countries (stage 2). The second section shows the 12 concepts that were not clearly endorsed. And the third section of the table shows an additional seven concepts arising from the second stage of the study that have yet to be tested with finance academics. The concepts have been categorised as basic, discipline and procedural using the framework developed by Davies and Mangan (2007) and the distinction has been made between finance and statistics concepts, allowing the role of mathematics and statistics in finance to be more precisely described. The figures to the right of the concepts indicate the extent to which the concepts were evident in the 750 student nominations for important concepts in finance (stage 3). Column E shows the explicit student nominations of each concept (for example, “risk”) and column R is the number of student nominations that were related to a threshold concept (for example, “contingent payments” categorised as relating to the threshold concept “risk”). These figures indicate the extent to which student understandings of what is important in finance overlap with the threshold concepts identified by academics.

For finance educators the ten clearly endorsed threshold concepts (Table I) provide an important starting point for curriculum design around essential conceptual finance knowledge. In addition, finance educators can also consider the 12 concepts not clearly endorsed – particularly the basic concepts, which are possibly overlooked by finance academics due to their own experience and expertise, and the seven untested concepts – particularly valuation (value) and return, which are strongly evident in the student data, and to a lesser extent, derivatives.

The student data (shown in columns E and R brackets in Table I) indicate that the extent to which students are explicitly aware of finance threshold concepts is inadequate, with only 18 per cent of the 750 student nominations for important concepts in finance being threshold concepts but 60 per cent of the student nominations being related to threshold concepts. (The remaining 22 per cent of the student responses were either generic skills or too general/unclear to classify.) Both the extent to which students are explicitly aware of threshold concepts and the extent to which the student nominations are related to threshold concepts can inform curriculum design

Type of conceptual change (Davies and Mangan, 2007)	Finance	E	R	Statistics	E	R
<i>Clearly endorsed</i>						
Basic	Information asymmetry	–	3	Expected value	–	–
	Risk vs return	18	50			
Discipline	Arbitrage	7	9			
	Diversification	2	23			
	Hedging	9	5			
	Market efficiency	5	–			
	Opportunity cost	2	1			
	Risk	21	33			
	Time value of money	21	31			
<i>Not clearly endorsed</i>						
Basic	Leverage/gearing	3	24	Probability/randomness	–	1
	Markets and market structure(s)	4	96	Time series	1	4
	Pricing	–	14			
	Trade offs	–	–			
Discipline	Cashflows	2	11	Central limit theorem and normal distribution	–	–
	Utility/risk preference	–	–	Correlation	–	–
				Statistical significance and hypothesis testing	–	1
Procedural	Modelling ^a	6	13			
<i>Yet to be tested with academics</i>						
Basic	Liquidity	–	–			
	Valuation (value)	19	54			
Discipline	Behavioural finance ^b	2	1			
	Derivatives	7	18			
	Principal-agent problem	–	–			
	Marginal costs	–	–			
	Return	9	59			
Total		135	445		1	6

Notes: E, explicit student nominations; R, related student nomination. ^abuilding, critiquing, implementing, discipline-specific models, e.g. pricing models, valuation; ^bmore than one concept

Table I. Threshold concepts in finance

and the way the concept is taught. Where the research indicates students are not aware of a threshold concept or are only aware of content related to a threshold concept, there is potential to put more emphasis on the concept and teach it more explicitly and in different ways to develop student awareness and understanding.

Importantly, statistics concepts, with the exception of expected value, are not clearly endorsed as threshold concepts by academics and are not evident in the student nominations. Modelling plays an integral role in finance in defining concepts and as the procedural knowledge (Wood *et al.*, 2012) to construct discipline-specific narratives and arguments (Davies and Mangan, 2007). Despite this, and despite being implied in other concepts such as the time value of money, pricing and valuation, modelling is also not clearly endorsed by academics or students as a threshold concept in finance. This indicates that the role of statistics and modelling in finance needs to be made much more explicit. Some participants in the stage 1 focus groups (reported in Hoadley *et al.*, 2015c) argued that such concepts should be taught in ways that are not dependent on

advanced mathematics skills such as via Microsoft Excel™ and programming languages, as shown to be effective by Kyng *et al.* (2011). However, this view was not universal with other participants arguing in favour of a more mathematically based approach.

The limited reference to behavioural finance in the threshold concepts identified is not surprising given Coleman's (2013) argument that the neoclassical approach has been the basis of finance teaching. However, it may indicate that the concepts identified are based on what has been taught rather than what should be taught. And indeed, there is very little in Table I that is entirely new or unrelated to the finance topics and concepts identified in research in the 1980s and 1990s listed in the literature review. Notwithstanding this, this study identifies the threshold concepts that underpin theories and approaches rather than the theories and approaches themselves, and as such there is scope to refresh the finance curriculum by considering and teaching the threshold concepts from a behavioural perspective (Shiller, 2006). For example, the neoclassical view of market efficiency is that markets are efficient (the price of a stock is equal to its fundamental value) and cannot be beaten, but the behavioural finance view is that markets are not efficient – although they may be difficult to beat, notwithstanding that the assumption of efficiency is a useful heuristic to focus the analysis of pricing on other factors (Statman, 2008).

The majority of the threshold concepts identified in this study are focused on discipline content knowledge. Some research has taken a broader view and identified more general or generic learning thresholds, for example, subjectivity, uncertainty, contextualised meaning in accounting (Lucas and Mladenovic, 2006) and thinking like a mathematician or critically in engineering (Galligan *et al.*, 2010; Worsley, 2011). Although more general and generic thresholds did arise in this research (mathematics and other more generic skills identified in the original focus group with academics and the student data), because they were not the focus of this study, they were not further explored as thresholds in finance.

The inclusion of more generic skills and more qualitative behavioural finance perspectives in the finance curriculum/learning and teaching finance is essential to prepare students for roles as finance practitioners. The failure of higher education programmes to adequately prepare students for professional roles, particularly in relation to generic skills, is a common complaint of industry (Freeman *et al.*, 2008). The importance of more generic skills, as opposed to discipline-specific knowledge, is reflected in graduate learning standards such as the Academic Learning Standards for Finance in the Australian Higher Education Context (Finance Learning Standards Working Party Australian Business Deans Council, 2014) which list application, judgement, communication, teamwork and reflection alongside knowledge. Furthermore, finance practitioners criticise the neoclassical finance theory which is the focus of finance programmes as being of limited use in practice because the data required are not available, it does not work and it ignores more valuable qualitative data that is available (Coleman, 2013). Baillie *et al.* emphasise the importance of linking threshold concepts with threshold capabilities to equip students with the capabilities required to act effectively in professional roles, as demonstrated in the work of Male *et al.* (2015) in relation to engineering students and critical thinking skills.

Threshold concepts as a theoretical framework

This research both supports and informs threshold concepts as a theoretical framework to inform learning and teaching (in finance) and the transformative,

integrative, irreversible and troublesome characteristics of threshold concepts. Motivated by the relative newness of threshold concepts and the limited research into threshold concepts in finance, in stage 2 of the study the views of finance academics as to the potential of threshold concept theory to inform learning and teaching in finance were sought. Most finance academics surveyed rated the potential of threshold concepts to inform curriculum design and learning and teaching in finance highly, even if they as academics had no or limited exposure to the threshold concepts framework prior to the survey (Hoadley *et al.*, 2015b). Thus, the research provides evidence in support of the appeal (Barradell, 2013) and acceptance of threshold concepts.

The transformative, integrative, irreversible and troublesome characteristics were used in stage 2 to analyse and verify the proposed threshold concepts from stage 1. At the same time, this approach has a reciprocal effect, in that it provides evidence as to the extent to which each of the four characteristics is associated with a concept being a threshold concept. The characteristic most strongly associated with a concept being a threshold concept in finance is the integrative characteristic, followed by the transformative and irreversible characteristics (Hoadley *et al.*, 2015b). This finding in relation to the integrative characteristic is particularly relevant for relatively new disciplines that have evolved from other disciplines, such as finance, where the discipline boundaries might be unclear. This is because, according to Davies and Mangan (2007), integration is associated with the definition of the boundaries of a discipline, such that the higher the integration, the clearer the discipline boundaries are. Thus, threshold concept theory through the integrative characteristic provides a way to define and delineate a discipline. Overall, this research supports Davies and Mangan (2007) in that the transformative, integrative and irreversible characteristics are the “primary” characteristics of threshold concepts.

Interestingly, the troublesome characteristic seems to have no clear relationship with a concept being a threshold concept in finance and perceptions of the troublesome characteristic are somewhat varied in the quantitative data (Hoadley *et al.*, 2015b). There appear to be three concerns with the troublesome characteristic. First, a concept may be troublesome but not necessarily a threshold concept (Barradell, 2013) as per the statistics concepts in this research. Second, the “troublesomeness” may be due to other factors (Quinlan *et al.*, 2013), as one of the participants in this research wrote:

It is hard to judge the difficulty of a concept when it is being lectured as students may either find the concept difficult or the lecturer's explanations insufficient.

Third, the “troublesomeness” may not be due to the difficulty of the concept, but rather due to the significant (conceptual and ontological) change brought about in the student (Land *et al.*, 2014). Thus, academics, having gone through and reconciled themselves to this change, may have lost sight of troublesomeness. Similarly, academics tended not to endorse basic concepts as threshold concepts in this study, despite the fact that it is these concepts that are most likely to be transformative for students. This is perhaps because, having gone through the ontological shift, academics lose sight of the significance of such basic concepts and possibly even the concept itself.

Finally, by focusing on the conceptual knowledge that underpins mastery in a discipline, as discussed above specifically in relation to finance, threshold concept theory perhaps focuses on what is most static and constant in a discipline at the expense of innovation and the future needs of the discipline. Thus overall, whilst this study provides evidence in support of threshold concept theory and its use in curriculum design and learning and teaching, its focus on essential conceptual

discipline knowledge and the subjectivity involved in the perception of the characteristics are factors which need to be taken into account when using threshold concept theory to investigate and inform curricula.

Threshold concepts as research methodology

Following Cousin's (2009) description of threshold concept research, the study was originally conceived as primarily qualitative, with data collected in focus groups and semi-structured interviews with finance academics and students. However, this approach does not take into account the fact that although qualitative research is well established and accepted in education, some disciplines, of which finance is one, place more emphasis on quantitative research. As the study progressed, the need to take into account the preferred research approach in finance, in part led to the adoption of more quantitative methods to validate the results of the qualitative research. This shift in approach was compounded by difficulties in getting sufficient discursive data from finance students. Thus, the collaboration between discipline specialists, educational researchers and students that is a feature of threshold concepts research (Cousin, 2009) may require the research methodology to be adapted and extended for the discipline. However, these adjustments and outcomes can inform and develop threshold concepts research methodology, as well as adding rigour to the theory by testing it in new ways.

Threshold concepts research is described by Cousin (2009) as a form of transactional curriculum inquiry, and hence the focus is on the concepts that academics identify as fundamental to the discipline, how students perceive these concepts and what curriculum design interventions are required to teach the concepts. However, this approach does not involve reference to industry practitioners, which is a significant omission for a vocational degree such as finance. Some finance industry practitioners are critical of the predominately neoclassical finance theory taught at universities (Coleman, 2013), and their involvement in threshold concept research would be a way to investigate and address the disjunction between what academics teach and the needs of the industry. This study therefore supports the argument of Barradell (2013) that transactional curriculum inquiry needs to be extended to include the professional community.

Threshold concepts methodology emphasises the role of discipline specialists in exploring the threshold concepts that are fundamental to a grasp of their own discipline (Cousin, 2009). However, when the discipline being researched involves enabling disciplines, such as mathematics in finance, the research should also involve academics from the enabling discipline. This would ensure that the contribution the enabling discipline makes to the threshold conceptual knowledge of the discipline being researched is more explicitly and comprehensively investigated. Whilst this study has explored and added clarity to the role of mathematics, and statistics as a types of mathematics, in finance and the extent to which mathematics concepts are threshold concepts in finance, it has only done so from the point of view of finance educators and would have benefited from the expertise of mathematics educators, particularly in relation to defining and developing mathematics skills in other disciplines. Furthermore, being involved in threshold concepts research would provide academics from enabling disciplines with additional insights into the perspectives of academics and students in relation to developing skills in the enabling discipline.

Conclusion

Finance is a relatively new discipline and highly interdisciplinary, involving economics, accounting and, traditionally, mathematics and statistics (Finance

Learning Standards Working Party Australian Business Deans Council, 2014). It might be anticipated that the discipline boundaries of finance are rather unclear, which is partly why the bounded characteristic of threshold concept theory is not explored in this research. However, an unexpected finding of the research is the extent to which finance threshold concepts are associated with the integrative characteristic, which, according to Davies and Mangan (2007), indicates clear discipline boundaries. Finance has coalesced into an agreed and integrated set of concepts. Further research into the integration of finance threshold concepts, for example, using concepts maps as discussed in Quinlan *et al.* (2013), offers a way to define, describe and distinguish finance as a discipline.

The study indicates that there is scope for threshold concepts to be made much more explicit to students in the design and delivery of the finance curriculum. Given that students were asked about important rather than threshold concepts in finance, the extent to which students experience the concepts identified here as threshold concepts could be further investigated, using the threshold concepts framework explicitly with more discursive data. As well as testing specific concepts, such research would provide a different perspective on characteristics associated with threshold concepts, particularly the troublesome and transformative characteristics which may be understated by academics. The difficulties in conducting research with students experienced in this study indicates that further research with students might be best undertaken as action research (Cousin, 2009) embedded in pedagogical practices, for example, threshold concepts expressed and made apparent to students in “pedagogical content knowledge” (PCK) as suggested by Shinnars-Kennedy and Fincher (2013). Since pedagogical practices are learning and teaching activities for students, this approach avoids the problem (ethical and practical) of trying to get students to give up their time to participate in research which they may perceive as having little direct benefit to themselves.

The research also provides quantitative evidence that threshold concept theory is a valid theoretical framework, particularly the transformative, integrative and irreversible characteristics, perceived by finance academics as being helpful to learning and teaching in finance. The study does not investigate the bounded characteristic, nor discursive, reconstitutive and liminal aspects of the threshold concepts framework which are increasingly discussed in the literature (Barradell, 2013; Flanagan, 2015; Land *et al.*, 2014). Although this study is focused on finance it shows the potential of threshold concepts to define and describe a discipline in terms of its boundaries and the role of key interdisciplinary knowledge, such as mathematics and statistics.

In relation to threshold concepts as a research methodology, the study demonstrates that threshold concepts research itself is interdisciplinary, and that whilst conducting threshold concepts research may require accommodating different research paradigms, this is likely to result in original and novel approaches and outcomes. However, without the involvement of industry the outcomes of threshold concept research may identify what is required to complete educational programmes successfully, rather than what is required to act effectively in professional roles. In addition, in order to achieve the latter, threshold concepts research needs to extend beyond highly discipline-specific threshold concepts, as have been the primary focus of this research, to more general or generic, and perhaps more significant and transformative, learning thresholds, as has been the focus in some threshold concepts research.

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Further reading

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Corresponding author

Susan Hoadley can be contacted at: susanhoadley@mac.com

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