DOI: 10.1002/vms3.174

Original Article

The influences of curriculum area and student background on mindset to learning in the veterinary curriculum: a pilot study

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Abstract

A student's mindset influences their achievement and response to challenge, with a 'fixed mindset' encouraging disengagement from challenging tasks and avoidance of learning and feedback opportunities. These behaviours resemble those reported for professional and non-clinical curriculum areas, which are important for employability and resilience in veterinary practice. Students with a 'growth mindset' to learning are more persistent when faced with challenges and actively seek more demanding tasks. They also demonstrate higher levels of psychological well-being. The objectives of this study were to explore whether variation in veterinary students' mindset to learning exists across different curriculum areas, and to identify whether students' backgrounds influence their learning mindset. The mindsets of veterinary students at a UK veterinary school were measured using an adapted version of the Implicit Theories of Intelligence Scale. The survey was constructed to compare mindset in clinical reasoning, professional reasoning (incorporating ethics and critical thinking), communication skills and reflection. More students demonstrated a growth mindset to communication skills (59%), reflection (84%) and clinical reasoning (83%) than to professional reasoning (34%). There were more students with a fixed mindset to professional reasoning (10%) than in other areas (0–5%). Students' background (international or non-traditional university access) did not appear to influence mindset to learning. Disengagement from professional studies curricula may be a consequence of students lacking a growth mindset in professional reasoning. Curriculum interventions that encourage engagement and the development of a growth mindset to learning non-clinical competences may be beneficial.

Keywords: critical thinking, mindset, professional studies, resilience, student engagement.

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Introduction

Students' mindset, or their beliefs about their capacity to learn, has important consequences for their academic achievement, retention and resilience (Yeager & Dweck 2012; Aditomo 2015). As described by Dweck (2006), students who believe intelligence to be a fixed trait (a function of 'who one is', or possibly one's genetic code) perceive their competence in a particular area to be pre-determined and therefore resistant to effort and engagement. Such students are described as possessing a fixed or entity mindset to intelligence (Dweck 2006). Not only is their academic achievement compromised, but they have also shown to demonstrate poor psychological well-being (Whittington *et al*. 2017). In contrast, other students, who believe intelligence to be malleable, with potential for development resulting from effort and engagement, are described by Dweck as possessing a growth or incremental mindset (Dweck 2006). They demonstrate greater potential for learning and improvement, as when they encounter challenge or failure, they tend to respond by engaging in learning to improve their performance.

Understanding veterinary students' mindset may help to better understand their engagement in learning, particularly in demanding areas of the veterinary

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course. When encountering a challenging academic task, students with a fixed mindset are prone to disengaging; they become frustrated with the task, reject feedback and demonstrate avoidance behaviour (failure to attend classes, disengagement from informal assessment opportunities) (Murphy & Lynda 2008; Sperling *et al*. 2012). This is reinforced by the contextual stressors of higher education, such as preparation for examinations (Dweck 2012). The development of a fixed mindset typically occurs as a consequence of being praised for highly successful outcomes, while the effort and achievement involved in tackling a more demanding task (which is not completed perfectly) are ignored (Dweck 2006). As such students become dependent on such praise they may also become highly strategic, seeking out tasks they know they can do well and avoiding those in which they may be challenged. In this way many high-achieving and 'perfectionist' students, who may be assumed to possess a growth mindset to their development, paradoxically demonstrate a fixed intelligence belief system (Clinkenbeard 2012). There is a potential risk of this occurring in veterinary students, in whom a history of being praised as 'high achievers' (Zenner *et al*. 2005) may make them more vulnerable to disengaging from opportunities in which they may be challenged.

Mindset can be demonstrated to show domain-specific variation, such that a student may believe themselves to have finite capacity for some subjects while accepting their potential for growth and development in others (Atwood 2010). Domain-specific research has particularly focused on those areas associated with high levels of student attrition and those associated with limited diversity in student admissions, such as the STEM subjects (Science, Technology, Engineering and Mathematics) (Fitzakerley *et al*. 2013; Scherr *et al*. 2017; Lisberg *et al*. 2018). These studies suggest that while students may demonstrate learning behaviours associated with a growth mindset in other subjects, their avoidance and attrition from mathematics and science subjects may relate to domain-specific fixed mindset beliefs in these areas.

Within the veterinary and medical sciences, similar rejection of specific curriculum areas has been described, for example in professionalism and business studies education (Leo & Eagen 2008; Birden & Usherwood 2013; Armitage-Chan & Jackson 2018). In these subjects, the skills required for success include entrepreneurial, interpersonal and reflective competences, and hence differ slightly to those utilised for learning and problem-solving clinical subjects (typically assumed to represent clinical reasoning of medical and surgical presentations). Student engagement is a multifaceted construct that can unlikely be explained on the basis of a single contributing element, and disengagement from non-clinical subjects is generally attributed to the hidden curriculum: sociocultural influences that under-prioritise certain curriculum areas, misalignment of taught content with the skills and behaviours observed in clinician role models, and lack of clarity in learning outcomes and assessment criteria (Brainard & Brislen 2007; Leo & Eagen 2008; Kahu 2013). However, given the similarities between the described behaviours of fixed mindset students when faced with a challenging task (missing classes, avoidance of informal assessment opportunities), and those observed institutionally for non-clinical subjects, it is possible that a fixed mindset belief surrounding capacity for learning in these areas also contributes to the reported engagement challenges. If students are identified as possessing a fixed mindset to these non-clinical subject areas, interventions could be designed to encourage the development of a growth mindset, such as positive feedback or awarding of credit for engagement in problem-solving processes (Dweck 2006).

Mindset also has important implications for achievement and retention in non-traditional university students. Cultural diversity in mindset has been reported, with higher levels of fixed mindset encountered in students from disadvantaged backgrounds (Claro & Paunesku 2014). Snipes *et al*. (2012) proposed that this may be reinforced by the lack of role models fostering a reduced sense of belonging in these students; when a challenging task is encountered, a student may attribute their failure to reduced intelligence associated with a perceived lack of belonging on the course (Snipes *et al*. 2012). Failure is therefore seen as a consequence of who the

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student is, rather than being interpreted as an incentive to work harder at the task or subject area. Higher education internationalisation research has included a focus on whether students from particular global areas are hampered in their learning of competences such as collaborative working and critical thinking (Auyeung & Sands 1996; Ip *et al*. 2000). The implications of this research are contested, with observed variation suggested to arise from linguistic limitations when expressing critical thinking in a non-native language (Chalmers & Volet 1997; Carroll & Ryan 2007). However, of particular interest are studies such as that performed by Ip *et al*. (2000), who proposed that students originating from their own geographical area (East Asia) have less educational experience in critical thinking, and consider themselves as less able in this area, compared to those from elsewhere (Ip *et al*. 2000). Despite the contested nature of this research, the work by Ip *et al*. and Auyeung and Sands demonstrates the risk that international students may perceive themselves as less experienced in certain curriculum areas, and may develop fixed mindset behaviours as a result.

Recent work in veterinary education highlights the importance of non-clinical competences such as critical thinking, communication and teamwork for employability and resilience (Armitage-Chan & May 2018a,b; Bell *et al*. 2018). It is therefore vital that curricula and teaching methods are structured to encourage success in these areas, that sub-groups of students (such as those from widening access programs and international backgrounds) are not disadvantaged and that efforts are made to encourage a growth mindset to learning in these non-traditional veterinary subjects. The aims of this pilot study were to explore whether domain-specific mindset variation is evident among veterinary students, and to evaluate whether students' backgrounds contribute to their self-intelligence belief systems.

Methods

The mindset of students enrolled on the 5-year BVetMed course at the Royal Veterinary College (RVC), United Kingdom (UK), was assessed using an adapted version of the Implicit Theories of Intelligence Scale, developed by Dweck and adapted extensively by others (Dweck *et al*. 1995; Atwood 2010; Bostock *et al*. 2018). In this survey instrument, a number of statements are presented surrounding the malleability or fixed nature of intelligence, and respondents are asked for the extent to which they agree with these, with responses provided using Likert scales (strongly agree, agree, disagree, strongly disagree). Statements are constructed around implicit beliefs of one's ability (for example, 'You have a certain amount of intelligence and you can't really do much to change it') and goal measures, such as a students' attitude when approaching a challenging task ('Trying new things is stressful for me and I avoid it') (Dweck 2006). As described by Atwood (2010), adapted versions substitute competences from the domain of interest where the word 'intelligence' appears in Dweck's original survey instrument.

For the purposes of this research, four domains of interest (Clinical Reasoning, Professional Reasoning, Communication Skills and Reflection) were selected from the RVC veterinary curriculum. The domains were selected firstly to allow comparisons between the analytical thinking required in clinical curriculum subjects ('Clinical reasoning', denoting teaching in medical and surgical subjects) and non-clinical subjects ('Professional reasoning', denoting ethics and professional studies). Next, domains were selected to explore areas where the literature suggested there may be variation as a result of students' cultural background (specifically collaborative working methods and critical thinking). As well as representing a non-clinical competence, Professional Reasoning was therefore also selected as an example of critical thinking, particularly the management of uncertainty that is emphasised institutionally in ethics and professional studies teaching. Within the institution, critical thinking and collaboration were also considered to be present within Communication Skills (taught through collaborative working) and reflection (incorporating critical thinking).

Survey statements were constructed to include both ability beliefs and goal measures, adapted for relevance to the domains of interest from online versions of Dweck's survey (e.g. at http://www.cla

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ssroom20.com/forum/topics/motivating-students-with). Five statements were constructed for each domain, and efforts were made to include a similar spread of question type (ability beliefs and goal measures). To make the individual domain questions as consistent as possible, attempts were made to incorporate enjoyment/interest and perceptions of value/relevance within each domain. However, questions also had to be constructed to reflect the different institutional approaches to curriculum delivery (e.g. feedback provision) in the individual subject areas (ethics, professional studies, communication skills, medical and surgical problem-solving), as well as reflection representing a generic competence rather than a taught subject area. Because of this, variation between the domains was impossible to eliminate entirely. Based on previously published versions of the survey, statements were also constructed to avoid repetition in the wording used (i.e. repetition of statements with single word substitutions to indicate different domains).

As an example of statement construction, within the communication skills domain, ability belief was represented by the statement 'Other people on my course are naturally better communicators and have an advantage in this area' and goal measures were represented by the statement 'The feedback that I receive on my communication skills is helpful'. Within the ethics/professional reasoning domain, ability belief was represented by the statement 'Other people on my course seem to have a more natural affinity for ethics problem-solving' and goal measures by the statement 'I enjoy the lack of a definite correct answer to the problems in the professionalism/ethics teaching'. The complete survey is provided in Appendix S1.

In accordance with earlier reported versions (Dweck 2006), for the purposes of scoring and response analysis, statements were classed as either 'growth mindset' or 'fixed mindset'. Examples of a 'growth mindset' statement included 'If I learn a logical approach to clinical problem-solving I am confident I will be able to reach a diagnosis in my patients' from the clinical reasoning domain, and 'The ability to solve problems with no universally correct answer is important to me' from professional reasoning. A 'fixed mindset' question in the clinical reasoning section was 'I find it unhelpful to receive feedback on the problem-solving process, what is needed is the diagnosis' and in the reflection section 'Reflection is difficult for people who learn like I do'. For 'growth mindset' statements, responses were scored from 3 (strongly agree) to 0 (strongly disagree); 'fixed mindset' statements were scored in reverse (i.e. 0 for 'strongly agree' and 3 for 'strongly disagree'). Scores were totalled for each area, providing a maximum of 15; scores of 10 and above were described as representing a growth mindset and those of 5 and below a fixed mindset, as described in the published model (Atwood 2010). Scores of between 6 and 9 are described as representing students with neither a strong fixed nor a strong growth mindset, and these were not used for data analysis in this study.

The survey, which also included questions to identify student demographic information, was constructed using web-based survey software (SurveyMonkey, San Mateo, CA). It was initially sent to a small group of six students who were asked to confirm whether they encountered any confusion or ambiguity in the survey statements. No further changes were made to the survey, and a link was then sent directly to the institutional email accounts of all eligible students. Consent to contact eligible students was provided by the institution, and students were informed within the email of the intended use and dissemination of the data obtained. They could then individually make the decision to participate on this basis, and they were informed via the survey software that they were under no obligation to answer all questions. Only students from the final 3 years of the course (year groups 3, 4 and 5) were deemed eligible, because students in the first 2 years of the course receive little content on the domains of interest. Demographic questions included year of study, gender, country in which the participant had most recently been educated prior to the veterinary course, country of closest cultural connection, access route to the veterinary medicine course (standard undergraduate entry, graduate entry or widening access programme) and whether the participant had been diagnosed with a specific learning difference

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(such as dyslexia). A small incentive for survey completion was provided (entry into a prize draw for a £10 voucher). The respondents were asked to provide their email address if they wished to enter the prize draw; however, email addresses were removed from the extracted data to ensure anonymity of responses. It was possible to complete the survey without providing an email address, should respondents wish to remain completely anonymous.

Participant responses were exported into spreadsheets for initial review, and then analysed using IBM SPSS Statistics (version 23). The scores for mindset were used to calculate numbers of students demonstrating a fixed and growth mindset in each curriculum area, which were then handled as categorical data. Comparisons between percentages of students with fixed and growth mindsets were performed using Fisher's exact tests and significance was set at $P < 0.05$. The study was approved by the institutional ethics committee, reference number URN 2016 1643-2.

Results

Completed surveys were received from 198 students, representing a response rate of 34%. Gender balance was as predicted by the student population: 78% female, 21% male (1% of respondents selected the option 'I do not self-associate with either gender'; there were no students who indicated they did not want to select a gender option). When examining the cultural background of respondents, the country with which the student felt the closest cultural connection was used (which in nearly all cases was the same as the country in which the respondent had most recently been educated). Response rates according to cultural background are shown in Table 1. There was an approximately equal spread of students from different year groups: 38% of responses were from year 3, 36% from year 4 and 26% from the final year.

The variation in growth and fixed mindset for different curriculum domains is shown in Figure 1. The percentage of students with a growth mindset for professional reasoning (34%) was significantly lower than the percentage with a growth mindset for other curriculum areas (for example compared to 59% who demonstrated a growth mindset for communication skills, $P = 0.005$). The presence of a fixed mindset was also higher for professional reasoning (10% of students) than for other curriculum areas (5% of students in communications skills, 0.5% in clinical reasoning and 0 in reflection); however, these data were not analysed statistically as this would be inappropriate given the low numbers of students represented.

Table 1. Cultural background of respondents

Region of closest cultural connection	Number of respondents (% of total responses)	Total number of students in cohort from each region
UK	163 (82%)	605
North America	22 (11%)	66
Asia (mainly Singapore and Hong Kong)	9 (5%)	19
EU	4 (2%)	21

Because of the greater variation in mindset evident for communications skills and professional reasoning (compared to minimal variation across the population in clinical reasoning and reflection), these were selected for further comparative analysis. The ranges of mindset evident across different cultural backgrounds in these curriculum areas are shown in Table 2. There was no significant effect of cultural background on the percentage of students demonstrating fixed or growth mindset in either communications skills or in professional reasoning.

The influence of other demographic variables was then investigated, the results of which are shown in Table 3. There were no differences in growth and fixed mindset proportions for professional reasoning between students who accessed the veterinary course from different educational backgrounds (traditional undergraduate entry or entry via the widening access course). When mindset to learning communications skills was analysed according to students' access route, there was a trend suggesting those who had entered via the widening access pathway may have an increased tendency towards a fixed mindset ($P = 0.053$). There were no differences in mindset proportions for either communication skills or

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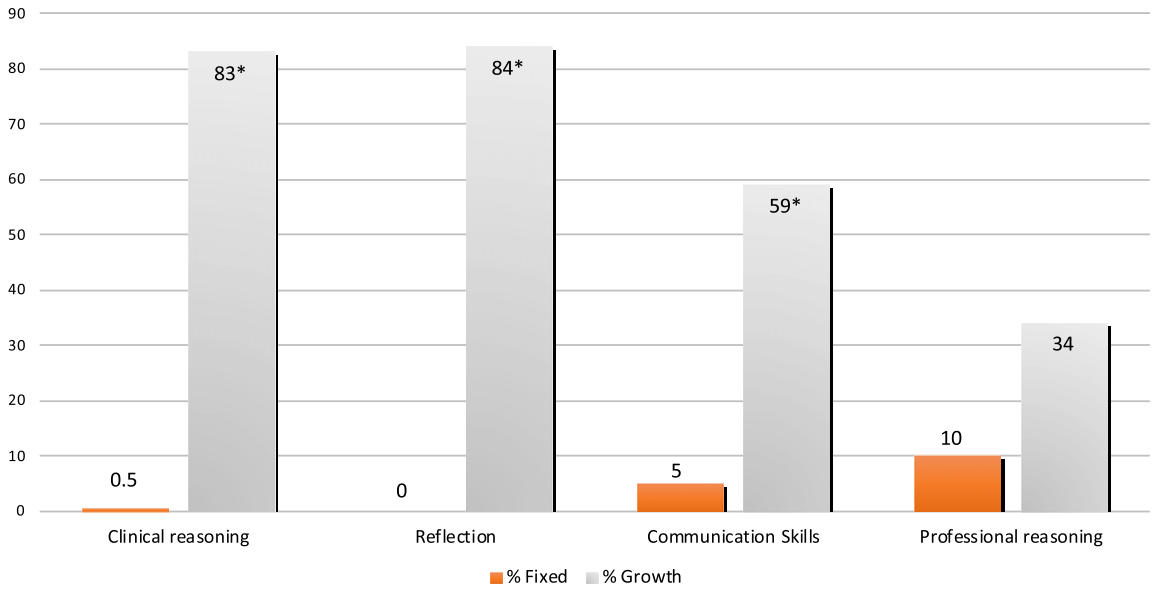

Fig. 1. Percentages of students demonstrating a fixed and growth mindset to learning in different curriculum areas. * = significant difference in growth mindset proportion compared to professional reasoning. Some students demonstrate neither a fixed nor a growth mindset to learning; these students are not represented within this figure.

Table 2. Mindset to learning communication skills and professional reasoning according to cultural background

	Communication skills Growth mindset	Communication skills Fixed mindset	Professional reasoning Growth mindset	Professional reasoning Fixed mindset
UK	58%	5%	9%	9%
North America	27%	0	14%	14%
Asia	44%	11%	11%	22%

Values are expressed as a percentage of the total number of respondents from each cultural region. Students demonstrating scores that represent neither a strong growth nor a strong fixed mindset are not represented. No significant differences were found in the effect of cultural background on mindset classification.

professional reasoning when students with a specific learning difference diagnosis were compared to those without a learning difference diagnosis. There were also no differences in mindset to either of the curriculum areas when responses were analysed by year of study (data not shown).

The potential for the variability in statement wording between the curriculum domains to influence the results was considered a risk of the study. To explore whether these differences in statement styles contributed to the observed differences in mindset across the subject domains, and to ensure that the wording of an individual statement had not singularly contributed to the results obtained, comparisons were repeated with responses from individual statements removed. This had no effect on the findings obtained (specifically, professional reasoning appeared to be persistently associated with lower growth mindset levels compared to the other domains, regardless of the statements used to perform this analysis).

Discussion

There are several findings in this study that have potential implications for veterinary education. The

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Table 3. Mindset to learning communication skills and professional reasoning according to access route to the course and diagnosis of specific learning difference

	Communication skills Growth mindset	Communication skills Fixed mindset	Professional reasoning Growth mindset	Professional reasoning Fixed mindset
Traditional student entry	63%	4%	32%	10%
Widening access (non-traditional higher education student)	53%	16%	47%	11%
Diagnosis of specific learning difference	54%	0	37%	3%
No diagnosis of specific learning difference	60%	5%	30%	12%

Values are expressed as a percentage of the total number of respondents from each category. No significant differences were found in the effect of educational background (student access route) or specific learning difference diagnosis on mindset classification.

higher incidence of a fixed mindset to learning professional reasoning (representing ethics and professional studies) compared to other areas of the curriculum, the apparent lack of difference relating to geographical cultural diversity and the potential for widening access students to demonstrate fixed mindset beliefs relating to communications skills are all of note and will be discussed.

Mindset for learning ethics/professional reasoning

Compared to other curriculum areas, the small number of students who demonstrated a growth mindset to learning professional reasoning (and the suggestion that there may be more students with fixed mindset to learning in this area) was notable. It is perhaps unsurprising that students find this area of the curriculum to be challenging. Based on curriculum content, the survey statements focused on finding solutions to problems with no universally correct answer and those where the student/veterinarian faces uncertainty in predicting whether their chosen action will be successful. The findings suggest that students perceive themselves to be more challenged when managing this uncertainty, and less confident that practicing this skill will help them to gain competence, compared to their perceptions of learning capacity in other areas (communication skills, clinical reasoning and reflection).

This lack of growth mindset for learning has implications for students' engagement with professional reasoning content. Engagement in professional studies education is widely known to represent a challenge (Brainard & Brislen 2007; Leo & Eagen 2008). Individuals with a fixed mindset are more likely to disengage from learning, so they avoid exposing their lack of ability. When faced with substantial learning challenge they fail to show up to class, see feedback as a threat or insult, avoid engaging in feedback opportunities, and tend to blame the content if they perform poorly in assessments (VandeWalle & Cummings 1997; Murphy & Lynda 2008). While it is unclear whether a fixed mindset is the cause or a significant contributor to observed engagement challenges in professional studies subjects, it is possible that encouraging a growth mindset may support better engagement.

It is interesting to compare the findings of students' attitudes to learning professional reasoning with their mindset to learning and achievement in clinical reasoning. In recognition of the complexity and risk of error associated with clinical problem-solving, analytical approaches have been developed that provide a systematic approach, in effect simplifying the complexity of disease presentation and attempting to avoid misleading clinical signs leading to diagnostic error (Maddison 2017). Teaching a systematic approach to clinical reasoning therefore conveys to students that if they work through the framework provided, they will successfully reach a diagnosis in their patients and avoid diagnostic error. Experiential learning opportunities are readily used by students to reinforce their clinical reasoning, for

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example during clinic placements and final year rotations (Matthew *et al*. 2010). The tangibility of clinical reasoning, exemplified through a systematic approach and readily available examples in the workplace, may have facilitated the development of a growth mindset to this domain.

In contrast, evidence suggests that students struggle to contextualise professional reasoning when they observe clinical practice (Matthew *et al*. 2010). A common complaint among medical students about this curriculum area is its lack of relevance to the work of the clinician (Morihara *et al*. 2013). Elements of professional reasoning, including the clinician's approach to resolving professional dilemmas, have also been poorly articulated to students, in part because of clinical faculty themselves receiving little formal education in this area (Stern & Papadakis 2006; Hawick *et al*. 2017). As a result, it appears that compared to the more tangible concepts of clinical reasoning, which emphasise a systematic, learnable process, professional reasoning may appear more elusive to students. Strategies to simplify professional reasoning, particularly at early stages of students' learning, may therefore be beneficial to scaffold students' learning, improve confidence and help them to identify aligned behaviours present in the clinic (Armitage-Chan 2018).

As discussed in the introduction to this paper, student engagement is multifactorial and much of the observed disengagement likely results from hidden curriculum influences such as lack of clinical faculty role modelling professional competences and neglect in university assessments (Cribb & Bignold 1999; Hafferty & Hafler 2011; Hawick *et al*. 2017). It is also possible that the responses obtained in this study simply reflected students' preferences for learning more overtly clinically useful competences, such as clinical reasoning and communication skills. However, on the assumption that a fixed mindset tendency may contribute to this complex issue, a number of curriculum interventions have been implemented to encourage students' engagement and development of a growth mindset in this area. The redesign of the curriculum has been undertaken with an increased understanding that students' attainment of multiperspective critical thinking is a gradual process, with a need for incremental developments in the level of complexity presented (Armitage-Chan & May 2018a,2018b). A systematic framework for professional reasoning is now used, which aims to scaffold students' integration of professional reasoning competences, and provide a more tangible, systematic approach to analysing complex problems (Armitage-Chan 2018). Greater use is also made of experiential learning and reflective assignments, so that students can apply their reasoning in context and receive feedback on this engagement.

Absence of effect of geographical cultural background on mindset to learning

In the light of increasing higher education internationalisation, it is reassuring that geographical cultural background had no effect on mindset to learning in any of the curriculum areas. Prior work suggested that inter-cultural mindset differences observed in critical analysis, deep learning and management of uncertainty, if present, are very small (Joy & Kolb 2009). Taken in the context of the balance of the literature on this subject (Kee & Kuok 2003; Carroll & Ryan 2007), the findings of this study appear to suggest that geographical cultural diversity should be ignored in student groups. However, this may risk neglecting students who are less experienced in critical thinking or collaborative learning. This issue has been explored by several authors, who describe a concept of 'meta-cultural competence' for diverse student populations (Carroll & Ryan 2007). Students should neither be treated as if they are all the same, nor should they be assumed to follow the patterns suggested by their cultural history (Louie 2007). Rather, the collection of knowledge about distinct cultural backgrounds should be applied individually, used to inform an educator's interactions with their student, but without assuming they will conform to stereotype.

The influences of educational history and specific learning difference

The finding that neither educational background nor diagnosis of a specific learning difference appeared

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to influence mindset to learning in the domains explored represents a positive outcome. Although students may feel challenged by having a learning difference or coming from a non-traditional background, the data appear to suggest this does not affect their perceptions surrounding their potential for achievement, at least in the domains examined. The trend towards more students from a widening access (non-traditional) higher education background having a fixed mindset to communications skills was of interest, and because the number of students with a fixed mindset was low, this may be a more significant finding than was suggested by statistical analysis. If there is a potential for some students to perceive themselves as innately less capable in this area, and therefore at risk of disengaging from classes, monitoring students' engagement in communications skills classes would be advisable.

Relationship of growth and fixed mindset scores to those in the wider literature

The findings demonstrated particularly high-growth mindset scores and low-fixed mindset scores across the student population, which is inconsistent with findings from previous studies in similar populations (Whittington *et al*. 2017; Bostock *et al*. 2018). However, it is to be noted that the domain-specific nature of the survey design did not provide a global assessment of students' mindset, and therefore comparison with other studies is of limited value. In general, student populations are described as being more balanced, with approximately 40–50% demonstrating a growth mindset and 40–50% a fixed mindset (Esparza *et al*. 2014; Yan *et al*. 2014). Studies in populations of particular relevance to the veterinary profession are similar to those reported for the general student population, with 51% growth/49% fixed mindset being described in paediatricians (Jegathesan *et al*. 2016) and approximately 43% growth/40% fixed mindset identified in veterinary students (Whittington *et al*. 2017).

The high-growth mindset scores for clinical reasoning and reflection were therefore initially puzzling. In clinical reasoning, much curriculum time in our institution has been devoted to the value of an analytical reasoning process, and a devaluing of memorising the 'correct answer' to a set of clinical signs. At the start of year 3, students are also given instruction in the science of growth and incremental mindset by the course lead in clinical reasoning development. These interventions, and their effect on clinical reasoning mindset, could be explained in two ways. It is possible that they have supported the development of growth mindset in our students in clinical reasoning activities. Alternatively, they may be sufficiently powerful that the students knew the more growth mindset 'right answers' to the statements provided in the survey. Further work is therefore needed to explore whether veterinary students in general demonstrate a particularly strong growth mindset to learning clinical problem-solving, whether this represented a consequence of teaching methods supporting growth mindset development, or whether it was a function of survey wording.

The findings relating to reflection were even more surprising. Explicit attention to reflection is a relatively recent intervention in our programme. At the time of data collection, students (particularly those in the surveyed years 3, 4 and 5) had not encountered high stakes, summative assessments that required reflective competence. In retrospect, the challenges experienced in engaging students in reflection on other courses (for example in postgraduate programs) had already led us to adopt many of the strategies for encouraging a growth mindset towards reflection in veterinary students. For example, when students had been asked to reflect on experiences in the clinic, they had been praised for engagement in the assignments, rather than critiqued for the depth of reflection achieved. Developing a growth mindset in students involves praising their process effort rather than their output (Dweck 2006). The focus of attention on students' engagement in reflective writing, and the fact that the output has not been summatively assessed, may therefore have encouraged students to believe themselves capable in this area, even if (because they have not been set challenging, high stakes reflective tasks) they may be at a level of 'unconscious incompetence'(Cannon *et al*. 2014). It is also possible that the recent discourse in the United Kingdom

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surrounding the importance of reflection to graduate continuing education (e.g. 'Reflecting on CPD', at http://veterinaryrecord.bmj.com/content/vetrec/178/25/618.full.pdf) has had a positive impact, at least on students' perceptions of the importance and relevance of this material to the veterinarian.

Conclusions and limitations

There are some significant limitations to the design of this study that are important to discuss. As described in earlier sections, the survey included inconsistencies between the statements for each domain of interest. While the rationale for this was explained in the methods section, and an attempt was made to analyse whether responses were unduly affected by individual statements, the potential remains for survey construction to have influenced the results. It was therefore not possible, based on the methods described, to identify whether students innately possess a variable mindset to learning across different domains, or whether this finding was a consequence of different approaches to statement construction. It was also possible that the observed differences represented a teaching or learning phenomenon: students' varying interest levels in different areas, or different teaching methods. For example, providing higher quality feedback or more explicit experiential learning opportunities in certain areas may have enhanced students' mindset to learning. The potential role of learning engagement has also been presented in a very simplified way, assuming that a growth mindset will enhance student engagement. As well as neglecting other influences on students' engagement (their interest and perceptions of relevance, the quality of teaching provided), this also over-simplifies the potential cause–effect relationship of mindset and engagement. While a growth mindset may foster engagement, the reverse may also be true: teaching techniques that scaffold engagement may help students to develop a growth mindset as they are guided to being able to learn and develop their competence in a challenging area.

It is therefore important not to over-state the significance of the study findings, particularly in comparisons between domain areas. However, the observed differences between students' responses to professional reasoning statements, and those for statements describing other domains, remain of interest. It is possible that the observed differences arose simply from differences in the statement wording. However, as the wording was modelled on the teaching content and delivery methods in professional reasoning (ethics and professional studies) and clinical reasoning (medical and surgical teaching), the observed differences remain important to address. Mindset evaluation within a particular field of interest typically involves a more extended survey instrument (Bostock *et al*. 2018). Comparisons between clinical and professional reasoning would therefore merit being explored using a lengthier, and more consistent, mindset tool.

Whether the observed differences arose from genuine mindset variation, or were a function of engagement challenges (including students' interest levels) or differences in curriculum expectations (for example, the focus on uncertainty in the professional reasoning survey statements, and in the teaching in this area), the results support the need to facilitate students' engagement in professional reasoning. The findings have therefore helped us to recognise that students need help to engage in the higher level competences of handling complexity and management of uncertainty that are emphasised within our professional studies teaching. We have also been alerted to the potential for some students to disengage from communications skills teaching if they perceive themselves to be inherently less capable in this area; as a result we have instituted monitoring mechanisms so that students in need of assistance do not disengage from the available learning opportunities.

A further limitation lies in the institutional specificity of the survey construct, and hence the reproducibility of the findings. The survey statements for each domain were based on how clinical reasoning, professional reasoning, critical thinking and communication skills are framed and delivered in our institution. For example, if the management of uncertainty is part of an institution's clinical reasoning course, then it is possible that the number of students with a 'growth mindset' in this area may be lower than we have reported, and may more closely

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resemble our professional reasoning results. The findings should therefore be interpreted in the context of the skills and teaching approaches that we have described when defining each of the survey domains (e.g. management of uncertainty and critical thinking representing the Professional Reasoning domain, collaborative learning representing the Communication Skills domain) rather than exclusively as a representation of each subject area.

Conflict of interest

The authors have no conflict of interest to report.

Ethical statement

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to and the appropriate ethics review committee approval has been received.

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Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. Complete survey.

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