Attributes and Generic Competencies Required of Doctors In 21st Century Health-Care Systems: A Participatory Concept Mapping Study

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Abstract

Background: Health professionals' education should ensure graduates are equipped for practice in modern health-care systems. One hundred years after the Flexner Report on medical education, transformation in health-care systems has warranted reflection on priorities for medical education. Practicing effectively in modern health-care systems requires contemporary attributes and competencies, complimenting core clinical competencies. These need to be made overt and opportunities to develop and practice them provided. This study explicates these attributes and generic competencies using Group Concept Mapping methodology, with the aim of informing curriculum development in pre-vocational medical education.

Methods: Group Concept Mapping consists of four phases: 1) Idea generation, review and synthesis; 2) Sorting and rating 3) Analysis of data using quantitative and qualitative techniques to produce a visual concept map; and 4) Confirmation and interpretation of results using logic model transformation. Multiple stakeholders contributed to the development of the conceptual model, including junior doctors who rated competencies according to importance to their practice and preparedness at graduation.

Results: Sixty-seven participants from stakeholder groups generated 338 responses to the prompt: *'An attribute or non-clinical competency required of doctors for effective practice in modern health-care systems is…'* These responses were synthesised into 60 statements which were sorted by participants into groupings according to similarity. Multi-dimensional scaling and hierarchical cluster analysis led to a conceptual map of seven clusters representing: Value-led professionalism; Attributes for self-awareness and reflective practice; Cognitive capability; Active engagement; Communication to build and manage relationships; Patient-centredness and advocacy; and Systems awareness, thinking and contribution. Logic model transformation identified three overarching meta-competencies: Leadership and systems thinking; Learning and cognitive processes; and Interpersonal capability. Ratings indicated that junior doctors believe system-related competencies are less important than other competencies, and they feel less prepared to carry them out.

Conclusion: Group Concept Mapping was used to conceptualise the attributes and generic competencies required for effective practice modern health-care systems. The operationalization of the model through logic model transformation further identifies the links between attributes, their application through competency, and the outputs that they lead to. Rating of items can identify priorities for ensuring a medical education which addresses contemporary health-care needs.

Background

The education of health professionals has an important role to play in ensuring graduates are equipped for practice in modern health-care systems. In 1910 the Flexner Report promoted a university-based scientific model of medical education, leading to an education grounded in foundation scientific knowledge followed by clinical immersion [1]. One hundred years later, the anniversary of the Flexner

Report prompted reflection on current medical education. On one hand Flexner has been lauded for the enormous contribution in bringing medical education into the 20th Century progressive education movement [2], and on the other hand, arguments are made that the Flexner Report led to an individualistic, expert-centric culture which may now work against the collaboration needed in modern health-care [3]. The debate has led to discussion and speculation about what is required of medical education to produce doctors equipped to practice effectively over the next century [4, 5, 6, 7, 8, 9].

Health and health-care have undergone an extraordinary transformation in the past 100 years in ways that Flexner could never have anticipated. Burgeoning knowledge and evidence-base about medical conditions and their management, coupled with a dramatic increase in preventable, non-communicable chronic illness and multi-morbidity, changes in community expectations of health-care, and increasing ethical and professional challenges have created a circumstance whereby the contemporary requirements of doctors continues to be re-evaluated [9].

It is now recognised that young doctors must have capabilities beyond core clinical knowledge and skills and medical education must embrace cultural change to address 21st century health-care needs, including generic capabilities such as working in collaborative teams, transformational leadership, innovation and improvement, and stewardship of funding [3]. In 2010 the global independent Commission on the Education of Health Professionals for the 21st century noted that “Health professionals have made huge contributions to health and socioeconomic development over the past century, but we cannot carry out 21st century health reforms with outdated or inadequate competencies” [9, p. 1954].

While medical education prepares doctors with the knowledge, skills and attitudes to deliver high quality direct care to patients, the attributes and competencies required for newly trained doctors to understand or meet the requirements of delivery of care within a complex system are less explicit [10]. Required competencies for pre-vocational medical education are implicit in statements from regulatory bodies (for example: [11, 12]), and outlined more explicitly in frameworks that largely are driven by post-graduate education bodies (for example: [13, 14, 15, 16, 17, 18]). However, the attributes that are required of doctors to achieve competencies are more obscure and guidance about how to achieve them in medical education is less clear. Enabling their development requires making these competencies overt and guiding the provision of learning opportunities [19, 20, 21]. These transformations necessitate reflection on the pedagogical strategies required to produce doctors for future health-care systems [22, 23, 24].

We aim to contribute to the re-shaping of medical education to suit the needs of current and future health-care systems, by further conceptualising and making explicit competencies which are required for doctors in 21st century health-care systems, with a specific focus on the attributes and competencies which are required to complement fundamental clinical knowledge and skills and enable effective doctoring. Terminologies used to represent these attributes and competencies are varied, including ‘soft-skills,’ [25] ‘non-technical skills’ [26], ‘non-academic attributes’ [27], ‘non-cognitive attributes’ [28], ‘generic skills’ [29] and ‘personal attributes’ [30]. Collectively they can be considered as the scaffolding which enables

doctors to work effectively within modern health-care systems to optimise the delivery of health-care. They are referred to here as attributes and generic competencies, where generic competencies are those which are not specifically clinical, albeit often carried out in a clinical setting.

We used participatory Group Concept-Mapping [31] to conceptualise the attributes and generic competencies required for effective practice in modern health-care systems. Logic model transformation and ratings of importance to practice and preparedness, sought from junior doctors, further develop the conceptualisation in the context of medical education.

Methods

Overview

Group Concept Mapping (GCM) provides a structured approach for consensus building, using quantitative and qualitative methods, allowing for the integration of input from multiple sources into a visual representation of a conceptual framework, and is described in detail by Kane and Trochim [31]. GCM leads to a visual representation of composite thinking of participants and stakeholder groups with the ability to engage in and represent complexity. An online platform supports the collection, management and analysis of data [32]. Stakeholders are engaged to generate ideas, sort the ideas into groups, and rate ideas according to value. The statistical techniques of multi-dimensional scaling and hierarchical cluster analysis aggregate data to reveal patterns through visualisation, allowing for interpretation to support further utility of the model. GCM is a structured applied social research methodology, to connect theory to observation and research to practice, has been widely used in the health-care sector for policy and planning for health services [33, 34, 35, 36, 37] and increasingly in the medical education sector to understand educational processes and outcomes [38, 39, 40].

The GCM process consisted of four key phases: 1) Idea generation, review and synthesis [31]; 2) Sorting and rating facilitated by the online platform [32]; 3) Analysis of data using quantitative and qualitative techniques to produce a visual concept map; 4) Confirmation and further interpretation of results using logic model transformation [41]. This study was approved by the Human Research Ethics Committee of Tasmania (reference number H0015769).

Participants

Participants were identified using a purposive sampling strategy which aimed to ensure representation from the following stakeholder groups: patients and carers, clinicians from a variety of disciplines, health-care managers, educators and professional association representatives. Potential participants were invited to participate in one or more stages of the project. Junior doctors were recruited for the rating component. Approaches were made both directly by researchers, and through third parties who distributed the invitation via email. This study was conducted between October 2017 and October 2019 with participants across five of eight Australian states and territories.

Generating ideas

Participants were invited via email to contribute responses using an online platform [32]. They were asked to complete the focus statement “An attribute or non-clinical competency required of doctors for effective practice in modern health-care systems is . . . ” as many times as they liked. Participants were provided with the following definitions:

- Attribute: A quality or feature regarded as a characteristic or inherent part of someone or something and does not depend on acquired knowledge; and
- Non-Clinical Competency: Transferable, generic professional skills which are not rooted in the medical profession. They may be carried out in a clinical or non-clinical environment by health-care workers but are not uniquely clinical in nature (e.g. communication related skills).

Statements were iteratively reviewed, refined and synthesised with duplicates and irrelevant ideas removed, and similar ideas combined. Guidelines for this review process included determining whether statements needed to be split into more than one idea, elimination of repeated ideas, elimination of statements which were not relevant to the focus statements (e.g. health-care specific clinical skills), and clarification of content if required to ensure ideas were concise and understandable [31]. We determined data saturation through iterative synthesis and comparison of ideas as they were generated onto the online platform. Once we were satisfied that the point of saturation had been reached a research advisory group convened for the project which composed of five clinicians from the disciplines of nursing, medicine and psychology, and one consumer, reviewed the statement list and provided feedback with regards to relevance of the statements to the research, clarity of statements, and completeness of the statement list to confirm saturation. A final set of statements detailing attributes and non-clinical competencies was generated.

Sorting of statements

Participants were invited to sort the statements into groups in a way that made sense to them [31, p.72], and provide a relevant name for each group. This activity occurred online using the Concept Systems Global Max^{tm} platform [32]. We set a minimum target of 30 sorters with representation from all stakeholder groups, which is in line with the recommended number (20-30) to provide reliable results while acknowledging that larger number of sorters yields higher inter-rater reliability estimates [42].

Data analysis for cluster map

A cluster map was built and labels determined using the online Concept Systems Global Max analysis program [31, 32] which integrates qualitative and quantitative methods [43, 44], in addition to a qualitative sense-making process.

A similarity matrix was created to identify how often statements were sorted together. Through the process of multidimensional scaling [45], this similarity matrix was then used to create a two-dimensional

‘point map’ of each statement to visually represent the sorting data, with statements sorted together more often placed closer on the map. A stress value statistic was generated as an indicator of how well the point map represented raw sorting data [42].

Hierarchical agglomerative cluster analysis using Ward’s algorithm [46] was used to group statements into clusters. A bridging value was identified for each statement, indicating whether it was anchoring - sorted primarily with others close by, or bridging – sorted with others across a larger area of the map. The option of imposing a filter on the analysis which would require statements to be sorted together more than one time was explored but did not significantly change the outcome and therefore was not utilised.

Determining the number of clusters relied on qualitative review by researchers [44] using interpretive analysis [47]. Statements in each cluster were examined from maps with five through to 15 clusters, and using expertise in medical education and clinical medicine, the optimal cluster solution was determined [42]. This process was undertaken by one author (KO) and reviewed and confirmed by other authors and the research advisory group. Examination of statements was then made to determine whether there were any statements placed on a cluster boundary which were deemed to better fit in an adjacent cluster and if so the boundary was changed.

Cluster labels were determined using three sources of information: GCM software provides list of 10 best fit labels provided by participants [48]; the statement bridging values provided information about which statements are the most central to the cluster; and researchers read and synthesised their understanding of the statements in each cluster.

One author (KO) proposed cluster names, the other authors and research advisory group reviewed the decision and made alternative suggestions until agreement was reached. All participants in the GCM process were provided with a provisional set of results and invited to make comment over a 2-week period. A further seven clinicians were interviewed and their feedback on the relevance and utility of the model sought (not reported here). Feedback was considered by the research team for incorporation into the models.

Data analysis for logic model

Subsequently we developed a logic model as a tool to further operationalise the data incorporating inputs, processes and activities, and outputs [49, 50]. Impacts and outcomes are not incorporated in the model as they were not included as part of the initial concept mapping process, rather the logic model focuses on strategies [50]. Each statement was examined to determine whether it related to input, process or activity, or output elements. Statements which incorporated more than one of these categories were split into individual elements and re-worded to ensure that they were understandable. Each element was then grouped according to thematic similarity, starting with elements within the same cluster but incorporating those from other clusters if appropriate. Groupings were then examined for causal linkages between inputs, processes and activities, and outputs, including feedback loops. This process was

performed by one author (KO) and the logic model reviewed by all other authors and the research advisory committee to provide input and ultimately confirm the model.

Ratings

Junior doctors were invited to rate each of the statements generated in the above process using Likert scales according to the following two prompts:

1. Relatively how important is this attribute or competency to your role as a doctor? (1=Relatively less important to 5=Relatively more important)
2. How well prepared were you when you graduated? (1=not prepared; 2=somewhat prepared; 3=reasonably prepared; 4=well prepared; 5=very well prepared)

Data were entered directly onto a web-based platform. Ratings for each statement were averaged, to provide indicative representation of the relative importance and preparedness as reported by respondents for each statement. The nature of the scale and significantly skewed data warrants caution in further analyses, however these averages were used to produce visual tools to enable a 'birds-eye' view of the data. Importance and Preparedness ratings were graphed against each other for all data and for each cluster to produce 'go-zones'. Go-zones also allow for the identification of statements into one of four quadrants using the average of all statements to determine the distinction between high and low (Figure 1).

Figure 1. Go-zone template

Averages were calculated for illustrative purposes for each cluster and clusters ranked according to least-most important, and least-most prepared. A visual 'pattern match' was produced which demonstrates for each cluster, relative importance and preparedness, allowing the easy identification of clusters which are perceived as more or less important, and how this relates to perception of preparedness.

Results

Participants

There were 67 participants, 43 (62.7%) female, from across the stakeholder groups contributing to brainstorming (51) and to structuring the statements through sorting (37), they nominated up to two roles in health-care (Table 1). Most participants were from the Australian state of Tasmania, with 10 participants from four other states across Australia. Thirty-seven hospital doctors responded to the rating component of the project. Of those who provided their sex (n = 35), 21 (60.0%) were female, 13 (37.1%) were male, and 1 (2.9%) identified as other. 24 (64.9%) were in the first three years post-graduation and 13 (35.1%) had been graduated > 3 years. Due to third party recruitment it is unknown how many people received an invitation to participate.

Table 1
Participant roles in health-care (combined nominated primary and secondary roles, brainstorming and sorting only)

Role in health-care		Total
Consumers		19
	Patient 18	
	Carer 1	
Medical Practitioners		28
	General Practitioner 12	
	Physician 5	
	Anaesthetist 4	
	Surgeon 3	
	Prevocational doctor 2	
	Psychiatrist 1	
	Paediatrician 1	
Other Clinicians		17
	Nurse 8	
	Allied health practitioner 7	
	Psychologist 1	
	Pharmacist 1	
Academic		31
	Educator 22	
	Researcher 9	
Management and administration		11
	Health-care policy and administration 7	
	Practice management and administration 2	
	Community health organisation 2	
Pastoral carer		2
Peak body representative		2
Health informatician		1

Role in health-care	Total
Coaching and performance specialist	1

The Concept Map

Participants contributed 338 ideas which were iteratively reviewed and synthesised into statements, while at the same time evidence of saturation was sought. A detailed representation of this process is provided (Online Appendix, Item 1). The final statement list consisted of 60 attributes and generic competencies. Sorting data from 36 participants were analysed and statements located in a two-dimensional point map with a stress value of 0.259, which indicates a good fit between the raw sorting data and the two-dimensional configuration [42]. Participant and working group review of the concept model led to minor changes in wording. Interviews were conducted to elaborate on its relevance and utility however are beyond the scope of this report.

Hierarchical cluster analysis and interpretive analysis led to a seven-cluster concept map of attributes and generic competencies of required of doctors for practice in modern health-care systems (Fig. 2). Yellow dots in Fig. 2 represent each statement and their number. Close examination of the statements within each cluster led to four statements being moved from one cluster to an adjacent cluster (Online Appendix, Item 2). A summary of the construct of each cluster is provided (Table 2), however the full list is fundamental to the interpretation and meaning of the overarching map (Online Appendix, Item 3).

Figure 2. Seven Cluster Concept Map of Attributes and Non-Clinical Competencies for Effective Practice in Modern Health-care Systems. Sixty statements are represented by black dots and statement numbers. Statement details available in online appendix.

Table 2
Description of the elements and constructs within each cluster

Cluster 1. Value-led professionalism	**Cluster 1 is underpinned by a professional commitment and work ethic, integrity, empathy, initiative and willingness to make time when needed. Elements relate to effective role-modelling and leadership; and conduct in a manner that is consistent with community expectations.**
Cluster 2. Attributes for self-awareness and reflective practice	Cluster 2 is underpinned by curiosity, self-awareness, insight, resilience and perseverance. The ability to reflect and learn from failures, an awareness of limitations, and ensuring own well-being are also highlighted.
Cluster 3. Cognitive capability	Cluster 3 is underpinned by attributes which lead to cognitive ability, including flexibility, analytical capacity, creativeness and innovation, situational awareness, resourcefulness and self-directed learning. Highlighted is the ability for decisive action, clarity of thought processes, and ability to manage uncertainty and ambiguity.
Cluster 4. Active engagement	Cluster 4 relates to a set of attributes and skills which promote full engagement between doctors and those who they work with – patients and colleagues. It includes the embracing of cultural diversity, responsiveness to the communication needs of patients, engaging in narrative, and ensuring seamless transfer of care through the health system.
Cluster 5. Communication to build and manage relationships	Cluster 5 is underpinned by exemplary communication skills including building rapport, demonstrating respect, active listening, open communication channels, and the effective use of written and modern communication technologies. Highlighted are skills in negotiation and conflict resolution, effective interpersonal dynamics and working relationships, trust, and ability to manage differing agendas.
Cluster 6. Patient-centredness and advocacy	Cluster 6 is underpinned by an approach to care which recognises the context in which patients exist, the importance of their priorities for care, and a willingness to advocate and prioritise activities for the benefit of patients. It is exemplified by an agile and pragmatic approach to the delivery of individualised care, ability to assist patients to navigate the health-care system, maintaining respectful relationships, and a commitment to the notion of co-creation of health
Cluster 7. Systems awareness, thinking and contribution	Cluster 7 is underpinned by an awareness and understanding of systems and the organisational aspects of health-care, an understanding of the doctor's role within the system and the local community, leading collaborative care, commitment to the team, and courage to advocate for systemic change.

Logic Model

The 60 statements represented in the concept map were transformed into 51 input elements, 37 process/activity elements, and 35 output elements. This organisation of the data distinguished between attributes (input elements) and competencies (processes and activities), with the interaction of these leading to desirable outputs. Connections between elements were identified, including feedback loops, to produce a logic model. Through this process it emerged that there were three overarching domains or

meta-competencies to the conceptual model, with significant interaction between the items from each cluster within the domains. These were:

1. *Leadership and systems thinking*: Incorporating Cluster 1: Value led professionalism and leadership, and Cluster 7: Systems awareness, thinking and contribution
2. *Learning and cognitive processes*: Incorporating Cluster 2: Attributes for self-awareness and reflective practice, and Cluster 3. Cognitive capability.
3. *Interpersonal capability*: Incorporating Cluster 4: Active engagement Cluster 5: Communication to build and manage relationships, and Cluster 6: Patient-centredness and advocacy.

Three logic models, one for each domain, were identified, with numbering indicating the cluster and statement number (e.g. 7–22 comes from cluster 7, statement 22). The models demonstrate the integration of clusters into domains or meta-competencies, with statements which spanned across domains are highlighted in italics. The model for Leadership and systems thinking is shown (Fig. 3), the other two are available in the Online Appendix (Item 4).

Figure 3. Logic Model. Leadership and systems thinking

Go-zones For Individual Statements

All but one go-zones had positive correlations of between 0.45 and 0.77, indicating that items that respondents felt were more important, they were generally more prepared for (Online Appendix, Item 6). Cluster 2 however, showed a negative correlation between responses for Importance and Preparedness (Fig. 6), with one notable statement (43. A skill set that ensures own well being and an appropriate work-life balance) which rated highly for importance but lowly for preparedness. This is one of seven statements which rated above the overall average for importance and below the average for preaparedness (Table 3).

Figure 6. Go-zone Cluster 2.

Table 3
Statements which were rated above average for Importance and below average for Preparedness

		Importance	Preparedness
Cluster 2 Statement 13	Self-awareness and understanding of own motivations, responses, biases and emotional triggers. Ensuring that these things don't impact on patient care and that actions are always in the best interest of patients	4.20	3.17
Cluster 2 Statement 39	Resilience - the ability to recover from adversity	4.26	2.88
Cluster 2 Statement 43	A skill set and lifestyle that ensures own well-being and an appropriate work-life balance	4.54	2.49
Cluster 3 Statement 55	Ability for decisive action by assessing relevant information, putting this into perspective of other considerations, weighing up the risk and benefit and acting accordingly	4.32	3.16
Cluster5 Statement 4	Skills in negotiation and conflict resolution, including the ability to challenge in a non-confrontational manner and to view conflict as a source of learning and innovation	4.37	2.87
Cluster 5 Statement 38	Being able to manage differences in agenda between members of the health team, including the patient	4.20	2.73
Cluster 7 Statement 49	49. The ability to work collaboratively with all clinical colleagues, which includes: an understanding of the role of self and others in the health professional team; a disposition to engage allied health professionals in the care of patients and value the care that is provided by allied health; and taking on a coordinating leadership role where appropriate	4.18	2.89

Discussion

Through participatory concept mapping, we have developed a conceptual model of attributes and generic competencies that are required for doctors to contribute effectively in modern health-care systems. Harnessing the views and experience of multiple stakeholder groups, all of whom have regular contact with health-care systems, enabled a shared representation of these requirements into a seven-cluster concept map, represented in 60 statements of attribute and generic competency. Seven key areas were identified: Value-led leadership and professionalism; Attributes for self-awareness and reflective practice; Cognitive capability; Active engagement; Communication to build and manage relationships; Patient-centredness and advocacy; and Systems awareness, thinking and contribution. On examination, the

statements could be transformed into a logic model of inputs (pre-requisite attributes), processes and activities (applied competencies), and outputs that can contribute to an optimal health-care. This empirically derived model represents the integrated views of a range of stakeholders. Unique to this model is the identification of links between these elements, through transformation into a logic model. The explicit demonstration of how attributes and competencies are incorporated into practice through inputs, processes and activities, leading to desirable outputs provides educators with a translational blueprint upon which to map activities and ensure curricula opportunities to develop and demonstrate relevant behaviours. The logic model transformation highlights a clear distinction between attributes, identified as inputs in the logic models, and behaviours, identified as processes and activities.

As highlighted in the introduction, frameworks to guide medical education exist and provide comprehensive appraisal of both clinical and generic requirements. The post-graduate colleges are particularly advanced in framework development. CanMEDS [51] is one of the most cited frameworks and the attributes and generic competencies identified in this research are visible throughout CanMEDS. However, our deliberate strategy to make explicit what is often tacit, by challenging our participants to focus attention solely on attributes and generic competencies, enabled us to detail a rich behavioural conceptualization of these aspects of doctoring. Mapping of the outcomes from this study to the CanMEDS framework showed that the vast majority of competencies in CanMEDS can be identified in the Concept Map, and vice versa, however highlighted that the items in the Concept Map are more behaviourally anchored and attributional, that is, they describe how the competencies in CanMEDS can be achieved through desirable attributes and their application in practice (Online Appendix 2).

Emphasised in this research are behaviors that have been identified by stakeholders who work in or engage with health-care systems, collectively in multiple ways, bringing a practicality to the outcomes of the research. A former president of the Royal Australasian College of Surgeons (Personal communication, J Batten, August 2020) noted on review of the model that “The professional colleges are looking for candidates who are trustworthy, diligent, an ethical team player who has leadership qualities and will model ideal behaviour for younger trainees and staff...someone they would be proud and pleased to work alongside. This model encapsulates and highlights these qualities and it is crucial that [pre-registration] medical education is able to deliver.” Identifying candidates with the desired attributes provides a challenge for specialty program selection, with academic parameters heavily weighted and theoretical and conceptual frameworks for holistic and equitable selection lacking [52].

On examination, it is apparent that the attributes and competencies identified are transferable professional skills, required across a range of professional contexts. For example, the pre-requisite attributes (inputs) and activities (processes) which lead to trust, making a difference and contributing to community, ensuring quality, and advocating for change (all outcomes), are desirable attributes across many professions. Achieving rapport, possessing excellent communication skills, and achieving respectful relationships with patients/clients are relevant across the professional landscape, as do the cognitive skills of learning, decisive action, reflection and managing uncertainty. This affirms that we have achieved our objective of highlighting attributes and skills which are not *specific to* the clinical

setting, despite being *important in* the clinical setting. The notion of generic skills in education is not new [53], however differentiating generic skills from disciplinary knowledge can be challenging, and finding a way for different disciplines to interpret the skills in their context remains important [54]. In medical education, students need to be provided with opportunities to develop and practice generic skills [29], and explicating them can aid this process.

Fraser and Greenhalgh urge that we move beyond educating for competency, to educating for capability – "the ability to adapt to change, generate new knowledge, and continuously improve performance" [55, p. 799]. The product of this research highlights requirements of doctors that will lead to capability; medical educationalists are entrusted to provide opportunities for students to acquire, practice and master. Understanding these enables mapping of curricula and development of innovative pedagogies and opportunities required for capability and to transform the medical workforce to meet current and future health-care needs [55, 56], moving beyond a reductionist approach [57]. The design of educational programs must adapt to ensure that future doctors are equipped for the challenges of modern health-care, exemplified by lens of complexity science on health-care systems [58, 59, 60].

Further work in identifying how to develop and teach these attributes and competencies is needed, however it is apparent that a wide range of opportunities will be required. The need to place greater weight on non-clinical competencies in medical education has been identified [61] as has a need for incorporation of systems sciences [62, 63]. A small sample of newly graduated doctors rated each of the 63 attributes and competencies according to their perceived importance and their preparedness to perform in the way described on graduation. This group identified the cluster of statements relating to 'systems awareness, thinking and contribution' as relatively less important, and for which they were less prepared, compared with all other clusters. The finding is consistent with experiences in two medical schools in the US [64] where systematic introduction of a health-systems curriculum has been challenging on several fronts, one of the most notable challenges being mixed receptivity of students. The authors identified tensions in students' perception of their professional roles, not seeing systems reform as something which is important for them or feeling powerless to contribute [64]. Further, there are seven important items which were rated highly for importance, and lowly for preparedness. Although a small sample, this illustrates how the conceptual model can be used to inform medical education.

We acknowledge that there are limitations to this study. It is relatively small, undertaken in a limited geographic region and its external validity has not been demonstrated. However, mapping of the constructs and domains to existing competency frameworks provides some validation of the content of the model broadly, with this study a distinctive extension of existing frameworks due to the participatory concept mapping methodology it uses, the focus on a limited set of attributes and competencies, and the attitudinal and behavioural constructs that are identified. Ratings were completed by one distinct population with a limited sample, however they demonstrate how this methodology can be used locally to identify priorities in local areas, with the potential to survey other populations. Further work is required to determine how doctors acquire the attributes and competencies, and how they are enacted in clinical

practice to lead to positive outcomes for patients and for the health-care systems. This can then inform the necessary educational opportunities that will lead to their acquisition.

Conclusion

Participatory concept mapping has proven useful to detail the attributes and non-clinical competencies required for effective practice in complex adaptive health-care systems. This can contribute to informing the education of students to operate effectively within modern health-care systems and be prepared for post-graduate training. They model has been operationalised through a logic model transformation and rating of items in the concept map. This allows the links between attributes, their functional application through competency, and the outputs that they lead to, for both patient care and health-care systems to be made clear, and priorities identified.

Abbreviations

GCM
Group concept mapping

Declarations

Ethics approval and consent to participate

This study was approved by the Human Research Ethics Committee of Tasmania reference H0015769. A full participant information form was provided to participants prior to participation. Then, upon registration to the online platform, a consent screen appeared with critical information. Consent was then implied if participants progressed beyond the consent screen and completed the task, according to Section 2.2.5, Chapter 2.2 of the NHMRC National Statement on Ethical Conduct in Human Research 2007 (Updated 2018).

Consent for publication

Not applicable

Availability of data and materials

There are three datasets generated from the study. The similarity matrix (representative of sorting data) and rating data are available as appendices. Data representing statements generated from brainstorming was iteratively edited and is difficult to represent simply. The authors are willing to provide this upon request, given a detailed explanation of the process undertaken is required to make sense of the spreadsheets on which they are stored.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

All authors made substantial contributions to the conception and design of the project. KO was responsible for the acquisition and analysis of data, all authors contributed to the interpretation of the data. KO drafted the manuscript with all authors providing input into the final version.

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Authors' information

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KR is a current practitioner member of the Medical Board of Australia's Notification Standing Committee and Sexual Boundaries notification committee. She is the immediate past lead of the Launceston Clinical School, UTAS and a recently retired Director of the Australian Medical Council.

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Figures

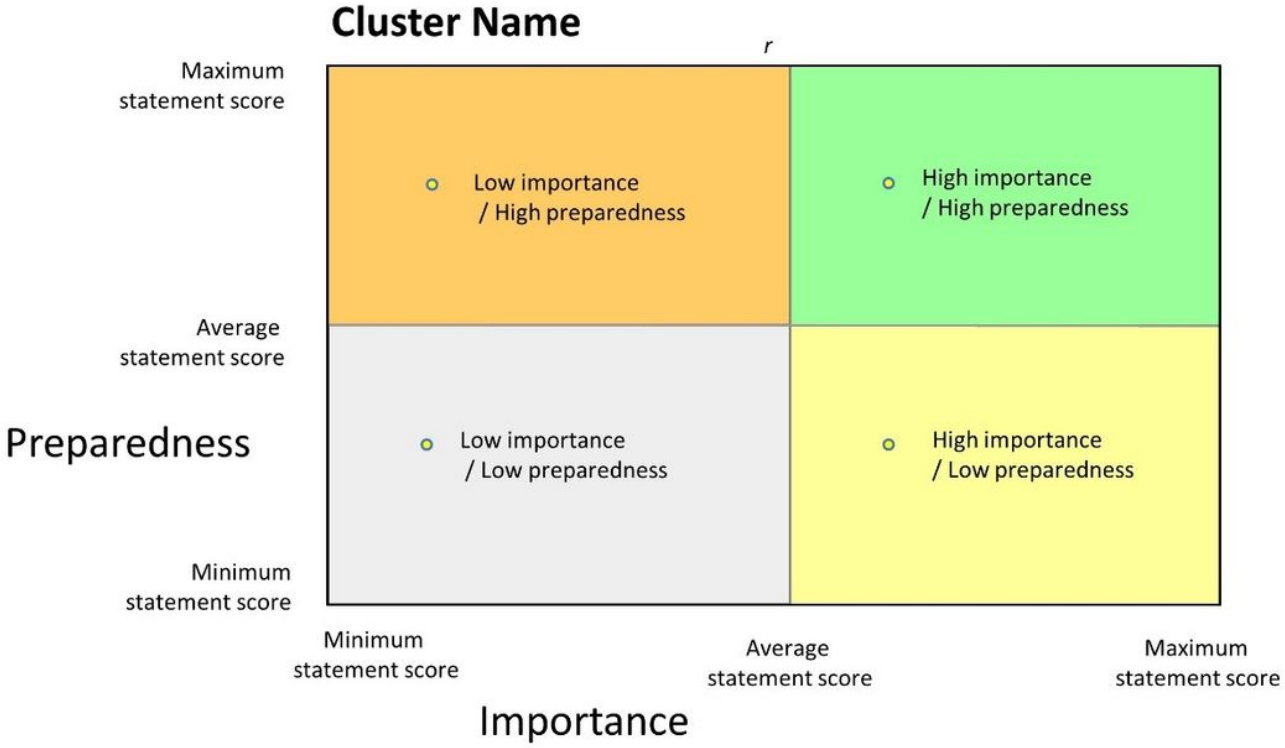

Figure 1

Go-zone template

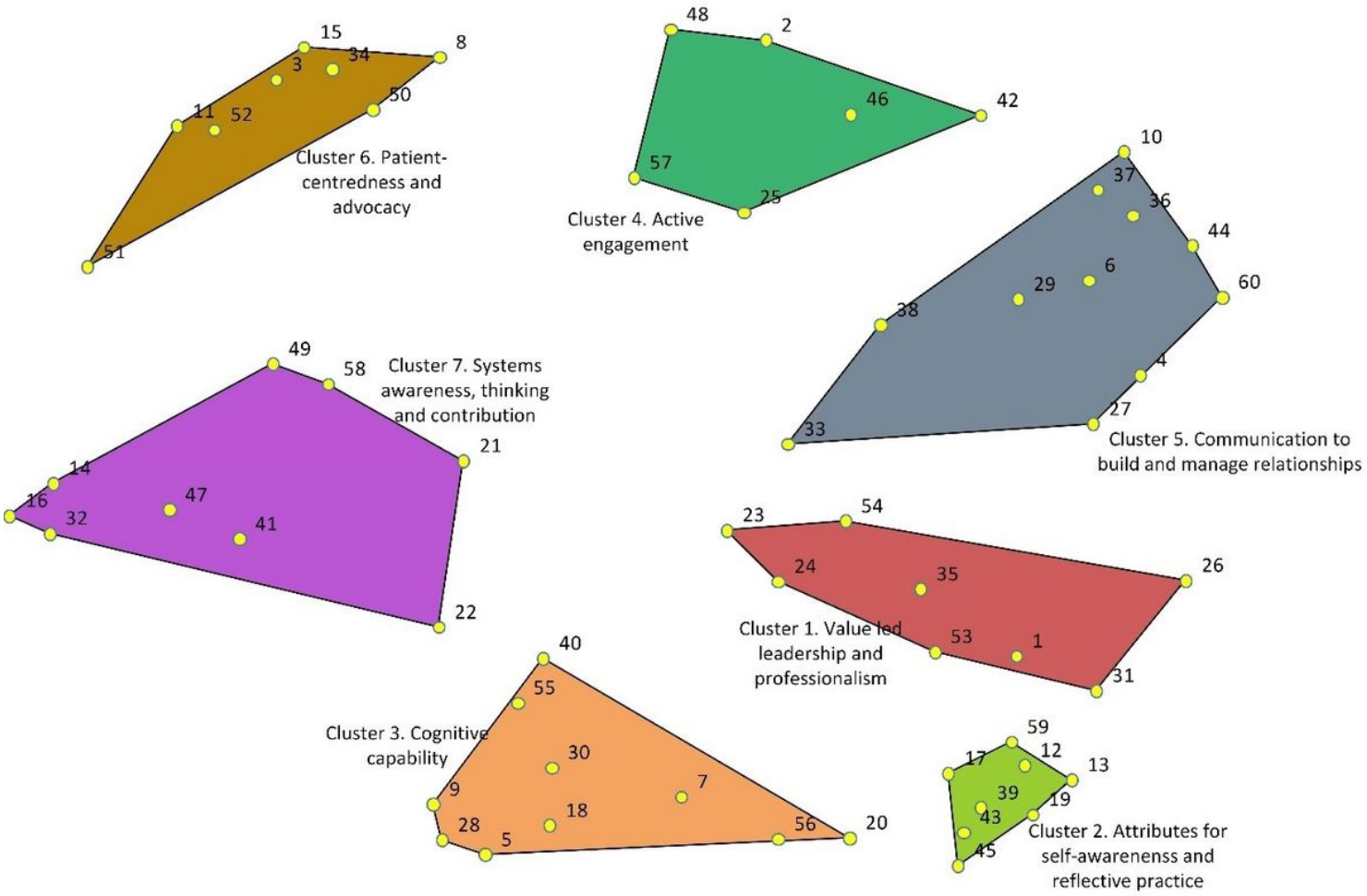

Figure 2

Seven Cluster Concept Map of Attributes and Non-Clinical Competencies for Effective Practice in Modern Health-care Systems. Sixty statements are represented by black dots and statement numbers. Statement details available in online appendix.

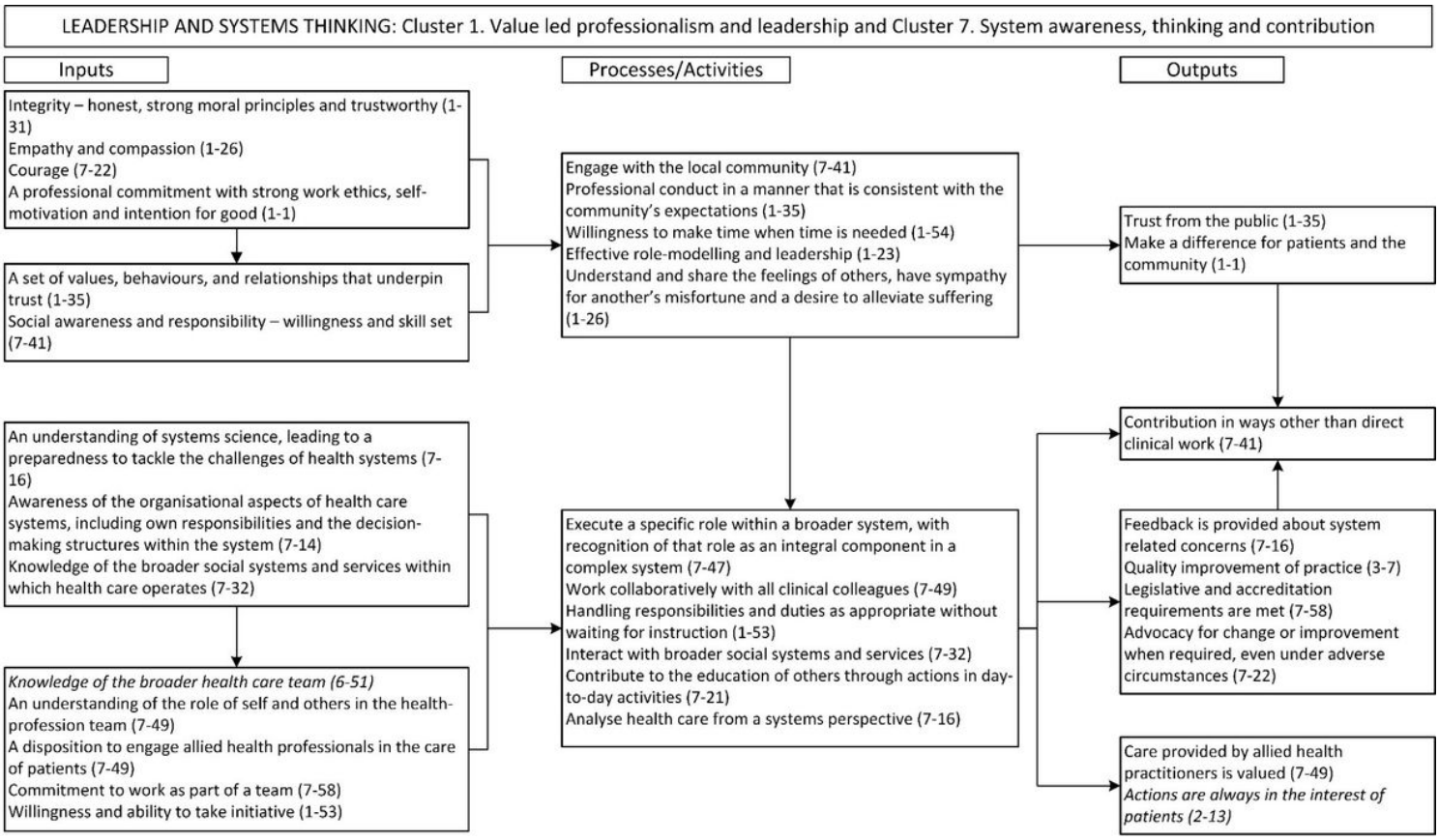

Figure 3

Logic Model. Leadership and systems thinking

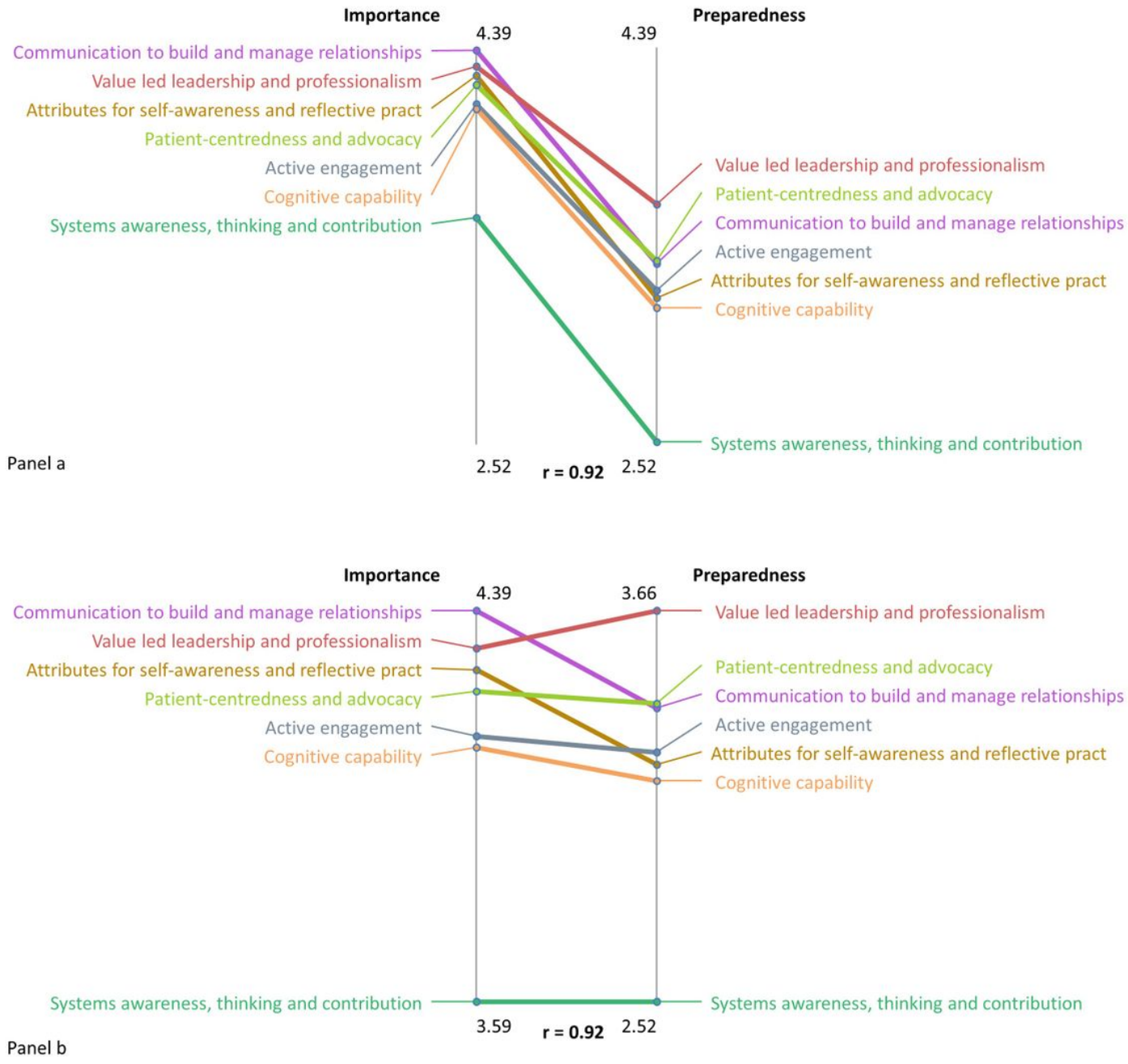

Figure 4

Pattern matches Importance vs Preparedness. Panel a: Unadjusted axes. Panel b: Adjusted axes.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- OnlineAppendix1.pdf
- OnlineAppendix2.MappingtoCanMeds.pdf
- personratings.xlsx
- similaritymatrixdiagonal.xlsx