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Medical students' understandings of academic and medical professionalism: Visual analysis of mind maps

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ABSTRACT

Introduction: Several studies have begun to explore medical students' understandings of professionalism generally and medical professionalism specifically. Despite espoused relationships between academic (AP) and medical professionalism (MP), previous research has not yet investigated students' conceptualisations of AP and MP and the relationships between the two.

Objectives: The current study, based on innovative visual analysis of mind maps, therefore aims to contribute to the developing literature on how professionalism is understood.

Methods: We performed a multi-layered analysis of 98 mind maps from 262 first-year medical students, including analysing textual and graphical elements of AP, MP and the relationships between AP and MP.

Results: The most common textual attributes of AP were learning, lifestyle and personality, while attributes of MP were knowledge, ethics and patient-doctor relations. Images of books, academic caps and teachers were used most often to represent AP, while images of the stethoscope, doctor and red cross were used to symbolise MP. While AP-MP relations were sometimes indicated through co-occuring text, visual connections and higher-order visual metaphors, many students struggled to articulate the relationships between AP and MP.

Conclusions: While the mind maps' textual attributes shared similarities with those found in previous research, suggesting the universality of some professionalism attributes, our study provides new insights into students' conceptualisations of AP, MP and AP-MP relationships. We encourage medical educators to help students develop their understandings of AP, MP and AP-MP relationships, plus consider the feasibility and value of mind maps as a source of visual data for medical education research.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This is the first study to explore pre-clinical medical students' understandings of academic professionalism (AP), medical professionalism (MP) and the relationships between the two
- The use of innovative visual methods helped us to demonstrate more clearly students' perceptions (including potentially hidden perceptions) of the relationships between AP and MP
- We did not engage in dialogue with students about their mind map creations so our interpretations of their mind maps are tentative

INTRODUCTION

While professionalism is one of the core concepts of contemporary medical education worldwide, there is no globally agreed definition, with understandings depending on cultural context [1,2,3]. Although literature is now beginning to accumulate exploring what scholars, medical students and medical practitioners think professionalism and medical professionalism is [e.g.4,5,6,7,8,9], much of this research has employed traditional methods in medical education (e.g. surveys and interviews). Furthermore, despite espoused relationships between academic and medical professionalism (AP; MP), to our knowledge, studies have not yet explored medical students' understandings of AP and MP and the relationships between the two. To address this gap in the literature, the current study explored pre-clinical medical students' understandings of AP and MP and the relationships between the two using innovative visual methods in medical education.

Conceptualisations of professionalism

Numerous papers have considered what professionalism is over recent years, including those using primary [e.g. 4,6,9] and secondary research [e.g. 8,10,11]. Some authors have considered common discourses of professionalism in the literature, suggesting that discourses can be classified by epistemology (positivist-objectivist or subjectivist-constructivist) and scope e.g. individual, interpersonal, collective or complexity [6,8,10], while others have considered professionalism from a particular disciplinary perspective such as sociology, emphasizing the dynamic nature of professionalism and its multiple dimensions, including gender, race and class [11].

Both reviews of the professionalism literature [8] and interviews and surveys with medical students and medical practitioners [e.g. 4,6,9] have identified a wide variety of attributes and dimensions of professionalism with dominant ones within and/or across studies including: individual attributes such as knowledge, competence, technical skills, keeping up-to-date, honesty, integrity,

motivation, and being well-organised; interpersonal relationships with patients such as respect, trust, confidence, compassion, and patient-centredness; interpersonal relationships with colleagues such as team-working; and collective attributes such as recognising the trust society places in the medical profession, following rules and being law-abiding [4,6,8,9].

Students' understandings of professionalism can vary according to their stage of study (pre-clinical versus clinical) and the professionalism curriculum they are exposed to [6]. Specifically, Monrouxe et al. [6] found that clinical students experiencing longitudinal professionalism curricula based on small groups presented more complex and nuanced understandings of professionalism compared with their pre-clinical counterparts, whereas clinical students experiencing suboptimal professionalism curricula (e.g. lectures delivered mostly in the pre-clinical phase) demonstrated less sophisticated accounts of professionalism than pre-clinical students. To properly design and implement professionalism curricula therefore, medical educators not only need to know national and institutional definitions of professionalism [2], but they also need to understand how students conceptualise professionalism during pre-clinical (so AP) and clinical stages (MP) of medical curricula. Indeed, although relationships are believed to exist between AP and MP [12], medical students/practitioners sometimes see these two concepts as unrelated, for example, that academic dishonesty does not necessarily translate to dishonesty within patient-orientated contexts. While we are beginning to understand better medical students' and practitioners' conceptualisations of professionalism and MP, we still do not understand their conceptualisations of AP or MP and the relationships between the two [13,14,15]. Therefore, this study seeks to address this important gap in the professionalism research literature.

Exploring students' understandings of professionalism using innovative visual methods

While publications on professionalism were initially most often authored and consecutively read by medical doctors, social scientists have brought new methodologies to bear on professionalism research [16,17]. While the above studies predominantly employ traditional quantitative (e.g. surveys) or qualitative (e.g. interviews) methods, social scientists nowadays are beginning to emphasise the visual intensity of the modern era, with Jay [18] introducing the term "ocularcentrism" to highlight the central role of visual data in contemporary Western culture. Indeed, semiotic studies devoted to the meaning (signification) of visual signs and relations between the signifiers (any kind of visual expression from a logo to a gesture) and the signified are growing in popularity [19,20]. While previous professionalism research has drawn on visual materials, for example, video recordings of professionalism lapses as a stimulus to collect data from study participants [21], no published research has so far employed concept or mind maps as a data source

for understanding professionalism. Concept and mind maps are graphic, schematic outcomes of learning activity, which aim to organise knowledge and clarify the learnt or investigated problem and have been used as researchers' aids to increase understanding of research processes, as well as to enhance self-reflection and document new ideas [22,23]. While concept and mind maps have become popular learning tools in medical education [e.g. 24,25,26], there are no published papers on the advantages and disadvantages of maps used as data sources for research in medical education.

We decided to employ mind maps as a data collection method in this study rather than more traditional methods (e.g. interviews) because we thought the visual nature of mind maps would provide us with already structured and pre-coded data, as study participants create their own, clear hierarchy of attributes and descriptors, equivalent to the creation of code families during the qualitative interview analysis process. In mind maps, participants also generate visual connections for themselves, indicating perceived relations between particular concepts (e.g. AP and MP), similar to networks only recently implemented in computer assisted qualitative data analysis software (CAQDAS) such as Atlas.ti. Finally, as suggested by Woodhouse [27], visual research methods using drawings can reveal additional information difficult to elicit if using interviews or questionnaires. Indeed, like with metaphoric talk [28,29], we felt that collecting and analysing visual data pertaining to students' understandings of AP and MP and their relations, would help to reveal insights into students' ways of conceptualising AP and MP and AP-MP relations that went beyond what would be collected through talk alone: insights that might even be hidden (unconscious) to student participants themselves.

Aims of the study and research questions

Given the importance of understanding AP and MP, alongside the potential for mind maps as a source of research data exploring relationships, this study explored pre-clinical medical students' understandings of AP and MP and their relationships through a visual analysis of mind maps. This study aims to address the two research questions (see below), along with establishing the feasibility of using mind maps as an innovative source of qualitative research data:

- How do preclinical medical students understand AP and MP?
- What are their perceptions of the relationships between these two concepts?

METHOD

Study design

This study employs visual methodology to explore students' conceptualisations of AP and MP and their relations. A multi-layered process of thematic analysis of both textual and graphical data was

based on an interpretative approach [30].

Context

Polish medical schools offer MD (Doctor of Medicine) and DMD (Dentistry Medicine Doctor) courses to Polish and international students, both in English and Polish, with both degrees being equivalent to Masters level, classified in the European Union as Bologna second cycle. While courses in Polish last for 6 years (MD) and 5 years (DMD) and are aimed at high-school graduates, courses in English last for 6 years for high-school graduates or 4 years for students holding previously obtained pre-medical degrees at Bachelors level (Bologna first cycle). As Polish diplomas are recognised in all EU countries or undergo typical validation procedures in non-EU countries, the student population at the participating University is highly heterogeneous and includes students from Europe, Asia, Australia and the Americas, bringing challenges related to teaching professionalism in the pre-clinical years [31].

Participants

Participants of this study were in the first semester of the 1st year of the Polish and international MD and DMD courses at one Polish Medical University. 151 Polish MD, 45 international 6-year course MD and 21 international DMD students were recent high-school graduates, while 45 international 4-year course MD students were Bachelor-level premedical college graduates (total 262 students). The majority of the sample was female (64%) and white (82%). Students' ages ranged from 18 to 35 (mean=20.24, SD=1.8). The individual demographic data (age, gender, and ethnicity) are not attributed to particular students' mind maps in order to maintain the anonymity of the mind maps.

Both Polish and international post-high school students had no previous clinical experience and had not participated in any explicit courses on AP and MP previously. A minority (n=10) of the international pre-medical college graduates reported previous participation in courses on professionalism and had some clinical experience. All of the students, divided into small groups (of 2 or 3), participated during the first two months of their university education in an introductory short course on learning skills including setting ground rules for team cooperation, a workshop on team-based learning and a workshop on mind mapping, focused on using mind maps to enhance creative thinking, brainstorming and generating new ideas.

Data collection

The student activity was described as follows: "*Prepare a mind map presenting medical and academic professionalism and indicating connections and relations between these two types of*

professionalism. You may prepare either a hand-made or a computer based project". Students were given resources and 3 weeks to fulfil the above task. They were asked to follow the general mind mapping rules and simultaneously to express creativity within the accepted framework. They had been advised that: mind maps, developed by Buzan [32], were non-linear and should contain more pictures than textual labels; the process of mind mapping included creating branches arising from the central concept with the thickest branches to the most peripheral and thinnest, with the final project resembling a tree-like structure; and the most central branches should represent basic, most important ideas, explanations or features (called in this paper 'attributes'), further supplemented with thinner branches (called in this paper 'descriptors'), elaborating and further describing attributes [32]. For the main study exercise, students were allowed to voluntarily form a two- or three-person team, as a pilot study involving 20 students (not reported here) indicated that mind maps prepared by small teams were richer in textual and visual data than projects prepared by individual students. Additionally, the team creation process was accompanied by intensive team member discussions. The team-based exercise design explains the lower number of mind maps (n=98) than participants.

Both the introductory course on learning skills and the mind mapping exercise are typical elements of teaching processes aimed at enhancing students' reflections on AP and MP. Ethical approval for the study was obtained from the bioethical committee of the participating University. Upon ethics committee approval, during the introductory course, students were informed about their task and asked if they wanted to volunteer their anonymous mind maps for the purposes of the current research. All of them received a participant information sheet and were asked to decide at the end of their activity whether to fill in the written consent form and volunteer their mind map, or to not consent to the research and keep their mind map. The drop-out rate was 2 people (amounting to 1 mind map) only.

Data analysis

All mind maps collected were scanned and imported into Atlas.ti (Version 7) software for qualitative analysis. Our analysis could best be described as an inductive framework analysis [33], which also drew on semiotics based on Peirce's typology [19] (see Box 1 and Figures 1-2).

Box 1. Glossary of terms with explanations (see also Figures 1 and 2)

Mind maps being the primary documents for this project were described using the following terms:

1. **Main concepts:** Academic and medical professionalism (**AP** and **MP**)
2. **Attributes:** branches arising from main concepts
3. **Descriptors:** smaller branches arising from attributes. Branches arising from descriptors are called lower-level descriptors.
4. **Connections:** lines and other visual signs joining attributes and/or descriptors and indicating uni- or bi-directional relations
5. **Visual signs:**
    a. **Icons**: signs resembling the signified (represented concepts), e.g. student learning (see Figure 1, sign 5a), heart and brain (see Figure 2, signs 5)
    b. **Indexes**: signs connected to the represented concepts, e.g. balloon representing leisure (see Figure 1, sign 5b)
    c. **Symbols**: signs not resembling visually represented concept e.g. caduceus as a symbol of medical profession (see Figure 1, sign 5c)

Lexical items frequency reflects individual words' occurrences with components of phrases (e.g.*"communication skills"*) assigned to separate sets (*"communication", "skills"*).

Frequency of attributes and descriptors reflects occurrences of phrases (e.g. *"communication skills"*).

Stage 1: We each familiarised ourselves with an initial 10% sample of the mind maps. We identified textual and graphical elements of AP, MP and AP-MP relationships. We not only explored the main concepts of AP and MP and connections between them, but we also examined attributes and descriptors related to AP and MP and the connections between them (see Box 1 for glossary of terms).

[Insert Figure 1 around here]

Stage 2: We came together to discuss our analysis of the mind maps, followed by a comparison and negotiation of suggested themes to develop the coding framework.

[Insert Figure 2 around here]

Stage 3: The first author indexed all data using our coding framework within Atlas.ti (Version 7). Note that the coding framework was further developed by the authors after the first author coded

the first 20 mind maps (the 10% above and a further 10%) with the first 10% being re-analysed to ensure no important codes identified later were missed. The key branches arising from the main concepts were coded as "attributes" of AP and MP and the sub-branches were coded as higher and lower level "descriptors" (see Box 1 and Figures 1 & 2). All visual aspects of mind maps were coded, in particular, visual signs for the central concepts of AP and MP (for example, see the heart and brain in Figure 2), their attributes and descriptors, and connections between attributes and descriptors of AP and MP and AP-MP relationships.

Stage 4: The first author interrogated the coding using Atlas.ti such as identifying the frequency of the different textual and graphical themes. Atlas.ti was also able to create code families representing higher-order themes (e.g. family 'health professionals' for codes 'doctor', 'nurses', and 'physiotherapists'). Note that we do not report all lexical and visual items in this paper because there were such a large number (e.g. 686 different lexical items across the maps), but we instead report those that are most frequent and therefore robust across the mind maps. While the first author also explored some correlations between lexical items using Statistica 12 software, in order to illustrate patterns in our large qualitative dataset, we still maintain a process-orientated qualitative approach [33].

Stage 5: We interpreted our findings by comparing them with themes identified in previous research [e.g. 4,6,8,9].

Team reflexivity

The data analysis process was accompanied by systematic reflection by the researchers on their perspectives and influences caused by previous experiences or beliefs. Such reflexivity was recorded in memos. The valuable diversity of background and experience was brought by the first author being a medical doctor and teacher of international students from Poland and the second author being a social scientist researcher and teacher of postgraduate international students from the UK (at the time of the study). The second author also has long-standing expertise in teaching and researching healthcare professionalism.

RESULTS

Students' understandings of AP and MP: analysing textual elements

In 20 cases, students renamed the main concept of 'academic professionalism' to 'professionalism in education', 'professionalism of learning' or 'educational professionalism'. In two cases, participants

decided to replace the two concepts with one (i.e. "*professionalism*"), although attributes of AP and MP were still clearly distinct in the mind maps. There were 138 different attributes used to describe AP (3-10 per mind map, median=5) and 146 to describe MP (4-11 per mind map, median=5). To explain their understandings of attributes of AP and MP, students also added descriptors (3 descriptors per attribute on average). While the majority of attributes (e.g. *"empathy")* were understandable without any further descriptors, others (e.g. "*personality*") possessed descriptors in order to clarify students' perceptions and valuings of particular attributes. The AP attributes were explained by 474 different descriptors (10-81 per mind map, median=19) and MP attributes by 478 descriptors (13-87 per mind map, median=20.5). See Table 1 for the top 10 attributes and descriptors used for AP and MP in the mind maps. While students sometimes used the same attributes and descriptors commonly for both AP and MP (e.g. "knowledge", "personality", "honesty", "respect" etc.), there were also differences in terms of the common attributes and descriptors flagged for AP (e.g. "learning", "motivation", "confidentiality", "empathy" etc.) compared with MP (e.g. "ethics", "patient-doctor relations", "time management", "responsibility" etc.), indicating differences in students' conceptualisations of the importance of elements within AP and MP.

Table 1. Most common attributes, descriptors and signs applied to AP and MP in the 98 mind maps (top 10)

ATTRIBUTES of AP	Number	ATTRIBUTES of MP	Number
Learning	39	*Knowledge*	28
Lifestyle	22	*Ethics*	26
Personality	21	*Patient-doctor relations*	26
Motivation	20	*Responsibility*	24
Knowledge	19	*Personality*	23
Responsibility	18	*Lifestyle*	21
Team work	15	*Team work*	18
Morality	15	*Communication skills*	16
Organizational skills	15	*Competencies*	13
Respect	14	*Lifelong learning/constant development*	13

DESCRIPTORS of AP	Number	DESCRIPTORS of MP	Number
Honesty	38	*Time management*	42
Confidentiality	38	*Honesty*	38
Learning activities	37	*Respect*	36
Empathy	35	*Responsibility*	32
Altruism	31	*Team work*	28
Helping others	31	*Self-improvement*	27
Respect	31	*Learning activities*	26
Punctuality	30	*Communication skills*	26
Team work	24	*Respect for colleagues*	25
Diligence	22	*Punctuality*	20

Signifiers of AP	Number	Signifiers of MP	Number
Book	25	*Stethoscope*	19
Academic cap	15	*Doctor*	13
Teacher	6	*Red cross*	7
Pen/pencil	5	*Caduceus*	5
Diploma	4	*Syringe*	5
Brain	4	*Book*	4
Apple	2	*Academic cap*	4
Students (learners)	2	*Money*	4
Doctor	1	*Heart (anatomic)*	4
Money	1	*Rod of Asclepius*	4

Students' understandings of AP and MP: analysing graphical elements

The spatial layouts of AP and MP within the mind maps were compared in order to get a sense of students' perceptions of the importance of items relative to one another. In the majority of cases (n=75, 76.5%) the size of the AP and MP areas were similar (see Figure 3 as an example), indicating that students thought the two concepts were equally important. Study participants provided a range of approaches to their mind maps, including three computer-generated ones, multiple cases of 'typical' designs but with varying degrees of complexity and visual richness (see Figures 2-3), and twelve documents coded as "not following the mind mapping rules", with the use of totally different visual approaches (see later). Visual signs other than the typical, basic visual elements of the mind maps (e.g. central shapes and branches) were used to enhance particular textual contents around main concepts (e.g. *brain* and *heart* in Figure 2 or *book* and *red cross* in Figure 3), as elements of branches and connections (e.g. *journey* in Figure 4) and as enhancements of attributes and descriptors. Students almost exclusively used drawings as enhancements of adjacent textual contents (e.g. an image of a student reading next to the attribute or descriptor: "*learning": see Figure 1, image 5a*). All visual elements were classified according to the Peirce typology into icons, indexes and symbols (see Box 1 for a glossary). Most (79.1%) of the signs were classified as icons or indexes, while the remaining 20.9% were classified as symbols. Table 1 presents the visual signs used most often as the AP and MP signifiers. The three most commonly used signifiers of AP (*academic cap, book, diploma*) and MP (*anatomic heart, stethoscope, caduceus*) are presented in Figure 5. While students sometimes used the same signs commonly for both AP and MP (e.g. book, academic cap, doctor and money), there were also differences in terms of the common signs illustrated for AP (e.g. teacher, diploma, pen/pencil, brain etc.) compared with MP (e.g. stethoscope, red cross, caduceus, syringe etc.), indicating students' different conceptualisations of AP and MP.

[Insert Figures 3-6 about here]

Students' understandings of the relationships between AP and MP: analysing textual elements

Relations between maps' elements were indicated by visual connections, using the same or similar attributes and descriptors for both main concepts, and indicated by added textual explanations. We explored correlations between attributes used within the same mind maps (in other words, correlations represent how often attribute X in AP co-occurs with attribute X in MP in one mind map). The strongest correlation values were detected between academic and medical "*honesty"* (r=0.73), *"relations"* (r=0.72), "*social competencies"*(r=0.70), *"lifestyle"* (r=0.67)*, "morality"* (r=0.62), "responsibility"* (r=0.59), "diligence" (0.54), and "self-improvement" (0.52). Those correlations asterisked above were additionally reinforced by visual connections.

Students' understandings of the relationships between AP and MP: analysing graphical elements

As well as exploring correlations, we also analysed how students perceived relations between AP and MP by analysing the connections drawn between attributes, descriptors and other visual signs. The connections were often enhanced with arrowheads indicating the direction of connection (i.e. the influence of one attribute on another: see Figures 2,4). Attributes were also qualified as connected (related) if branches presenting the particular attribute were clearly pointing towards each other and/or were clearly marked with the same colour (see Figure 3). Despite clear instructions asking for identification of relations between the main concepts, 10 of the 98 mind maps presented no visual representation of relations at all. While the asterisked correlated attributes above were also most often visually connected, we found four common visual connections in over 10% of the maps: between AP lifestyle and MP lifestyle (n=14), between AP knowledge and MP knowledge (n=12), between AP responsibility and MP responsibility (n=11), and between AP respect and MP respect (n=11).

The mind map presented in Figure 3 serves as an example of visually and textually well-developed relations between attributes of both main concepts as clouds containing descriptors shared between them. Apart from visual connections between attributes of AP and MP, students also identified multiple visual connections between attributes and descriptors of the same concept (marked with "x" in Figure 3). Such internal connections indicate either strong interrelations of attributes or suggest that the same descriptors apply to diverse attributes. Both branches and connections between attributes and descriptors were often enhanced to take on forms of biological, veiny and neuronal structures or botanical shapes of stalks with leaves and flowers (e.g. MP as a circulatory system with blood vessels and a heart as a central concept: see Figure 5, top right).

Relations and connections were additionally represented by higher order visual metaphors, which often included joining the two main concepts together unidirectionally as in the *journey* from AP to MP (see Figure 4) or as a *state of war* between AP and MP (see Figure 6). Indeed, Figure 4 suggests that the journey from AP to MP is a difficult one, with the early part of the journey (AP) involving rain, treacherous mountains to climb and going backwards, and latter parts of the journey (MP) involving sun, running forwards and flying. Alternatively, Figure 6 depicts a very dynamic battle between a warship fleet (with the largest ship representing the main concept of AP) and a castle representing MP, illustrating students' perceptions of conflict between AP and MP.

DISCUSSION

This innovative study used mind maps designed by preclinical medical students to analyse their understandings of AP and MP and AP-MP relationships. To our knowledge, no previous research has examined students' understandings of AP specifically or AP-MP relations.

Summary of key findings and comparison with existing literature

In terms of our first research question, although some textual attributes and descriptors were commonly used for both AP and MP (e.g. knowledge, personality), differences also existed in terms of frequent attributes and descriptors for AP (e.g. learning, motivation) and MP (e.g. ethics, doctor-patient relations). Moreover, while some visual signs were regularly used for both AP and MP (i.e. book, academic cap), there were also differences between the common visual signs for AP (e.g. teacher, diploma) and MP (e.g. stethoscope, red cross). Taken together, these patterns in textual and visual signs illustrate that students conceptualise AP and MP as only partly similar. The textual attributes and descriptors for AP and MP (both those common to AP and MP and those specific to one or the other) were on the whole consistent with those identified in previous studies [4,6,8,9], indicating the universality of most commonly identified professionalism attributes and descriptors across different regional contexts [4]. While previous research has identified the importance of these textual attributes for professionalism more generally [e.g. 6, 8], they have not differentiated between these attributes along the lines of AP and MP previously, nor have they explored the visual signs associated with AP or MP before. Indeed, our study illustrates how AP and MP are conceptualised differently through text and visual signs, with students seemingly focused on academic-orientated professionalism (e.g. learning and teacher) for AP and patient-orientated professionalism (e.g. doctor-patient relations and stethoscope) for MP.

In terms of our second research question, over 10% of the mind maps did not indicate AP-MP relationships and only two attributes co-occurred with both AP and MP based on strong correlations between text *and* clear visual connections (i.e. lifestyle and responsibility). Therefore, it was clear to us that students struggled to conceptualise AP-MP relationships, as has been found previously with medical students struggling to articulate their understandings of professionalism more generally [6]. Interestingly, higher-order visual metaphors indicated interesting and sometimes unexpected conceptualisations of AP-MP relationships, for example, as a *journey* from AP to MP or as a *war* between AP and MP. While previous research in medical education has illustrated students' conceptualisations of student-assessor relationships as journey and/or war [28,34], or student, clinical teacher and patients' conceptualisations of student/doctor-patient relationships as war [29],

such metaphors have not been found in relation to AP-MP relationships previously.

Feasibility of mind maps as a data source

Our project, being the first of its kind to use mind maps as a source of data in medical education, provided us with experience regarding the feasibility and value of working with conglomerates of text and images as data. Using mind maps as data was not without its challenges. Unlike qualitative data from interviews, where much can be gleaned from how people speak in addition to what they say (e.g. through tone of voice, pace of speech, laughter, etc.), mapping encourages the use of individual words or short phrases and visual symbols instead of typical sentences or paragraphs. While mapping enables other opportunities for analysis of simultaneously created textual and visual data, it does not offer an opportunity to ask students clarification questions, meaning that it was sometimes challenging to tease out the meaning of brief text or illustrations [35]. Indeed, while Woodhouse [27) suggests enhancing visual data with dialogue with drawing creators to provide correct interpretations of images, the lead author did participate in all mind mapping sessions, observing the dynamics of the processes of mapping, which helped to enhance his contextual understanding of the visual material. Furthermore, the qualitative analysis of mind maps was time consuming and currently available software, while helpful, was not yet sufficient to meet the analytical needs of such visually and textually rich documents, especially with regards to the two-dimensional organisation of documents. Moreover, the visual richness of mind maps was probably influenced by the graphical skills of the student illustrators and not only by their understandings of AP, MP and AP-MP relations. Finally, visual connections might have been applied purely to enrich the visual aesthetics of the project. We therefore had to be careful not to over-interpret the visual aspects of the mind maps. For example, AP-MP orientation, coverage and use of colours, may have all been heavily influenced by external factors such as the availability of drawing tools and the team-working environment.

Using mind maps, however, had various strengths. They focused on spontaneous thinking and creativity and explored perceived associations between concepts, so were well-suited to our research questions. Indeed, the visual complexity of many mind maps was advantageous in terms of collecting abundant in-depth and rich data. Unlike traditionally used transcripts of interviews, mind maps provided us with already structured and pre-coded data, as participants constructed their own hierarchies of attributes and descriptors for AP and MP, alongside generating visual connections between AP and MP, thereby emphasising AP-MP relations. Furthermore, visual metaphors (e.g. AP-MP relationships as journey or as war) helped to visibilise students' conceptualisations of AP-MP relationships that traditional methods like interviews might not have revealed [28,29]. Therefore, we

suggest that mind maps could be a valuable source of data for medical education research, and we encourage other researchers to consider employing them for relevant research questions such as those around relationships between concepts. Furthermore, we would encourage researchers to employ mind maps in combination with conversations with mind map illustrators to help further elucidate the meanings behind brief text and illustrations, as has been done with other visual methods such as the pictor technique [36].

Educational implications

This study reveals that preclinical students often perceive AP and MP as two separate constructs characterised by different attributes. This dissociation of two types of professionalism may be caused by multiple factors, including students' previous educational and cultural backgrounds and the traditional, non-integrated curriculum with lecture-based methods of preclinical teaching that students are exposed to at this participating school. We think that educators need to help students understand better AP, MP and the relationships between the two as part of their formal professionalism curriculum, starting in the pre-clinical phase. Furthermore, as part of the informal curriculum, we need to ensure that both medical educators at the pre-clinical (e.g. basic sciences teachers) and clinical levels (e.g. clinical teachers) have an awareness of themselves as professionalism role models for students, and how they might enact both academic and medical professionalism. We think that this paper, and particularly the mind maps contained within it, could act as trigger material for both medical students and educators to discuss the relationship between academic and medical professionalism and consider how they might bridge any perceived gaps between the two.

FIGURES - LEGEND

Figure 1. Schematic explanation of terms used in paper (see glossary in Box 1)

Figure 2. Explanation of terms used in paper applied to one of the primary documents (see glossary in Box 1)

Figure 3. Mind map presenting strong relations between the main concepts
A-Lifestyle, B-Knowledge, C-Personality, D-Motivation, t-linear connection between "academic teachers" and "medical professionalism" as a whole concept, x-internal connections

Figure 4. Visual metaphor indicating a difficult journey from AP to MP

Figure 5. Examples of signifiers of AP and MP

Figure 6. Visual metaphor indicating AP-MP relations as a state of war

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Contributors

JJ and CR together contributed to the design of the study, analyzing and interpreting data, and writing and editing the manuscript. JJ secured ethics approval, collected all data and coded all data using Atlas-ti.

Ethical approval

We received ethics approval from the Human Research Ethics Committee of the Medical University of Lodz, Poland (No. RNN/225/13/KE).

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Declaration of competing interests

We have read and understood the BMJ policy on declaration of interests and declare that we have no competing interests.

Data sharing

We do not have ethics approval to make raw data from this study available for sharing. Additional, unpublished data including the project cohort characteristics, analysis of lexical items, attributes, descriptors, visual signs, visual links between attributes and descriptors are available from the authors.

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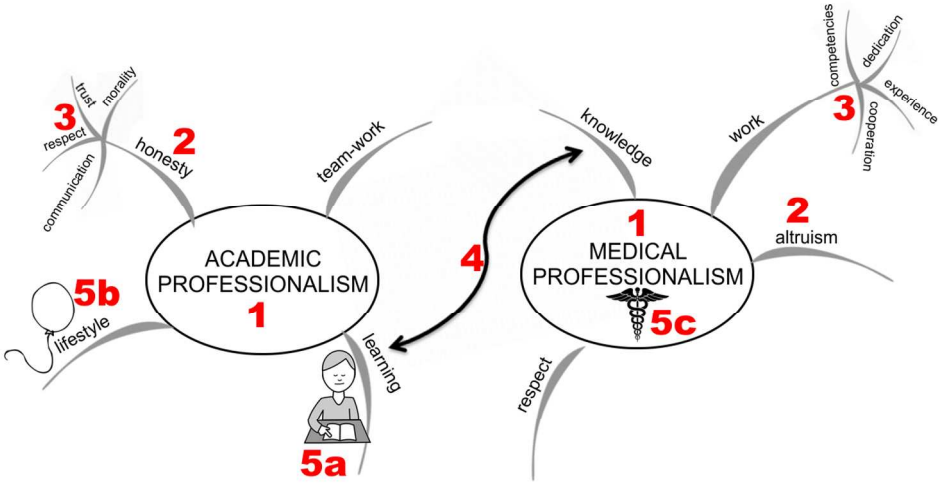

Schematic explanation of terms used in paper (see glossary in Box 1)

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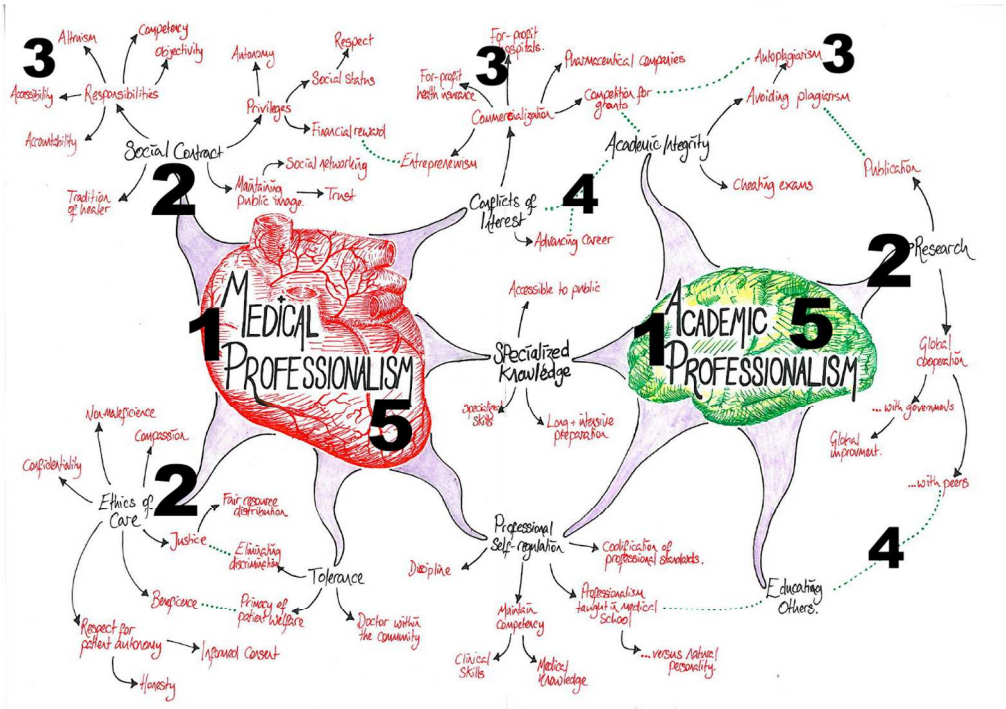

Explanation of terms used in paper applied to one of the primary documents (see glossary in Box 1)

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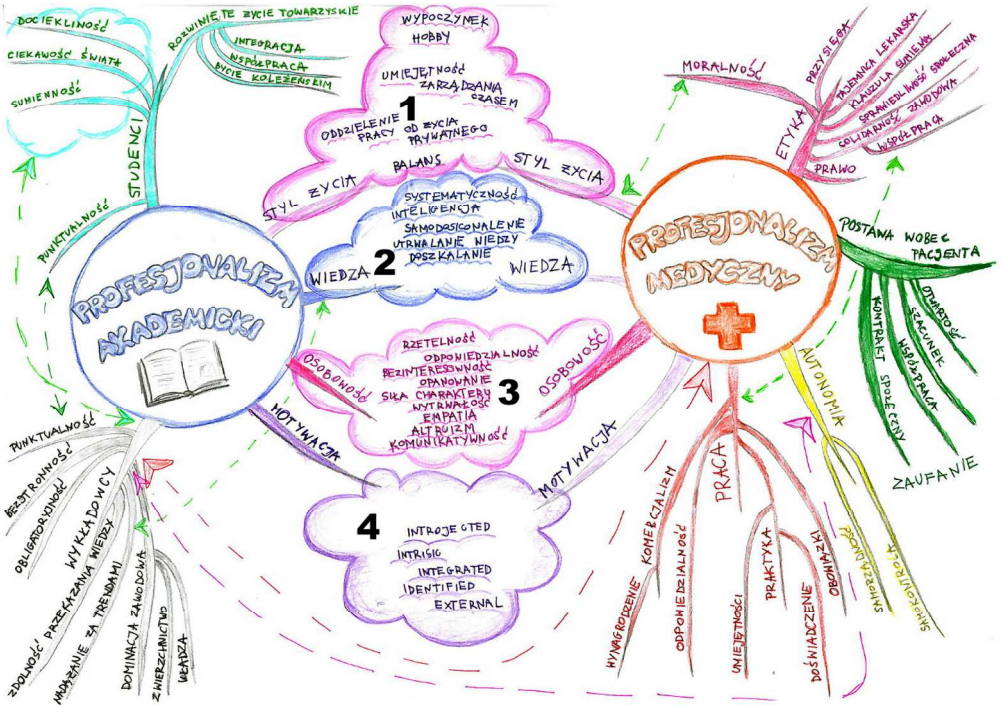
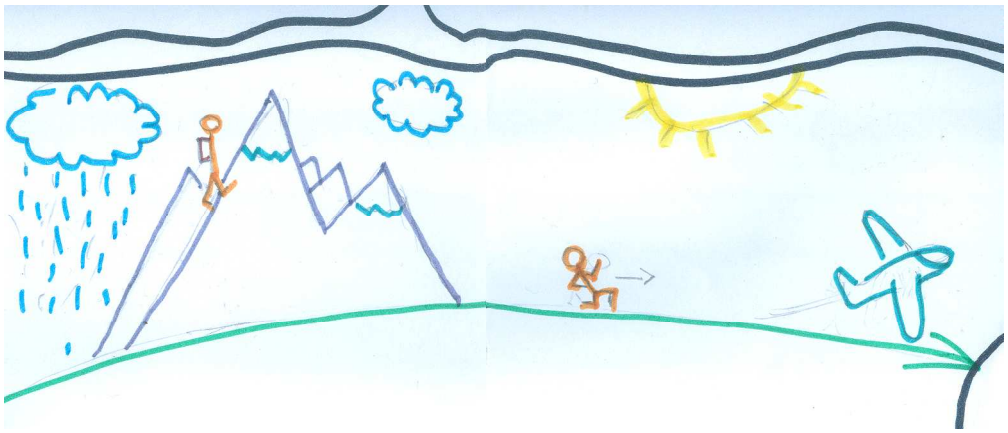


Mind map presenting strong relations between the main concepts
A-Lifestyle, B-Knowledge, C-Personality, D-Motivation, t-linear connection between "academic teachers" and "medical professionalism" as a whole concept, x-internal connections

199x141mm (300 x 300 DPI)



Visual metaphor indicating a difficult journey from AP to MP

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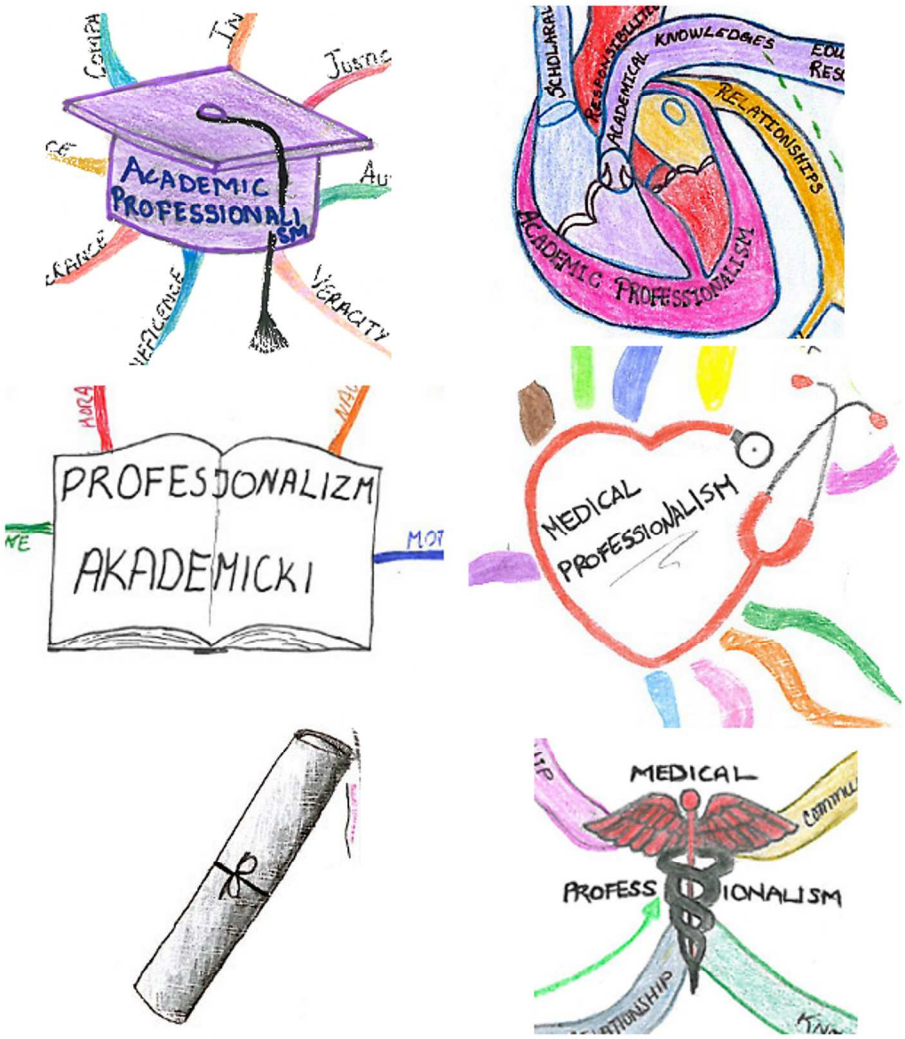
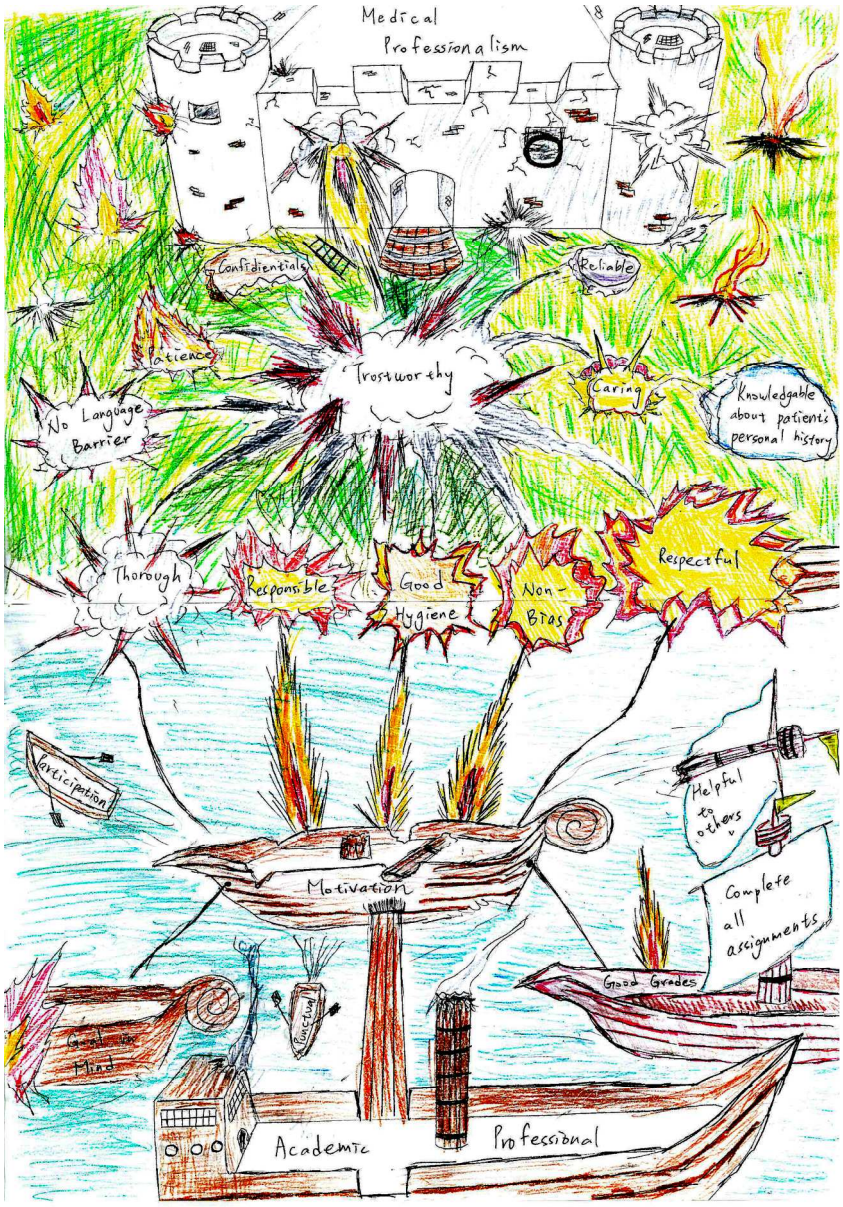


Examples of signifiers of AP and MP

165x217mm (300 x 300 DPI)



Visual metaphor indicating AP-MP relations as a state of war

174x250mm (300 x 300 DPI)

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Pre-clinical medical students' understandings of academic and medical professionalism: Visual analysis of mind maps

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Pre-clinical medical students' understandings of academic and medical professionalism: Visual analysis of mind maps

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Pre-clinical medical students' understandings of academic and medical professionalism: Visual analysis of mind maps

ABSTRACT

Introduction: Several studies have begun to explore medical students' understandings of professionalism generally and medical professionalism specifically. Despite espoused relationships between academic (AP) and medical professionalism (MP), previous research has not yet investigated students' conceptualisations of AP and MP and the relationships between the two.

Objectives: The current study, based on innovative visual analysis of mind maps, therefore aims to contribute to the developing literature on how professionalism is understood.

Methods: We performed a multi-layered analysis of 98 mind maps from 262 first-year medical students, including analysing textual and graphical elements of AP, MP and the relationships between AP and MP.

Results: The most common textual attributes of AP were learning, lifestyle and personality, while attributes of MP were knowledge, ethics and patient-doctor relations. Images of books, academic caps and teachers were used most often to represent AP, while images of the stethoscope, doctor and red cross were used to symbolise MP. While AP-MP relations were sometimes indicated through co-occuring text, visual connections and higher-order visual metaphors, many students struggled to articulate the relationships between AP and MP.

Conclusions: While the mind maps' textual attributes shared similarities with those found in previous research, suggesting the universality of some professionalism attributes, our study provides new insights into students' conceptualisations of AP, MP and AP-MP relationships. We encourage medical educators to help students develop their understandings of AP, MP and AP-MP relationships, plus consider the feasibility and value of mind maps as a source of visual data for medical education research.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This is the first study to explore pre-clinical medical students' understandings of academic professionalism (AP), medical professionalism (MP) and the relationships between the two
- The use of innovative visual methods helped us to demonstrate more clearly students' perceptions (including potentially hidden perceptions) of the relationships between AP and MP
- We did not engage in dialogue with students about their mind map creations so our interpretations of their mind maps are tentative
- Our study was conducted at one medical school, thus limiting the transferability of our findings to other schools

INTRODUCTION

While professionalism is one of the core concepts of contemporary medical education worldwide, there is no globally agreed definition, with understandings depending on cultural context [1,2,3]. Although literature is now beginning to accumulate exploring what scholars, medical students and medical practitioners think professionalism and medical professionalism is [e.g.4,5,6,7,8,9], much of this research has employed traditional methods in medical education (e.g. surveys and interviews). Furthermore, despite espoused relationships between academic and medical professionalism (see Box 1 for understandings of these concepts), to our knowledge, studies have not yet explored medical students' understandings of academic (AP) and medical professionalism (MP) and the relationships between the two. To address this gap in the literature, the current study explored pre-clinical medical students' understandings of AP and MP and the relationships between the two using innovative visual methods in medical education.

Box 1. Understandings of professionalism, academic professionalism (AP) and medical professionalism (MP)

Professionalism	Professionalism has been conceptualised more broadly by Freidson [10] as including interrelated features such as: specialised work underpinned by knowledge and skill; authority around division of labour established and monitored through occupational cooperation; protected position in labour force based on occupational qualifications; formal higher education producing qualifications controlled by occupation; and occupational ideology of doing good work [11].

Medical professionalism	By 'medical professionalism', we are referring to students' professionalism in relation to their future professional role (as doctors to be) and within the medical workplace setting such as in hospitals, primary care, etc. Published definitions of medical professionalism vary but often centre on the behaviours and values of doctors and their relationships with patients underpinned by trust. For example: 'medical professionalism signifies a set of values, behaviours, and relationships that underpins the trust the public has in doctors' [12, p.14]; and 'medical professionalism consists of those behaviours by which we—as physicians—demonstrate that we are worthy of the trust bestowed upon us by our patients and the public, because we are working for the patients' and the public's good' [1, p.614].
Academic professionalism	Academic professionalism has typically related to the professionalism of academics including key characteristics such as educactional expertise, autonomy, generating new knowledge, altruistic concern for students, etc. [13]. However, by using the term 'academic professionalism' in the current study, we are specifically referring to students' professionalism in relation to their student/academic role and within the University setting such as classrooms, virtual learning environments, examinations, etc. Understandings of academic professionalism in this sense have typically centred on the academic integrity of students including issues such as examination/assessment integrity (not cheating in examinations, not plagiarising coursework), attendance and punctuality for classes, appropriate behaviours towards University-based staff, not manipulating research data, contributing appropriately to group work, and so on [14,15].

Conceptualisations of professionalism

Numerous papers have considered what professionalism is over recent years, including those using primary [e.g. 4,6,9] and secondary research [e.g. 8,16,17]. Some authors have considered common discourses of professionalism in the literature, suggesting that discourses can be classified by epistemology (positivist-objectivist or subjectivist-constructivist) and scope e.g. individual, interpersonal, collective or complexity [6,8,16], while others have considered professionalism from a particular disciplinary perspective such as sociology, emphasizing the dynamic nature of professionalism and its multiple dimensions, including gender, race and class [17].

Both reviews of the professionalism literature [8] and interviews and surveys with medical students and medical practitioners [e.g. 4,6,9] have identified a wide variety of attributes and dimensions of professionalism with dominant ones within and/or across studies including: individual attributes such as knowledge, competence, technical skills, keeping up-to-date, honesty, integrity, motivation, and being well-organised; interpersonal relationships with patients such as respect, trust, confidence, compassion, and patient-centredness; interpersonal relationships with colleagues such

as team-working; and collective attributes such as recognising the trust society places in the medical profession, following rules and being law-abiding [4,6,8,9].

Students' understandings of professionalism can vary according to their stage of study (pre-clinical versus clinical) and the professionalism curriculum they are exposed to [6]. Specifically, Monrouxe et al. [6] found that clinical students experiencing longitudinal professionalism curricula based on small groups presented more complex and nuanced understandings of professionalism compared with their pre-clinical counterparts, whereas clinical students experiencing suboptimal professionalism curricula (e.g. lectures delivered mostly in the pre-clinical phase) demonstrated less sophisticated accounts of professionalism than pre-clinical students. To properly design and implement professionalism curricula therefore, medical educators not only need to know national and institutional definitions of professionalism [2], but they also need to understand how students conceptualise professionalism during pre-clinical (so AP) and clinical stages (MP) of medical curricula. Indeed, although relationships are believed to exist between AP and MP [18], medical students/practitioners sometimes see these two concepts as unrelated, for example, that academic dishonesty does not necessarily translate to dishonesty within patient-orientated contexts. While we are beginning to understand better medical students' and practitioners' conceptualisations of professionalism and MP, we still do not understand their conceptualisations of AP or MP and the relationships between the two [19,20,21]. Furthermore, we do not fully understand what *a priori* understandings of professionalism that first year medical students bring with them to medical school and before they are socialised into professionalism codes laid down by regulatory bodies. Therefore, this study seeks to address this important gap in the professionalism research literature.

Exploring students' understandings of professionalism using innovative visual methods

While publications on professionalism were initially most often authored and consecutively read by medical doctors, social scientists have brought new methodologies to bear on professionalism research [22.23]. While the above studies predominantly employ traditional quantitative (e.g. surveys) or qualitative (e.g. interviews) methods, social scientists nowadays are beginning to emphasise the visual intensity of the modern era, with Jay [24] introducing the term "ocularcentrism" to highlight the central role of visual data in contemporary Western culture. Indeed, semiotic studies devoted to the meaning (signification) of visual signs and relations between the signifiers (any kind of visual expression from a logo to a gesture) and the signified are growing in popularity [25,26]. While previous professionalism research has drawn on visual materials, for example, video recordings of professionalism lapses as a stimulus to collect data from study participants [27], no published research has so far employed concept or mind maps as a data source

for understanding professionalism. Concept and mind maps are graphic, schematic outcomes of learning activity, which aim to organise knowledge and clarify the learnt or investigated problem and have been used as researchers' aids to increase understanding of research processes, as well as to enhance self-reflection and document new ideas [28,29]. While concept and mind maps have become popular learning tools in medical education [e.g. 30,31,32], there are no published papers on the advantages and disadvantages of maps used as data sources for research in medical education.

We decided to employ mind maps as a data collection method in this study rather than more traditional methods (e.g. interviews) because we thought the visual nature of mind maps would provide us with already structured and pre-coded data, as study participants create their own, clear hierarchy of attributes and descriptors, equivalent to the creation of code families during the qualitative interview analysis process. In mind maps, participants also generate visual connections for themselves, indicating perceived relations between particular concepts (e.g. AP and MP), similar to networks only recently implemented in computer assisted qualitative data analysis software (CAQDAS) such as Atlas.ti. Finally, as suggested by Woodhouse [33], visual research methods using drawings can reveal additional information difficult to elicit if using interviews or questionnaires. Indeed, like with metaphoric talk [34,35], we felt that collecting and analysing visual data pertaining to students' understandings of AP and MP and their relations, would help to reveal insights into students' ways of conceptualising AP and MP and AP-MP relations that went beyond what would be collected through talk alone: insights that might even be hidden (unconscious) to student participants themselves.

Aims of the study and research questions

Given the importance of understanding AP and MP, alongside the potential for mind maps as a source of research data exploring relationships, this study explored pre-clinical medical students' understandings of AP and MP and their relationships through a visual analysis of mind maps. This study aims to address the two research questions (see below), along with establishing the feasibility of using mind maps as an innovative source of qualitative research data:

- How do pre-clinical medical students understand AP and MP?
- What are their perceptions of the relationships between these two concepts?

METHOD

Study design

This study employs visual methodology to explore students' conceptualisations of AP and MP and their relations. A multi-layered process of thematic analysis of both textual and graphical data was

based on an interpretative approach [36].

Context

Polish medical schools offer MD (Doctor of Medicine) and DMD (Dentistry Medicine Doctor) courses to Polish and international students, both in English and Polish, with both degrees being equivalent to Masters level, classified in the European Union as Bologna second cycle. While courses in Polish last for 6 years (MD) and 5 years (DMD) and are aimed at high-school graduates, courses in English last for 6 years for high-school graduates or 4 years for students holding previously obtained pre-medical degrees at Bachelors level (Bologna first cycle). As Polish diplomas are recognised in all EU countries or undergo typical validation procedures in non-EU countries, the student population at the participating University is highly heterogeneous and includes students from Europe, Asia, Australia and the Americas, bringing challenges related to teaching professionalism in the pre-clinical years [37]. While increasing numbers of medical schools are moving towards a Z-shaped model of vertical integration with better integration between basic and clinical sciences learning across curricula [38], the current school has a relatively traditional basic and clinical sciences divide, with students starting their clinical experiences after the end of the first year of study.

Participants

Participants of this study were in the first semester of the 1st year of the Polish and international MD and DMD courses at one Polish Medical University. 151 Polish MD, 45 international 6-year course MD and 21 international DMD students were recent high-school graduates, while 45 international 4-year course MD students were Bachelor-level premedical college graduates (total 262 students). The majority of the sample was female (64%) and white (82%). Students' ages ranged from 18 to 35 (mean=20.24, SD=1.8). The individual demographic data (age, gender, and ethnicity) are not attributed to particular students' mind maps in order to maintain the anonymity of the mind maps.

Both Polish and international post-high school students had no previous clinical experience and had not participated in any explicit courses on AP and MP previously. Despite being early in their medical education and having no clinical experiences we still expected these students to have some *a priori* understandings of professionalism on which to draw for the current study, in the same way that medical schools with multiple-mini interviews (MMI) and situational judgement tests (SJT) at selection expect prospective medical students to have some understandings of professionalism [39,40]. A minority (n=10) of the international pre-medical college graduates reported previous participation in courses on professionalism and had some clinical experience. All of the students, divided into small groups (of 2 or 3), participated during the first two months of their university

education in an introductory short course on learning skills including setting ground rules for team cooperation, a workshop on team-based learning and a workshop on mind mapping, focused on using mind maps to enhance creative thinking, brainstorming and generating new ideas.

Data collection

The student activity was described as follows: "*Prepare a mind map presenting medical and academic professionalism and indicating connections and relations between these two types of professionalism. You may prepare either a hand-made or a computer based project*". Students were given resources and 3 weeks to fulfil the above task. They were asked to follow the general mind mapping rules and simultaneously to express creativity within the accepted framework. They had been advised that: mind maps, developed by Buzan [41], were non-linear and should contain more pictures than textual labels; the process of mind mapping included creating branches arising from the central concept with the thickest branches to the most peripheral and thinnest, with the final project resembling a tree-like structure; and the most central branches should represent basic, most important ideas, explanations or features (called in this paper 'attributes'), further supplemented with thinner branches (called in this paper 'descriptors'), elaborating and further describing attributes [41]. For the main study exercise, students were allowed to voluntarily form a two- or three-person team, as a pilot study involving 20 students (not reported here) indicated that mind maps prepared by small teams were richer in textual and graphical data than projects prepared by individual students. Additionally, the team creation process was accompanied by intensive team member discussions. The team-based exercise design explains the lower number of mind maps (n=98) than participants.

Both the introductory course on learning skills and the mind mapping exercise are typical elements of teaching processes aimed at enhancing students' reflections on AP and MP. Ethical approval for the study was obtained from the bioethical committee of the participating University. Upon ethics committee approval, during the introductory course, students were informed about their task and asked if they wanted to volunteer their anonymous mind maps for the purposes of the current research. All of them received a participant information sheet and were asked to decide at the end of their activity whether to fill in the written consent form and volunteer their mind map, or to not consent to the research and keep their mind map. The drop-out rate was 2 people (amounting to 1 mind map) only.

Data analysis

All mind maps collected were scanned and imported into Atlas.ti (Version 7) software for qualitative analysis. Our analysis could best be described as an inductive framework analysis [42], which also drew on semiotics based on Peirce's typology [25] (see Box 2 and Figures 1-2).

Box 2. Glossary of terms with explanations (see also Figures 1 and 2)

Mind maps being the primary documents for this project were described using the following terms:

1. **Main concepts:** Academic and medical professionalism (**AP** and **MP**)
2. **Attributes:** branches arising from main concepts
3. **Descriptors:** smaller branches arising from attributes. Branches arising from descriptors are called lower-level descriptors.
4. **Connections:** lines and other visual signs joining attributes and/or descriptors and indicating uni- or bi-directional relations
5. **Visual signs:**
    a. **Icons**: signs resembling the signified (represented concepts), e.g. student learning (see Figure 1, sign 5a), heart and brain (see Figure 2, signs 5)
    b. **Indexes**: signs connected to the represented concepts, e.g. balloon representing leisure (see Figure 1, sign 5b)
    c. **Symbols**: signs not resembling visually represented concept e.g. caduceus as a symbol of medical profession (see Figure 1, sign 5c)

Lexical items frequency reflects individual words' occurrences with components of phrases (e.g.*"communication skills"*) assigned to separate sets (*"communication", "skills"*).

Frequency of attributes and descriptors reflects occurrences of phrases (e.g. *"communication skills"*).

[Insert Figure 1 around here]

[Insert Figure 2 around here]

Stage 1: We each familiarised ourselves with an initial 10% sample of the mind maps. We identified textual and graphical elements of AP, MP and AP-MP relationships. We not only explored the main concepts of AP and MP and connections between them, but we also examined attributes and descriptors related to AP and MP and the connections between them (see Box 2 for glossary of mind map terms).

Stage 2: We came together to discuss our analysis of the mind maps, followed by a comparison and negotiation of suggested themes to develop the coding framework.

Stage 3: The first author indexed all data using our coding framework within Atlas.ti (Version 7).

Note that the coding framework was further developed by the authors after the first author coded the first 20 mind maps (the 10% above and a further 10%) with the first 10% being re-analysed to ensure no important codes identified later were missed. The key branches arising from the main concepts were coded as "attributes" of AP and MP and the sub-branches were coded as higher and lower level "descriptors" (see Box 2 and Figures 1 & 2). All visual aspects of mind maps were coded, in particular, visual signs for the central concepts of AP and MP (for example, see the heart and brain in Figure 2), their attributes and descriptors, and connections between attributes and descriptors of AP and MP and AP-MP relationships.

Stage 4: The first author interrogated the coding using Atlas.ti such as identifying the frequency of the different textual and graphical themes. Atlas.ti was also able to create code families representing higher-order themes (e.g. family 'health professionals' for codes 'doctors', 'nurses', and 'physiotherapists'). Note that we do not report all lexical and visual items in this paper because there were such a large number (e.g. 686 different lexical items across the maps), but we instead report those that are most frequent and therefore robust across the mind maps. While the first author also explored some correlations between lexical items using Statistica 12 software, in order to illustrate patterns in our large qualitative dataset, we still maintain a process-orientated qualitative approach [4333].

Stage 5: We interpreted our findings by comparing them with themes identified in previous research [e.g. 4,6,8,9].

Team reflexivity

The data analysis process was accompanied by systematic reflection by the researchers on their perspectives and influences caused by previous experiences or beliefs. Such reflexivity was recorded in memos. The valuable diversity of background and experience was brought by the first author being a medical doctor and teacher of international students from Poland and the second author being a social scientist researcher and teacher of postgraduate international students from the UK (at the time of the study). The second author also has long-standing expertise in teaching and researching healthcare professionalism.

RESULTS

Students' understandings of AP and MP: analysing textual elements

In 20 cases, students renamed the main concept of 'academic professionalism' to 'professionalism in

education', 'professionalism of learning' or 'educational professionalism'. In two cases, participants decided to replace the two concepts with one (i.e. "*professionalism"*), although attributes of AP and MP were still clearly distinct in the mind maps. There were 138 different attributes used to describe AP (3-10 per mind map, median=5) and 146 to describe MP (4-11 per mind map, median=5). To explain their understandings of attributes of AP and MP, students also added descriptors (3 descriptors per attribute on average). While the majority of attributes (e.g. *"empathy")* were understandable without any further descriptors, others (e.g. "*personality"*) possessed descriptors in order to clarify students' perceptions and valuings of particular attributes. The AP attributes were explained by 474 different descriptors (10-81 per mind map, median=19) and MP attributes by 478 descriptors (13-87 per mind map, median=20.5). See Table 1 for the top 10 attributes and descriptors used for AP and MP in the mind maps. While students sometimes used the same attributes and descriptors commonly for both AP and MP (e.g. "knowledge", "personality", "honesty", "respect" etc.), there were also differences in terms of the common attributes and descriptors flagged for AP (e.g. "learning", "motivation", "confidentiality", "empathy" etc.) compared with MP (e.g. "ethics", "patient-doctor relations", "time management", "responsibility" etc.), indicating differences in students' conceptualisations of the importance of elements within AP and MP.

Table 1. Most common (top 10) textual attributes, textual descriptors and graphical signs applied to AP and MP in the 98 mind maps

TEXTUAL ATTRIBUTES of AP	Number	TEXTUAL ATTRIBUTES of MP	Number
Learning	39	*Knowledge*	28
Lifestyle	22	*Ethics*	26
Personality	21	*Patient-doctor relations*	26
Motivation	20	*Responsibility*	24
Knowledge	19	*Personality*	23
Responsibility	18	*Lifestyle*	21
Team work	15	*Team work*	18
Morality	15	*Communication skills*	16
Organizational skills	15	*Competencies*	13
Respect	14	*Lifelong learning/constant development*	13

TEXTUAL DESCRIPTORS of AP	Number	TEXTUAL DESCRIPTORS of MP	Number
Honesty	38	*Time management*	42
Confidentiality	38	*Honesty*	38
Learning activities	37	*Respect*	36
Empathy	35	*Responsibility*	32
Altruism	31	*Team work*	28
Helping others	31	*Self-improvement*	27
Respect	31	*Learning activities*	26
Punctuality	30	*Communication skills*	26
Team work	24	*Respect for colleagues*	25
Diligence	22	*Punctuality*	20

GRAPHICAL SIGNS of AP	Number	GRAPHICAL SIGNS of MP	Number
Book	25	*Stethoscope*	19
Academic cap	15	*Doctor*	13
Teacher	6	*Red cross*	7
Pen/pencil	5	*Caduceus*	5
Diploma	4	*Syringe*	5
Brain	4	*Book*	4
Apple	2	*Academic cap*	4
Students (learners)	2	*Money*	4
Doctor	1	*Heart (anatomic)*	4
Money	1	*Rod of Asclepius*	4

Students' understandings of AP and MP: analysing graphical elements

The spatial layouts of AP and MP within the mind maps were compared in order to get a sense of students' perceptions of the importance of items relative to one another. In the majority of cases (n=75, 76.5%) the size of the AP and MP areas were similar (see Figure 3 as an example), indicating that students thought the two concepts were equally important. Study participants provided a range of approaches to their mind maps, including three computer-generated ones, multiple cases of 'typical' designs but with varying degrees of complexity and visual richness (see Figures 2-3), and twelve documents coded as "not following the mind mapping rules", with the use of totally different visual approaches (see later). Visual signs other than the typical, basic visual elements of the mind maps (e.g. central shapes and branches) were used to enhance particular textual contents around main concepts (e.g. *brain* and *heart* in Figure 2 or *book* and *red cross* in Figure 3), as elements of branches and connections (e.g. *journey* in Figure 4) and as enhancements of attributes and descriptors. Students almost exclusively used drawings as enhancements of adjacent textual contents (e.g. an image of a student reading next to the attribute or descriptor: "*learning": see Figure 1, image 5a*). All visual elements were classified according to the Peirce typology into icons, indexes and symbols (see Box 2 for a glossary of mind map terms). Most (79.1%) of the signs were classified as icons or indexes, while the remaining 20.9% were classified as symbols. Table 1 presents the graphical signs used most often as the AP and MP signifiers. The three most commonly used signifiers of AP (*academic cap, book, diploma*) and MP (*anatomic heart, stethoscope, caduceus*) are presented in Figure 5. While students sometimes used the same signs commonly for both AP and MP (e.g. book, academic cap, doctor and money), there were also differences in terms of the common signs illustrated for AP (e.g. teacher, diploma, pen/pencil, brain etc.) compared with MP (e.g. stethoscope, red cross, caduceus, syringe etc.), indicating students' different conceptualisations of AP and MP.

[Insert Figure 3 about here]

[Insert Figure 4 about here]

[Insert Figure 5 about here]

Students' understandings of the relationships between AP and MP: analysing textual elements

Relations between maps' elements were indicated by visual connections, using the same or similar attributes and descriptors for both main concepts, and indicated by added textual explanations. We explored correlations between attributes used within the same mind maps (in other words, correlations represent how often attribute X in AP co-occurs with attribute X in MP in one mind map). The strongest correlation values were detected between academic and medical "*honesty"* (r=0.73), *"relations"* (r=0.72), "*social competencies"*(r=0.70), *"lifestyle"* (r=0.67)*, "morality"* (r=0.62), "responsibility"* (r=0.59), "diligence" (0.54), and "self-improvement" (0.52). Those

correlations asterisked above were additionally reinforced by visual connections.

Students' understandings of the relationships between AP and MP: analysing graphical elements

As well as exploring correlations, we also analysed how students perceived relations between AP and MP by analysing the connections drawn between attributes, descriptors and other visual signs. The connections were often enhanced with arrowheads indicating the direction of connection (i.e. the influence of one attribute on another: see Figures 2,4). Attributes were also qualified as connected (related) if branches presenting the particular attribute were clearly pointing towards each other and/or were clearly marked with the same colour (see Figure 3). Despite clear instructions asking for identification of relations between the main concepts, 10 of the 98 mind maps presented no visual representation of relations at all. While the asterisked correlated attributes above were also most often visually connected, we found four common visual connections in over 10% of the maps: between AP lifestyle and MP lifestyle (n=14), between AP knowledge and MP knowledge (n=12), between AP responsibility and MP responsibility (n=11), and between AP respect and MP respect (n=11).

The mind map presented in Figure 3 serves as an example of visually and textually well-developed relations between attributes of both main concepts as clouds containing descriptors shared between them. Apart from visual connections between attributes of AP and MP, students also identified multiple visual connections between attributes and descriptors of the same concept (marked with "x" in Figure 3). Such internal connections indicate either strong interrelations of attributes or suggest that the same descriptors apply to diverse attributes. Both branches and connections between attributes and descriptors were often enhanced to take on forms of biological, veiny and neuronal structures or botanical shapes of stalks with leaves and flowers (e.g. MP as a circulatory system with blood vessels and a heart as a central concept: see Figure 5, top right).

Relations and connections were additionally represented by higher order visual metaphors, which often included joining the two main concepts together unidirectionally as in the *journey* from AP to MP (see Figure 4) or as a *state of war* between AP and MP (see Figure 6). Indeed, Figure 4 suggests that the journey from AP to MP is a difficult one, with the early part of the journey (AP) involving rain, treacherous mountains to climb and going backwards, and latter parts of the journey (MP) involving sun, running forwards and flying. Alternatively, Figure 6 depicts a very dynamic battle between a warship fleet (with the largest ship representing the main concept of AP) and a castle representing MP, illustrating students' perceptions of conflict between AP and MP.

[Insert Figure 6 about here]

DISCUSSION

This innovative study used mind maps designed by pre-clinical medical students to analyse their understandings of AP and MP and AP-MP relationships. To our knowledge, no previous research has examined students' understandings of AP specifically or AP-MP relations.

Summary of key findings and comparison with existing literature

In terms of our first research question, although some textual attributes and descriptors were commonly used for both AP and MP (e.g. knowledge, personality), differences also existed in terms of frequent attributes and descriptors for AP (e.g. learning, motivation) and MP (e.g. ethics, doctor-patient relations). Moreover, while some visual signs were regularly used for both AP and MP (i.e. book, academic cap), there were also differences between the common visual signs for AP (e.g. teacher, diploma) and MP (e.g. stethoscope, red cross). Taken together, these patterns in textual and visual signs illustrate that students conceptualise AP and MP as only partly similar. The textual attributes and descriptors for AP and MP (both those common to AP and MP and those specific to one or the other) were on the whole consistent with those identified in previous studies [4,6,8,9], indicating the universality of most commonly identified professionalism attributes and descriptors across different regional contexts [4]. While previous research has identified the importance of these textual attributes for professionalism more generally [e.g. 6, 8], they have not differentiated between these attributes along the lines of AP and MP previously, nor have they explored the visual signs associated with AP or MP before. Indeed, our study illustrates how AP and MP are conceptualised differently through text and visual signs, with students seemingly focused on academic-orientated professionalism (e.g. learning and teacher) for AP and patient-orientated professionalism (e.g. doctor-patient relations and stethoscope) for MP.

In terms of our second research question, over 10% of the mind maps did not indicate AP-MP relationships and only two attributes co-occurred with both AP and MP based on strong correlations between text *and* clear visual connections (i.e. lifestyle and responsibility). Therefore, it was clear to us that students struggled to conceptualise AP-MP relationships, as has been found previously with medical students struggling to articulate their understandings of professionalism more generally [6]. Interestingly, higher-order visual metaphors indicated interesting and sometimes unexpected conceptualisations of AP-MP relationships, for example, as a *journey* from AP to MP or as a *war* between AP and MP. While previous research in medical education has illustrated students' conceptualisations of student-assessor relationships as journey and/or war [34,44], or student,

clinical teacher and patients' conceptualisations of student/doctor-patient relationships as war [35], such metaphors have not been found in relation to AP-MP relationships previously.

Feasibility of mind maps as a data source

Our project, being the first of its kind to use mind maps as a source of data in medical education, provided us with experience regarding the feasibility and value of working with conglomerates of text and images as data. Using mind maps as data was not without its challenges. Unlike qualitative data from interviews, where much can be gleaned from how people speak in addition to what they say (e.g. through tone of voice, pace of speech, laughter, etc.), mapping encourages the use of individual words or short phrases and visual symbols instead of typical sentences or paragraphs. While mapping enables other opportunities for analysis of simultaneously created textual and visual data, it does not offer an opportunity to ask students clarification questions, meaning that it was sometimes challenging to tease out the meaning of brief text or illustrations [45]. Indeed, while Woodhouse [33] suggests enhancing visual data with dialogue with drawing creators to provide correct interpretations of images, the lead author did participate in all mind mapping sessions, observing the dynamics of the processes of mapping, which helped to enhance his contextual understanding of the visual material. Furthermore, the qualitative analysis of mind maps was time consuming and currently available software, while helpful, was not yet sufficient to meet the analytical needs of such visually and textually rich documents, especially with regards to the two-dimensional organisation of documents. Moreover, the visual richness of mind maps was probably influenced by the graphical skills of the student illustrators and not only by their understandings of AP, MP and AP-MP relations. Finally, visual connections might have been applied purely to enrich the visual aesthetics of the project. We therefore had to be careful not to over-interpret the visual aspects of the mind maps. For example, AP-MP orientation, coverage and use of colours, may have all been heavily influenced by external factors such as the availability of drawing tools and the team-working environment.

Using mind maps, however, had various strengths. They focused on spontaneous thinking and creativity and explored perceived associations between concepts, so were well-suited to our research questions. Indeed, the visual complexity of many mind maps was advantageous in terms of collecting abundant in-depth and rich data. Unlike traditionally used transcripts of interviews, mind maps provided us with already structured and pre-coded data, as participants constructed their own hierarchies of attributes and descriptors for AP and MP, alongside generating visual connections between AP and MP, thereby emphasising AP-MP relations. Furthermore, visual metaphors (e.g. AP-MP relationships as journey or as war) helped to visibilise students' conceptualisations of AP-MP

relationships that traditional methods like interviews might not have revealed [34,35]. Therefore, we suggest that mind maps could be a valuable source of data for medical education research, and we encourage other researchers to consider employing them for relevant research questions such as those around relationships between concepts. Furthermore, we would encourage researchers to employ mind maps in combination with conversations with mind map illustrators to help further elucidate the meanings behind brief text and illustrations, as has been done with other visual methods such as the pictor technique [46].

Educational implications

This study reveals that preclinical students often perceive AP and MP as two separate constructs characterised by different attributes. This dissociation of two types of professionalism may be caused by multiple factors, including students' previous educational and cultural backgrounds and the traditional, non-integrated curriculum with lecture-based methods of preclinical teaching that students are exposed to at this participating school. We think that educators need to help students understand better AP, MP and the relationships between the two as part of their formal professionalism curriculum, starting in the pre-clinical phase. Furthermore, as part of the informal curriculum, we need to ensure that both medical educators at the pre-clinical (e.g. basic sciences teachers) and clinical levels (e.g. clinical teachers) have an awareness of themselves as professionalism role models for students, and how they might enact both academic and medical professionalism. We think that this paper, and particularly the mind maps contained within it, could act as trigger material for both medical students and educators to discuss the relationship between academic and medical professionalism and consider how they might bridge any perceived gaps between the two.

Research implications

This study has two further methodological challenges beyond those already discussed above that influence the need for further research. First, our study was conducted with one cohort of medical students at one medical school, thus limitating the transferability of our findings to other medical schools and in particular to students in medical schools with Z-shaped curricular [38]. Second, our study looked at junior pre-clinical students' understandings of professionalism at one point in time, at the start of their medical education and before they were socialised into espoused professionalism codes and/or clinical workplace learning professionalism practices. This means that our data are cross-sectional and cannot be extrapolated to more senior students such as clinical students. Therefore, we believe that further multi-school research is now needed using the methodological

approach outlined in this paper to further explore students' understandings at multiple schools and across multiple years of curricula, as has been done successfully in other qualitative research [6,11, p.7-29], albeit that that research did not explore students' understandings of AP, MP and AP-MP relations. Furthermore, we particularly think that it would be valuable to conduct longitudinal studies to explore how students' understandings of AP, MP and AP-MP relations change over time, through asking students to provide mind maps annually or around key transition phases such as the pre-clinical-clinical transition and/or the final year-junior doctor transition. As already mentioned above, we would also encourage further research to couple conversations with mind maps, either using individual or group interviews, to better clarify students' understandings of AP, MP and AP-MP relations, and essentially offer crystallisation of data (i.e. where multiple data sources can bring rigour through offering richer understandings of the topic of inquiry [47]). Finally, we think the diversity between us in terms of our personal and professional identities, education and expertise brought something unique to our conduct of this study including our interpretation of data. Therefore, we would strongly recommend that future research on this complex topic of professionalism embraces such diversity across research teams.

FIGURES - LEGEND

Figure 1. Schematic explanation of terms used in paper (see glossary in Box 2)

Figure 2. Explanation of terms used in paper applied to one of the primary documents (see glossary in Box 2)

Figure 3. Mind map presenting strong relations between the main concepts expressed by common attributes (1-Lifestyle, 2-Knowledge, 3-Personality, 4-Motivation) and connections between the other attributes and descriptors

Figure 4. Visual metaphor indicating a difficult journey from AP to MP

Figure 5. Examples of signifiers of AP and MP

Figure 6. Visual metaphor indicating AP-MP relations as a state of war

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Contributors

JJ and CR together contributed to the design of the study, analyzing and interpreting data, and writing and editing the manuscript. JJ secured ethics approval, collected all data and coded all data using Atlas-ti.

Ethical approval

We received ethics approval from the Human Research Ethics Committee of the Medical University of Lodz, Poland (No. RNN/225/13/KE).

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Declaration of competing interests

We have read and understood the BMJ policy on declaration of interests and declare that we have no competing interests.

Data sharing

We do not have ethics approval to make raw data from this study available for sharing. Additional, unpublished data including the project cohort characteristics, analysis of lexical items, attributes, descriptors, visual signs, visual links between attributes and descriptors are available from the authors.

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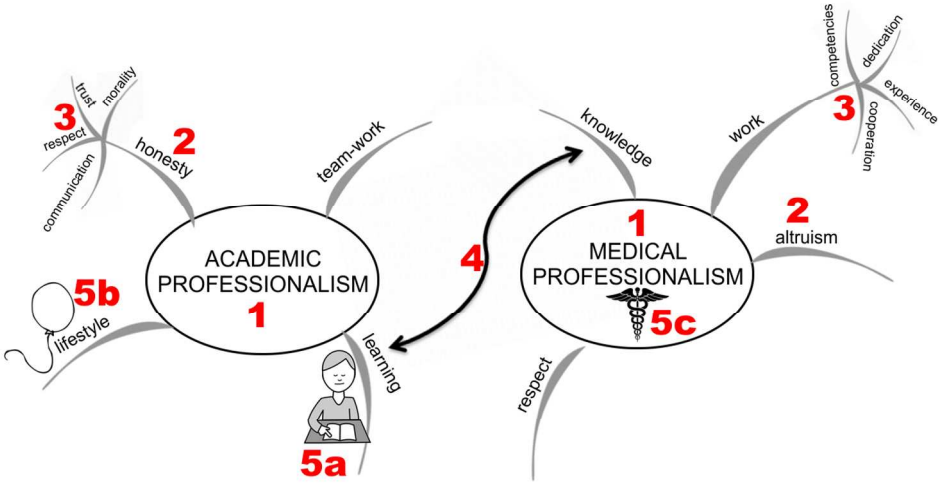

Figure 1: Schematic explanation of terms used in paper (see glossary in Box 2)

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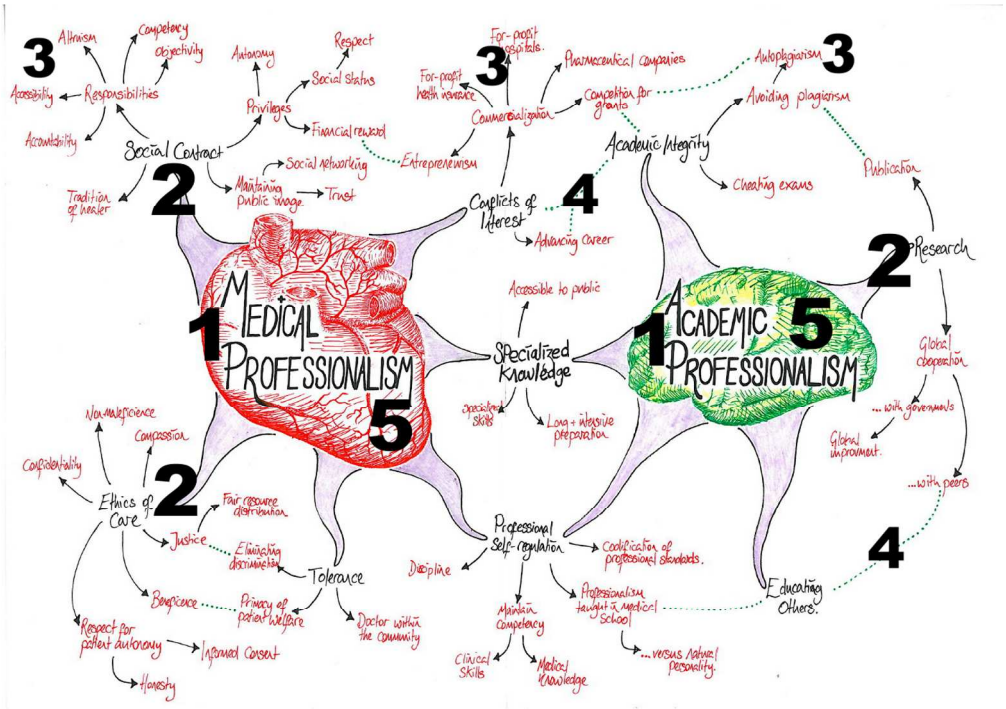

Figure 2: Explanation of terms used in paper applied to one of the primary documents (see glossary in Box 2)

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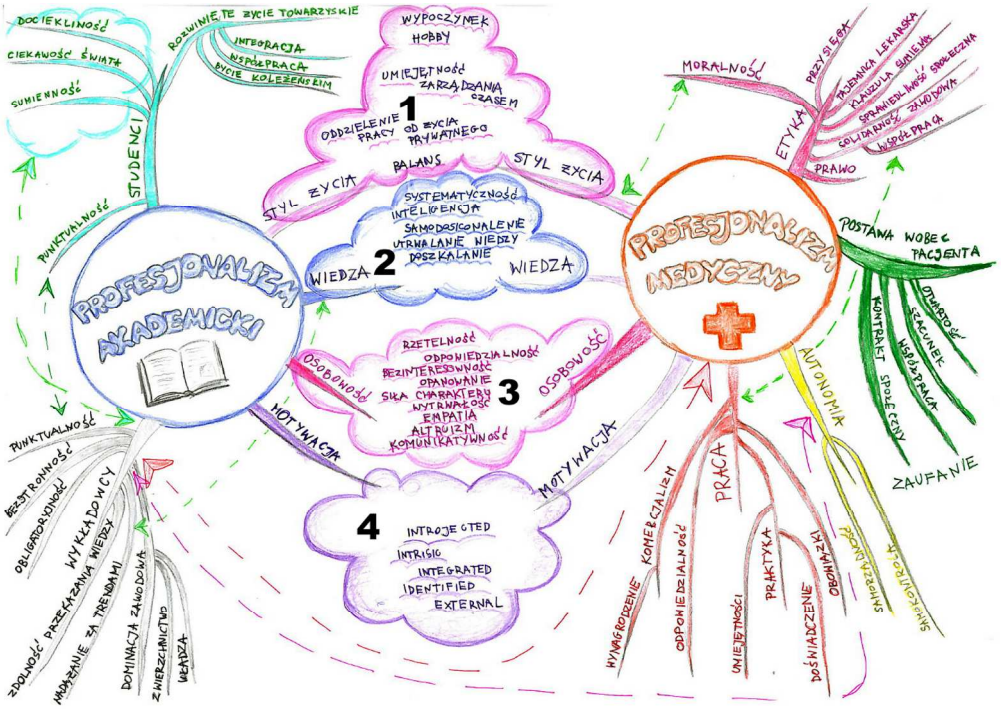

Figure 3: Mind map presenting strong relations between the main concepts expressed by common attributes (1-Lifestyle, 2-Knowledge, 3-Personality, 4-Motivation) and connections between the other attributes and descriptors

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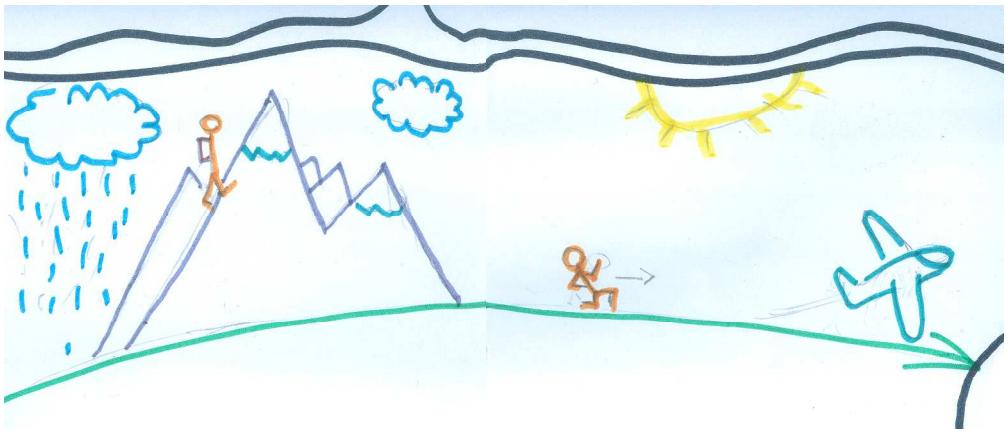

Figure 4: Visual metaphor indicating a difficult journey from AP to MP

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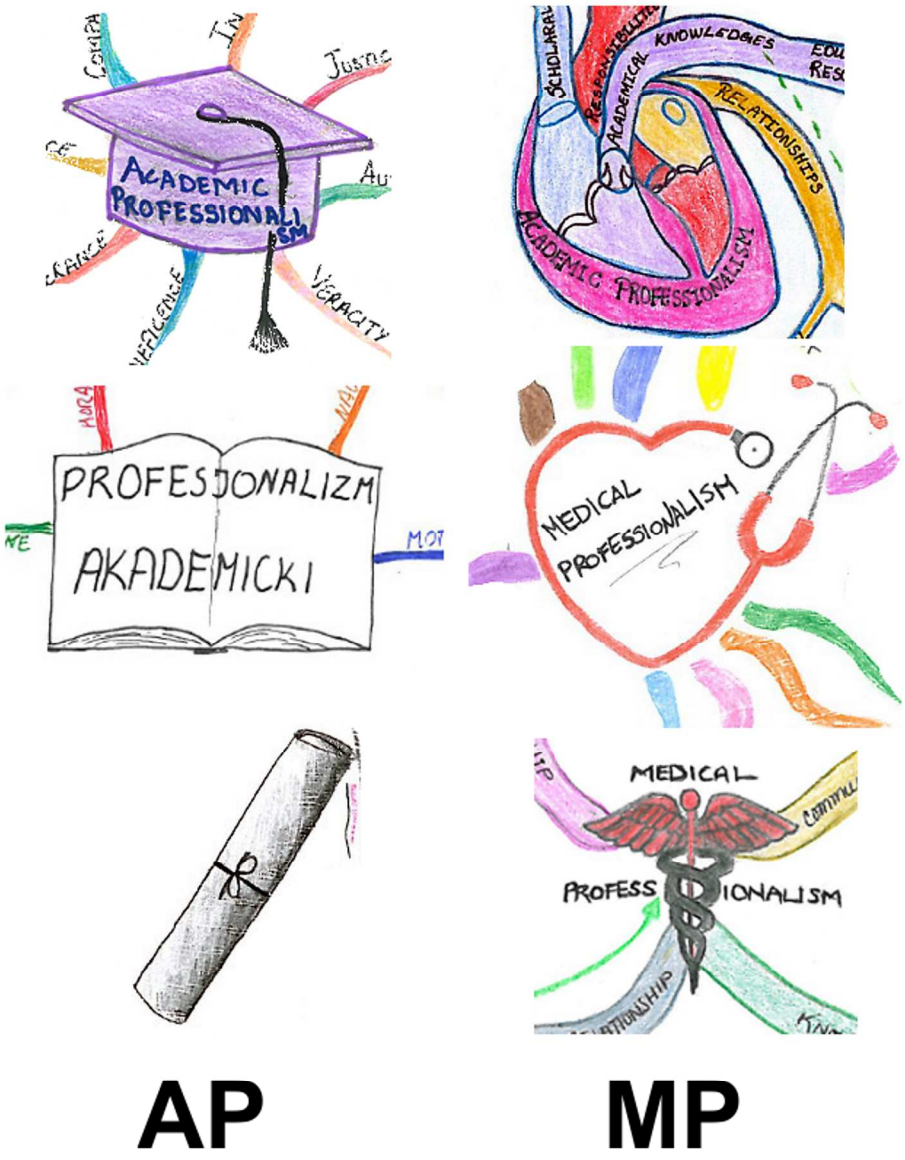

Figure 5: Examples of signifiers of AP and MP

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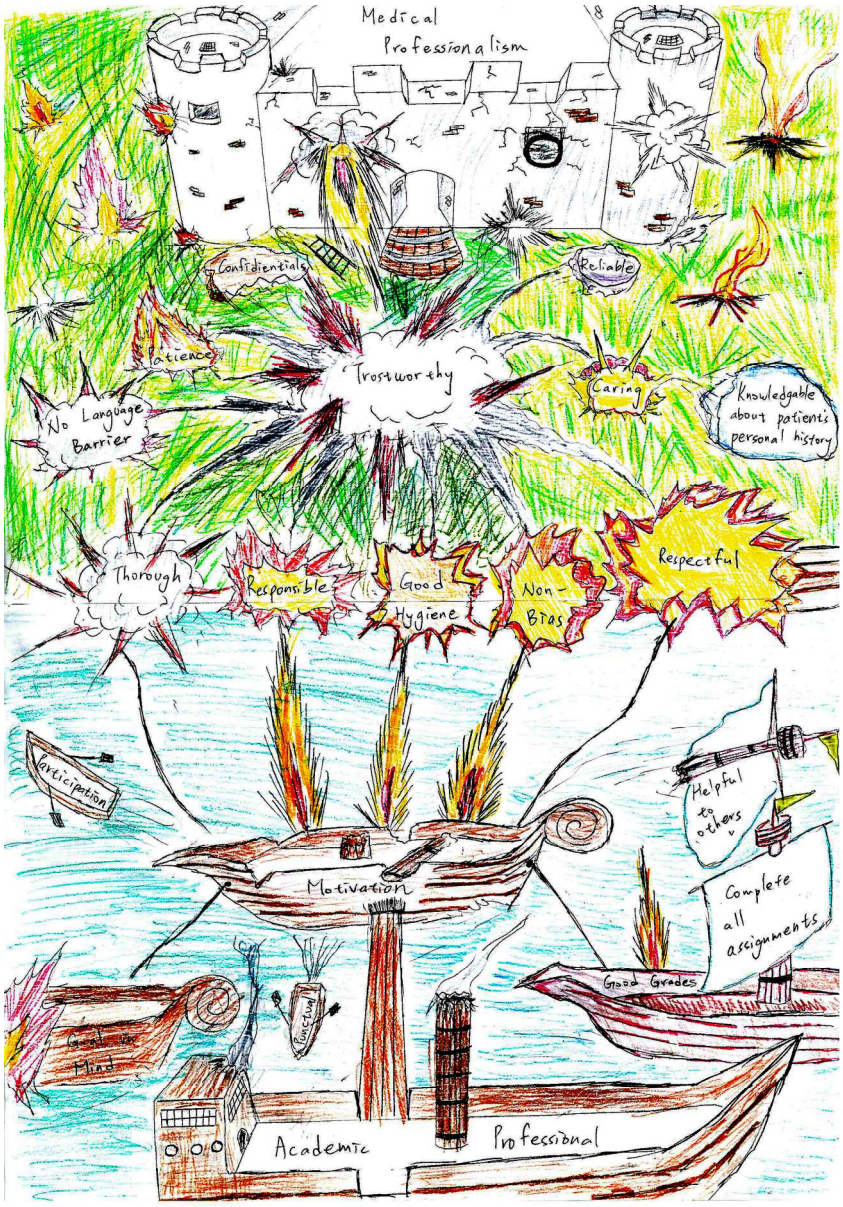

Figure 6: Visual metaphor indicating AP-MP relations as a state of war

174x250mm (300 x 300 DPI)