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Paper:
St John-Matthews, J., Newton, P., Grant, A. & Robinson, L. (2018). Crowdsourcing in health professions education: What radiography educators can learn from other disciplines. *Radiography*
http://dx.doi.org/10.1016/j.radi.2018.11.006

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Crowdsourcing in Health Professions Education: What Radiography Educators Can Learn From Other Disciplines.

Abstract

Objectives: Crowdsourcing works through an institution outsourcing a function normally performed by an employee or group of individuals. Within a crowdsource users, known as the crowd, form a community who voluntarily undertake a task which involves the pooling of knowledge resources. A literature review was undertaken to identify how the tool is being used in health professions education, and potential for use in radiography education.

Key findings: 17 papers were returned. Literature identified was assessed against an established crowdsourcing definition. Reviewing these yielded four themes for discussion: student selection procedures, lesson planning, teaching materials and assessment.

Conclusion: Crowdsourcing is associated with innovative activities through collective solution seeking via a large network of users. It is increasingly being adopted in healthcare training and maybe transferable to educational activities within the field of radiography education.

Introduction

Recent studies at colleges and universities have shown that applying crowdsourcing to education can be fruitful for both students and teachers [1]. Furthermore crowdsourcing in higher education can potentially result in a more personalised education and learners can access the best learning material [2]. The purpose of this paper to explore how healthcare educators are using the tool and if it can be applied in a radiography education context.

Coined by journalist Howe in 2006, the phrase 'crowdsourcing' originates from the combination of the words "crowd" and "outsourcing". Crowdsourcing works through an institution outsourcing a function normally performed by an employee or group of individuals [3]. Within the crowdsource, users known as the crowd form an online community who

voluntarily undertake a task, online, which typically involves the pooling of knowledge resources, and in which mutual benefit is experienced [4]. Hence the advantages of crowdsourcing is that it is easy to access a large pool of participants for a research problem, it offers time savings as a large number of contributors work in parallel and this can support lower labour costs. Furthermore, crowdsourcing is associated with innovative activities through collective solution finding which is due to the large network of potential users. There are also benefits for the participants. Through being part of a crowdsource, the user receives satisfaction of economic benefit, social recognition, self-esteem and/ or the development of individual skills [5].

The notion of crowdsourcing continues to evolve. In the digital age crowdsourcing involves an open-call through participatory online activity, providing a wider access to people internationally in less time and at a reduced cost than traditional methods [6]. However traditional outsourcing has been used for centuries. Furthermore the practice of using the "wisdom of the crowd" can be traced back to Aristotle in the 4th century who explored the concept in his work titled "Politics" [7]. Other significant pre-technology crowdsourcing events include the development of the marine chronometer, by John Harrison in 1774 an innovation which came to fruition through the government sponsored longitude prize [8.]

Examples of applying this tool in the digital environment for UK health projects include the "Allied Health Professions into Action: Using Allied Health Professions to transform health, care and wellbeing" on-line resource [9] and the "Mind the Gap" project [10.] Further ongoing activities include the "Health Education England Academy of Advanced Practice" programme [11] and the "Role of Allied Health Professions in Mental Health Service Provision [12]"

crowdsourcing initiatives. In these examples, crowdsourcing provides a data collection method in generating an accurate representation of statements whose contents are shared, broadly agreed and useful in achieving common goals within the setting under investigations [13]. For "AHPs into Action" through using the "Clever Together" platform [14], 16,000 healthcare practitioners and members of the public across diverse geographic locations were involved in the resource design. Subsequently the publication highlighted a clear view of the transformative potential of AHPs, examples of innovative AHP practice and a framework to develop local delivery plans. In contrast, the "Mind the Gap" project looked at the experiences of millennials working for the UK National Health Service (NHS) in the West Midlands region. This campaign received 276 contributions. From these action points were delivered on how to support the careers of these health care professionals.

However crowdsourcing is not without challenges and historically the term crowd has conjured negative meanings e.g. riots, mob mentality, looting [15]. Administrators of a crowdsource need to be aware of crowd-hijacking where a group respond to the initiative to pursue its own agenda [16]. An example of a failed crowdsourcing activity in popular media is the Natural Environment Research Committee (NERC) requesting that the public be involved with the naming of their new research vessel, the most popular name being Boaty Mcboat face [17]. Despite these challenges, carefully executed crowdsourcing campaigns can be valuable exercises that allow organisations to engage with stakeholders to elicit new ideas.

The objectives of this narrative review are:

- To provide a synopsis of current research in how crowdsourcing is applied in health professions education

- To review identified papers against an established crowdsourcing definition
- To explore how crowdsourcing could be applied to radiography education
- To suggest ways in which a crowdsource could be implemented in radiography education research.

Methods

The literature search alongside the initial groupings and analysis of identified papers was carried out by the lead article author. The lead author is a white, working-now-middle class, ethnic minority disabled female, who is a UK registered diagnostic radiographer with a decade of experience as a formal radiography educator in both the private sector and Higher Education where they have attained a teaching qualification and Fellowship of the Higher Education Academy. Her current role is as an academic director overseeing student journey for eight healthcare professions across fifteen programmes of study. She is also a doctorate candidate investigating inclusive curriculum design processes in pre-registration diagnostic radiography education using a participatory action research approach.

Using a framework to encapsulate the research question or problem aids the researcher in finding relevant evidence in the literature. Furthermore by using an objective tool it helps to address bias and ensure trustworthiness. For this search a SPIDER framework was adopted. SPIDER elements include: Sample; Phenomenon of Interest; Design; Evaluation; Research type. SPIDER is considered an alternative to PICO in health research as it more inclusive of qualitative and mixed methods research' [18]. Keywords adopted were: crowdsou*; wisdom of the crowd; crowd capital, collaboration; education; radiography education. To increase the sensitivity of the search, Boolean logic was used linking words such as "OR"; "AND" and "NOT"

[19]. 2006 to present day was selected as the date for searching to reflect the identifiable date when crowdsourcing was first described as an on-line activity thus distinguishing the tool from traditional outsourcing.

The search was carried out using on-line electronic databases [20] subscribed to by the Swansea University Medical School library portal. These included Health, Medical and Education databases- Medline, the Applied Social Science Index and Abstracts (ASSIA), the Cumulative Index of Nursing and Allied Health (CINAHL), Science Direct and ProQuest Education. Zero articles were returned relating to crowdsourcing in radiography education. This was deemed significant as it indicated a gap in the literature. As it was considered that the findings from the education literature of other health professions could be generally applicable to radiographers the search was broadened to include other nursing, midwifery allied health professions and radiography. Again there were zero returns. Subsequently the search was widened further to include medical education. This returned 68 articles.

As electronic databases can have both geographical and language biases a hand search was also conducted in journals that would most likely yield relevant articles [20.] A "snowballing" technique was also utilised to identify relevant articles included in the reference list of assessed articles thus helping to recognise any articles which may have been previously missed [21]. This resulted in two further articles being located. Literature searching was not confined to published articles and included information arising from non-research papers, editorials, letters to the editor, discussion documents and previous thesis in this area. Given the nature of crowdsourcing as an open source tool- Google Scholar and ResearchGate were also utilised. This yielded one unpublished thesis.

The overall search resulted in 71 papers. Two review papers were removed [22, 23]. The remaining 69 abstracts were screened. 49 were discarded as the content was not relevant to the review objectives. The Doctorate thesis was not included as the full thesis was embargoed [24]. From here 19 articles were assessed for quality using the Medical Education Research Study Quality Instrument (MERSQI) [25]. This tool has been validated as a reliable tool for appraising methodological quality of medical education research [26]. Subsequently 17 articles remained [27-43].

Study background information (authors, year, journal, and methodology) was collected for each article. Data regarding crowdsource aims, sample numbers, crowdworkers, crowd motivation and study location were also documented. The papers were read and categorised by theme by the lead author with groupings representing educational context, lesson planning, instructional material design, assessment identified- table one [(27- 43).] Of these one paper examined lesson planning, three addressed instructional material design, eleven concentrated on the role of crowdsourcing in the assessment of basic non-complex surgical skills and a further two studies focused on the recruitment of learners onto a surgical training programme.

The lead author has experience of narrative literature reviews as part of assessed course work and previous publications. However she acknowledges a bias towards this method of inclusive co-creation given it is the tool that will be used for her Doctorate work and her personal values. Hence a summary of the papers together with the initial categories developed were presented to the local monthly *"Research in Health Professions Education (RiPHE)"* research

group meeting for sense checking. This group includes professors, researchers, lecturers and doctorate candidates working in the field of health professions education. Three of the article authors are members of the group. The lead author is the only radiographer within the group. Other professions represented are biomedical science, midwifery and medicine and the level of research experience within the group ranges from novice to international discipline experts. Following discussion the research group confirmed the categories presented.

Crowdsourcing is a recent concept and as the tool evolves varying definitions have developed. It is deemed important to propose a definition of crowdsourcing so as not to confuse this with crowdlearning which is associated with platforms such as wikis, crowdtuition which can be used to fund individual tuition fees and crowdfunding to raise monies for educational infrastructures.

To determine how the term 'crowdsourcing' is used in health professions education, a crowdsourcing definition and typology was applied to the articles. As no definition is available in the literature specific to health professional's education, a definition from another research field was adopted [4] –table 2. This definition, developed by Estelles-Arolas and Gonzalez-Ladron-de-Guevara [4], is the only one available relating to crowdsourcing and was developed following the systematic review of six scientific databases. From the 209 documents reviewed, 40 unique definitions of crowdsourcing were identified and used to develop a final 8-point classification tool, which defines 'crowdsourcing'. However using this typology meant that three papers did not meet this established definition of crowdsourcing (shaded grey in table one) [27, 28, 29]. All of these related to instructional material design- as they

did not use the on-line environment to apply the crowdsource nor was the assigned task completed in the on-line environment.

Through carrying out this exercise it became apparent that the term *'crowdsourcing'* in health professions education does not strictly meet a definition as established in the literature by Estellles-Arolas and Gonzalez-Ladron-de-Guevara [4]. This is because the literature used to devise their definition has been drawn from business and human science literature and the health professions education articles yielded by this search were published after the definition was developed. As a result some of the nuances of crowdsourcing in health professions education as an emerging application may potentially be lost i.e. the space in which the crowdsource happens, the composition of the crowd and motivation of the crowd. Yet in the absence of another definition [4] it does provide an outline of how crowdsourcing differs from traditional group consensus techniques i.e. focus groups, nominal group techniques and the Delphi method hence the reason it was applied.

Results

The decision was made by the authors to include the initial seventeen articles identified so as to address the review question. The following offers a description and analysis of these.

The lesson planning paper, written by Penciner [30], describes how crowdsourcing had been used at an international emergency medicine conference to guide the delivery of a group conference session. Penciner[29] acknowledged that in traditional conference proceedings it is assumed that a single presenter has knowledge to share with the group. Hence conference session titles and content are predetermined by a single expert or narrow group of individuals.

In this instance the crowd attending the session were asked to submit three problems, controversies or questions to be discussed at the timetabled sessions. During the session the facilitator posed questions from the submitted lists. Rather than teach, the researcher facilitated the discussions. The study concluded a facilitated crowdsourced discussion can be used to harness collective wisdom and expertise from the crowd.

However the study does have limitations as the definition of expert is complex with participants self-reporting their level of expertise. Furthermore there are challenges with ensuring all voices are heard which is evident when comparison was made in this study [29] between the number of contributors to the crowdsource activity and the frequency of their contributions with some being more active than others. This "power law distribution" [44] or group dominance is important to note as one of the advantages cited for crowdsourcing as a group consensus technique is that it does not adopt a hierarchal management process. Therefore it is deemed more inclusive than face to face alternative techniques including focus groups [45] nominal group technique [46] and Interacting Groups [47]. However the authors of this review acknowledge that it is not always desirable or possible to have equity of participation and just because someone isn't verbal doesn't mean they aren't learning.

The largest yield of papers [31-43] addressed assessment of simulation surgical skills through crowdsourcing. Here learners preformed simple simulated surgical tasks including open square knot tying, surgical drills, laparoscopic peg transfer and robotic suturing. These were recorded and the videos were reviewed by crowd workers who worked for freelancing sites such as Amazon Mechanical Turk [48] and C-SATS [49] (Crowdsourced Assessment of Technical Skills). The outcomes of their assessment grading was compared to that of expert assessors.

These papers acknowledged that although the employed crowd lacked demonstrable expertise within the relevant fields, the distribution of the wisdom of the group brought advantages of efficiency, scalability and flexibility to assessing learners. Moreover the crowdsourced "non-expert" feedback appeared to be comparable to expert feedback. It is however noted that on evaluating these papers research is still needed to increase consistency in expert evaluations, to explore sources of discrepant assessments between surgeons and crowds, and to identify optimal populations and novel applications for this technology.

The next group of papers related to educational instructional material design [27, 28, 29] with two of these studies developing a pool of resources through national networks. Of particular note is the development of the RADExam project in America which sought to develop a web based bank of 3,000 test questions drawing inspiration from the framework used by Radiopedia, an on-line wiki based collaborative radiology resource [50]. In these papers mutual benefit was highlighted as a key driver of the crowdsource activity. Volunteers were encouraged to engage voluntarily and in return they were encouraged to use the exercise for their continuous professional development portfolios. Limitations of the papers was the need to edit the large amount of data generated [29]. Furthermore data was often submitted in rough form and needed editing and reviewing for scientific accuracy [28.]

The remaining papers [42, 43] addressed the recruitment of learners onto a surgical training programme through the use of simulated tasks similar to those described in the surgical assessment papers. These papers followed a similar method to the aforementioned assessment of simulation surgical skills literature and also used paid crowdworkers to

complete the assessment. This type of assessment was not a replacement but rather an adjunct to traditional selection techniques of academic qualifications, personal statement writing and interviewing.

Discussion

In trying to define what crowdsourcing is in healthcare professions education it became apparent whilst undertaking this review that there is a piece of work required with formulating a definition. Undertaking the review proved difficult as articles would use the term crowdsourcing but on further analysis this was not the case with papers often describing crowd learning or crowdfunding. The authors sought to address these challenges of a typology by applying an objective definition to fully understand the nub of crowdsourcing in the field of health professions education. However as highlighted this did not capture the nuances of healthcare education requirements.

Despite this observation, the authors propose that the themes identified in this literature review, could potentially be applied to radiography education. The papers presented give a useful insight into how and where these could be implemented and areas for further research. For example, crowdsourcing may provide alternative ways of co-creation of instructional materials, providing timely and cost-effective assessment feedback, and methods of student selection onto pre and post registration radiography programmes. Furthermore, through the application of crowdsourcing the allocation of resources dedicated to a task can be reduced.

Possible applications in radiography for consideration include:

- Assessing student during simulation based sessions with practical task focused skills i.e. positioning of phantoms/ mannequins for a radiographic examination or cannulation technique. This could be used as a formative assessment tool.
- Development of a national bank of teaching materials for shared subjects including anatomy, physics, radiographic technique
- Development of a national bank of examination questions including image interpretation
- Design of continuous professional development (CPD) lesson plans

Information pertaining to the crowd workers was limited in the reviewed articles an observation also highlighted in a systematic literature review of crowdsourcing in health published earlier this year [51]. Some points that remain controversial include the unethical aspect of payment and treatment of crowdworkers. For example Amazon Mturk [49] tasks are often completed by a small set of workers who spend long hours on the website, many with low income. Furthermore there is no way of ascertaining the work environment at the vendor location [52]. The authors of this review note Amazon MTurk is not the only provider of these services with alternate availability companies such as C-SATs [50] as noted in one returned article [42]. Using this option of crowdworkers may help address the concern of ethical and fair payment.

In the introduction the authors highlighted the role of crowdsourcing as a group consensus technique in co-production of framework developments and resources [8-11]. Yet no papers were returned that had adopted the tool in this way. This is deemed significant as the lead author is currently undertaking research which explores the use of crowdsourcing to encourage a broader range of stakeholders to help co-produce a new, relevant curriculum

which will then contribute to curriculum change. This is in place of methods currently adopted in radiography education research in the area of competency and curriculum development which have historically used tools such as focus groups, nominal group and the Delphi technique [53] for this work.

Given the relatively novel use of crowdsourcing in health professions education, and the lack of additional unique studies identified through speaking with subject matter experts the authors are confident this is the most comprehensive review on the topic to date. However it is acknowledged there are several limitations to this study. This report has been written to review the role of this established business tool in the realm of radiography education. In doing so a gap in the radiography education literature has been identified. Hence a limitation of the piece is that the discussions presented are theoretical in nature and seek to highlight how radiography educators could potentially use crowdsourcing.

Another limitation is that the selection, review and analysis of the papers presented has been performed by a single reviewer thus creating a potential bias. To address this, a robust search strategy and a validated appraisal tool were adopted and the proposed grouping of articles was presented to a local health professions education research group. Furthermore the lead author drew up a positionality statement to ensure they were conscious of how their values and experiences would affect their interpretation of the findings including power dynamics and inclusivity [54]. Finally while the authors acknowledge it is reasonable to draw parallels from other healthcare profession education research, it is noted radiographer skill sets do differ due to time-limited episodes of care [55.]

As per the challenges described of mapping health professions education literature against an established crowdsourcing definition it might be appropriate to reconsider this definition, or identify one which has a better fit with health professions education.

Conclusion

Crowdsourcing is associated with innovative activities through collective solution seeking via a large network of active on-line users. As crowdsourcing in health professions education remains a novel tool, the review has highlighted gaps in the current evidence base. The majority of the studies identified used crowdsourcing as a means of assessment. The remaining papers hint at the potential of crowdsourcing to benefit other areas of health professions training and there is clearly a need to develop this potential further, e.g. in design of instructional materials and the development of education policy or procedures. No papers addressed the co-design capabilities of the tool. This application is of interest as the tool has been used in Health campaigns such as *"AHPS into Action"* and *"Mind the Gap"*. Therefore the authors conclude that by reviewing crowdsourcing in the context of wider health professions education opportunities exist for radiography educators to explore the role of the tool within their own field.

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HIGHLIGHTS

- Crowdsourcing is the outsourcing of a function performed by a group of individuals
- Crowdsourcing is increasingly being adopted in health professions education
- The most popular application was the assessment of simulated practical assessments
- Other uses were instructional information design, course material, programme entry selection
- These examples maybe transferable to radiography educational activities

Year	Author	Crowdsource Aims	Subject Area	Crowd Numbers	Crowd Wo
2013	Bow et al [27]	Instruction al materials	Instruction materials	120	Experts in
2016	Blakewell et al [28]		Instruction materials: Neuroscience	200	Experts in
2017	Lewis et al [29]		Radiology exam question	170	Experts in
2015	Penciner et al [30]	Lesson Planning	Structure of a facilitated conference workshop	13	Experts atte confere
2014	Chen et al [31]	Skills Assessment	Simulated robotic surgical skills	409 67	Amazon Mecha Facebo
2015	Holst et al [32]		Simulated robotic surgical skills	50	Amazon Mecha
2015	Agadashi et al [33]		Simulated cricothyrotomy procedure	30	Amazon Mecha
2015	Malpani et al [34]		Simulated robotic segment-level surgical skill	30	Amazon Mecha
2015	White et al [35]		Simulated robotic surgical skills	30	Amazon Mecha
2016	Polin et al [36]		Simulated robotic surgical skills	41	Amazon Mecha
2016	Deal et al [37]		Laparoscopic skills	203	Amazon Mecha
2016	Powers et al [38]		Simulated robotic surgical skills	30	Amazon Mecha
2016	Ghani et al [39]		Robotic surgery:	30	Amazon Mecha

			prostatectomy		
2016	Kowalski et al [40]		Basic Urological Laparoscopic skills tasks	60	Amazon Mecha
2017	Yeung et al [41]		Laparoscopic skills	4	Not reco
2017	Vernez et al [42]	**Student Selection Process**	Student selection in surgery: Next generation of surgeons	Not recorded	Amazon Mecha
2017	Lee et al [43]		Student selection in surgery: Next generation of urology surgeons	Not recorded	Amazon Mecha

Table 1. Summary of current studies evaluating application of crowd-based activities in m

Tables

Application of crowdsource definition.

Paper	Clearly Defined Crowd	Task with Clear Goal	Reward	Identified Crowdsourcer	Online Assigned Process
Bow et al [27]	Y	Y	Not noted	Y	N
Blakewell et al [28]	Y	Y	Not noted	Y	N
Lewis et al [29]	Y	Y	Not noted	Y	N
Penciner et al [30]	Y	Y	Not noted	Y	Y
Chen et al [31]	Y	Y	Economic	Y	Y
Holst et al [32]	Y	Y	Economic	Y	Y
Agadashi et al [33]	Y	Y	Economic	Y	Y
Malpani et al [34]	Y	Y	Economic	Y	Y
White et al [35]	Y	Y	Economic	Y	Y
Polin et al [36]	Y	Y	Economic	Y	Y
Deal et al [37]	Y	Y	Economic	Y	Y
Powers et al [38]	Y	Y	Economic	Y	Y
Ghani et al [39]	Y	Y	Economic	Y	Y
Kowalski et al [40]	y	y	Economic	Y	Y
Yeung et al [41]	Y	Y	Economic	Y	Y
Vernez et al [42]	Y	Y	Economic	Y	Y
Lee et al [43]	Y	Y	Economic	Y	Y

Table 2. Papers were assessed to determine whether they met the 'fundamental elements' of a crowdso
Estelles-Arolas and Gonzalez-Ladron-de-Guevera [4]**.** Papers shaded grey did not meet t

Figure

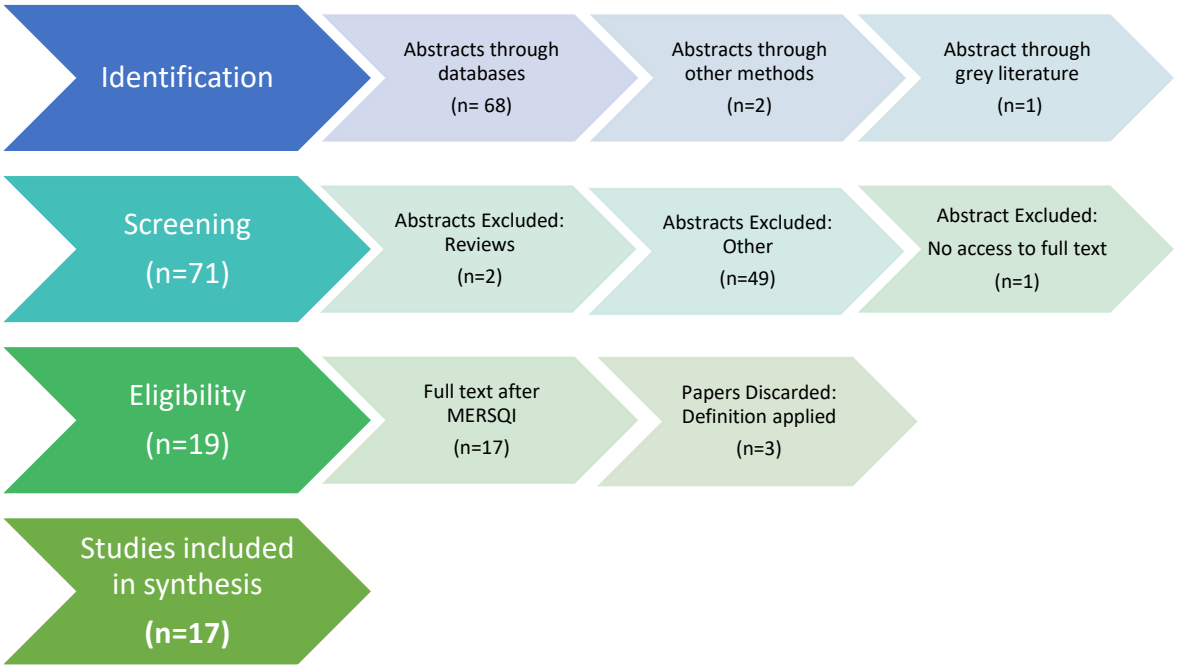

Figure one. Studies to be included in the literature review: decision tree