“Concrete ways we can make a difference”: a multi-centre, multi-professional evaluation of sustainability in quality improvement education

Quality improvement (QI) projects are a mandatory part of postgraduate medical training in the UK and graduating medical students must be competent in QI theory. We evaluated an educational toolkit that links concepts of sustainable healthcare with established quality improvement methodologies (the SusQI approach, available at www.susqi.org). The SusQI approach was implemented across a range of undergraduate and postgraduate nursing and medical education contexts. Educational strategies included guided online learning, live interactive webinars, small group activities and scaffolded project work. The evaluation strategy was informed by theories of academic motivation, educational value within communities of practice and behaviour change. A simultaneous nested design was tested using a mixed methods survey with input from learners and teachers. 177 survey responses were analysed to quantify and compare self-rated impacts of teaching across different audiences. Qualitative data were inductively coded into themes that were categorised according to above theoretical frameworks. Participants felt that this was ‘time well spent” and many described transformative impacts that guided their daily professional practice beyond learning about QI. We suggest that meaningful space is found within both undergraduate and postgraduate healthcare curricula for SusQI, as a way of engaging and motivating learners to contribute to the creation of a sustainable healthcare system.

Keywords; sustainable healthcare, quality improvement, medical education, nursing education, motivation

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Practice Points

- Following the Paris Agreement on climate action, healthcare practitioners need the skills and expertise to implement sustainability and Net Zero plans
- The SusQI toolkit articulates strategies for teaching and doing sustainable quality improvement projects and has now been validated across a range of health professional contexts
- SusQI helps learners to broaden their conception of sustainability to include preventative healthcare, supported self-care, lean systems and environmentally responsible swaps as well as resource stewardship
- Participants expressed strong intrinsic motivations to improve the sustainability of healthcare, and appreciated developing the capabilities to implement and evaluate change within their sphere of influence
- SusQI develops practitioners' motivations and capabilities to improve the sustainability of healthcare, however they also need scaffolded opportunities to complete projects in the workplace

Introduction

Today's healthcare professional students are already, and will increasingly be, on the frontline of responding to the impacts of climate change on human health (Watts et al. 2019). Yet, despite overwhelming recognition from health professionals that climate change impacts health, it is unclear in practice how healthcare delivery will become decarbonised and more environmentally and socially sustainable (Kotcher et al. 2021).

In 2020 NHS England became the first health system in the world to set a target for net zero carbon emissions, additionally the General Medical Council and Nursing Medical Council have included a requirement for new graduates "to understand and apply the principles of sustainable healthcare to clinical practice" but their guidance does not specify what this practically means (General Medical Council (GMC) 2018; Nursing and Midwifery Council (NMC) 2018; Greener NHS 2020). The recent AMEE consensus statement on education for sustainable healthcare gives more clarity and educators have been suggesting innovative ways in which to incorporate sustainability principles into health professional education (Shaw et al. 2021). There are varied definitions of sustainable healthcare (Shediac-Rizkallah and Bone 1998; Mortimer 2010; Shaw et al. 2021) and systems sustainability is sometimes separated from environmental or social sustainability. We argue that they are interlinked, as healthcare systems cannot be sustained without effective social, environmental and economic resource stewardship. We therefore define sustainable healthcare as healthcare that "delivers high quality care without damaging the environment, is affordable now and in the future and delivers positive social impact" .

There remain challenges to widespread inclusion of sustainable healthcare within undergraduate healthcare education, including overcrowded curricula and lack of faculty capacity and expertise of the topic (Tun 2019). Additionally, many healthcare students feel poorly equipped to practise healthcare sustainably and have demanded more educational time dedicated to the topic (PHRC 2021).

To address some of these challenges, the Centre for Sustainable Healthcare (CSH) has developed the Sustainability through Quality Improvement (SusQI) toolkit with the aim of integrating principles of sustainability into quality improvement teaching in order to improve the knowledge and skills required to change healthcare systems and practices so that they become more sustainable. The toolkit is available open access at www.susqi.org and is designed to be integrated across a range of undergraduate and postgraduate health professional contexts.

Quality improvement (QI) projects are a mandatory part of postgraduate medical training in the UK and graduating medical students must be competent in QI theory (General Medical Council (GMC) 2018). However, many trainees report feeling disengaged with QI with some describing it as a tick box

exercise(Azizi et al. 2017). Integrating sustainability with QI may provide an opportunity to enhance motivation and engagement in QI whilst simultaneously equipping learners to make practical changes to improve sustainability in healthcare within their future practice(Mortimer et al. 2018). A case-study of the SusQI approach at Bristol Medical School demonstrated it was effective in building motivation and skills, and re-framing thinking on QI in that context (Clery et al. 2021). In this study we aim to further understand how effective the approach is across both undergraduate and postgraduate medical and nursing education and from a wider range of institutional contexts. Our research question is formulated as an open question as we have taken an inductive approach to research. This aims to explore a phenomenon rather than to answer closed a-priori questions. In order to inform this approach we specifically hoped to further understand the following aims:

1) To describe how well learners felt they had met the intended learning outcomes, and to explore and explain any differences in outcomes across contexts.
2) To analyse how learners' self-rated academic motivations for engagement in the session related to their self-rated intentions to put their learning to practice.
3) To explore the broader educational value of this teaching through a thematic analysis of qualitative reflections.

Methods

Research approach

Our educational perspective is reformist: aiming to challenge, stimulate, and provoke critical thinking (Kaufman 2018). Our overarching aim was to describe, analyse and explore the application of the SusQI approach; who does it work for, in which professional and organisational contexts, and why, rather than aiming to build new theory, our research aims are translational(Ringsted, Hodges, and Scherpbier 2011) i.e. using existing theories to inform our implementation and analysis, and exploring the factors that influence outcomes. Our approach was informed by Stufflebeam's model (Stufflebeam 1984) which aims to evaluate the resources and processes, the influence of context, as well as to describe the impacts of training. Stufflebeam advocates an illuminative approach which looks at the experiences and outcomes of learning from the perspective of learners, rather than as imagined by teachers, allowing us to explore informal as well as formal learning as well as outcomes beyond our intended goals. The research involved multiple sites and contexts, therefore, we adopted a pragmatic survey-based approach. The survey had a mixed-methods simultaneous nested design(Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., &

Hanson, W. E. 2003) where qualitative data are used to triangulate and explain quantitative findings, as well as thematically analysed to identify emergent phenomena of interest.

Researcher characteristics and reflexivity

The research team comprised: three medical educators (FM, RS, VS) and a nursing educator (SPW) involved in developing and delivering the SusQI toolkit; and a full-time educational researcher from a second institution (KLG). As teachers of SusQI, our positionality is that sustainability in healthcare is an important and desirable outcome. To mitigate the potential conflicting goal of 'showcasing' SusQI, we held reflective discussions at our research meetings and KLG audited the analysis to ensure that both successes and challenges were reported.

Teaching context and intervention

Live teaching took place between September 2020 and March 2021 and was delivered via video-conferencing software (Microsoft® Surface Hub, Zoom®, or Microsoft® Teams). The content of the teaching was tailored to the background of the learners and was based on the resources available at http://www.susqi.org. However, although some content was adapted to the learner's background all teaching sessions included these core elements:

- Pre-workshop tasks introducing environmental and social challenges of healthcare, current policy contexts, and videos describing case studies of SusQI in clinical practice.
- Live online workshops included a short lecture to introduce the Centre for Sustainable Healthcare's 4 principles of sustainable clinical practice: prevention, patient empowerment and self-care, lean clinical pathways and low-carbon alternatives, illustrated through the use of a driver diagram.
- Small group, breakout sessions, using online collaborative worksheets, supported by a facilitator which applied learning to a SusQI case study. Students completed tasks to apply strategies for analysing systems, co-designing solutions, and implementing and evaluating QI changes including how to measure patient and population impacts against the triple bottom line (social, environmental and economic impacts). Particular attention was given to measuring environmental and social outcomes, including a demonstrating of a top-down method of how to calculate the carbon footprint of a hospital appointment.

Active learning was facilitated through online polls, breakout rooms, and structured online whiteboards (Miro®.). The best worksheets were shared and challenges discussed. Depending on the institutional context, some learners had opportunities to consolidate their learning through additional project work, this was either voluntarily or in the case of the 3 week selected study module in Bristol this took place under with a GP supervisor. Data collection took place immediately after the end of the teaching sessions, between October 2020 and April 2021. Participating institutions are listed in Table 1.

Participants and sampling strategy

All attendees were invited to complete a Qualtrics® anonymous online survey with 5 minutes dedicated at the end of teaching for this purpose. Completion of the evaluation survey was anonymous and voluntary. We don't have precise attendance records as not all institutions monitor this. Where this was not the case, we asked for estimates which ranged from 50 to 95% attendance. Where attendance was recorded, the questionnaire response rate varied between 48% and 94%, mean of 72%. Participant characteristics are listed in Table 1.

Ethics

This research had ethical review via Imperial College Education Ethics Process: EERP-2021-010, with local approval given from participating sites. Participation was voluntary, responses were recorded anonymously, and participants gave informed consent for their feedback and reflections to be analysed for research purposes.

Data generation

The survey was informed by existing theories of academic motivation(Cook and Artino 2016) and educational value (Wenger, Trayner, and Laat 2011) . Survey questions are outlined in Table 1, full text in supplemental materials. Quantitative questions invited respondents to agree/disagree with a set of statements on a 7-point Likert scale centred on neutral. Qualitative questions invited participants to explain their quantitative answers, to reflect on their experience of the session and what they gained from it, and to articulate the barriers and facilitators to putting their learning into practice. The survey wording was co-constructed with 5 experienced SusQI educators and improved and simplified from the user perspective by 2 postgraduate and 2 undergraduate volunteer learners.

Table 1. Survey informed by existing theories of academic motivation (Cook) and educational value (Wegner)

Descriptors and demographics	Outcomes	Motivations	Educational value 7 point agree/disagree sliders	Qualitative questions
Drop down, categorical	7 point agree/disagree sliders, ordinal	7 point agree/disagree sliders, ordinal	7 point agree/disagree sliders, ordinal	6 qualitative questions
Institution Role Age Gender Ethnicity How did you engage? (live/recording/e-learning/pre-reading/f2f/webinar)	I feel able to ● set a goal ● analyse a system ● design changes to deliver sustainable value ● implement and evaluate changes to sustainable value	Because I enjoy it Because it interests me Because the environment is important to me Because social justice is important to me It's not relevant to me To improve healthcare To gain respect To progress my career	Time well spent I learnt useful skills I have specific ideas that I intend to apply I am capable of having an impact on the sustainability of healthcare	Impression of teaching Changes to thinking about sustainability Changes to thinking about quality improvement How have you applied / intend to apply (qual) Sustainability focus within project plans (qual) Challenges and strategies for applying learning in practice (qual) Also: invitation for explanatory insights after quantitative questions

Data analysis

Our quantitative analysis was conducted using SPSS(v28). We used non-parametric Spearman correlations to explore the relationships between Likert scores, in particular which motivations and capabilities were most strongly correlated with intention to apply learning in practice.

We used non-parametric Kruskal-Wallace tests to determine whether there were significant differences in the distribution of Likert scores (treated as scalars) between sites and professions, followed by pairwise comparisons and whisker plots to explore and illustrate significant findings.

Qualitative data were analysed using Dedoose ®. All content was coded with its underlying meaning, then similar codes were grouped into themes which were then categorised according to the Wenger-Trayner framework for educational value (Wenger et al, 2011) which we adapted to our learning context:

- Immediate value: what did students think of the activities and interactions? What was their experience?
- Potential value: what did students state that they learned? In what ways did they feel the learning was relevant to their future practice?
- Applied value: how did students describe translating their learning into action?
- Realised value: what value was created for service users and service providers?
- Reframing value: what transformations and perceptual shifts happened?

RS and SPW coded all content on Dedoose ®. RS, SPW and KLG co-created themes and categorised them according to the above framework through consensual discussion. Themes were checked and refined by KLG and audited against the underlying data to ensure all perspectives had been fairly captured.

Results

Participant characteristics

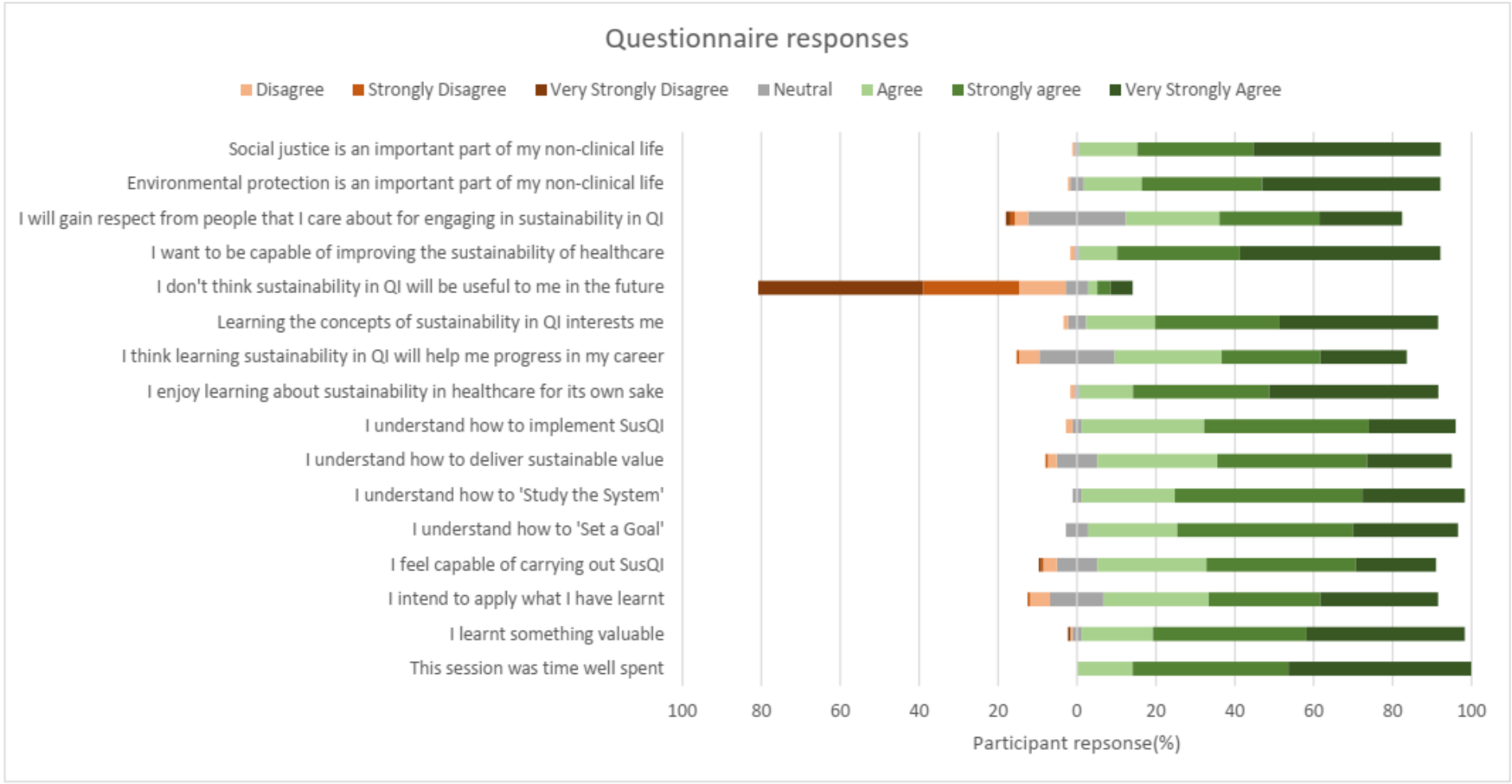
Table 2 shows the characteristics of the 177 participants who responded to the survey. All questions were optional, therefore the total number of respondents answering each question is not always 177. We therefore state absolute numbers alongside percentages which are reported a proportion or respondents to the question.

Table 2. Participant Characteristics

Health professional group	(n)	(%)
Specialist Community Public Health Nurses	6	3.4
Pre-registration MSc Nurses	30	17
Undergraduate Medical Student	52	29.3
Postgraduate Medical Doctors	89	50.3
Total	**177**	
Age		
25 and under	83	53.2
Over 25	73	46.8
Total	**156**	
Gender		
Female	104	64.2
Male	58	35.8
Total	**162**	
Ethnicity		
Asian/Asian British	43	28
Black/African/Carribbean/Black British	13	8.5
Mixed/Multiple	14	9.2
Other ethnic group	5	3.3
White	78	51
Total	**153**	
Teaching setting/Attendance (M= Mandatory, S= Self-selected)		
Barts and the London Medical School (M)	45	57.7
Bristol University Student Selected Component (S)	6	7.6
East of England Foundation School (S)	52	66.7
Health Education England North West (S)	11	14.1
King's College Medical School (M)	5	6.4
Kings College Nursing (M)	35	45
Severn Deanery Foundation School (S)	23	30.1
Total	**177**	

Graph 1 shows the number of responses per category for each question on a balanced Likert scale centred on neutral. Where appropriate we interpret our findings next to our results.

Graph 1: Questionnaire responses



Motivations

The most frequently agreed motivating factors for engaging in SusQI teaching were both intrinsic motivations: wanting to learn about sustainability in healthcare for its own sake (98.8%, n=162) followed by wanting to be capable of improving the sustainability of healthcare (98.2%, n=162). The lowest scoring motivating factors were both extrinsic: wanting to gain respect from people they care about for engaging in SusQI (77.5%, n=124) and believing that SusQI would help career progress (83.0%, n=131). Being motivated by environmental protection and social justice in non-clinical life were also important motivating factors, with positive responses from 90.4% (n=160) and 91.5% (n=162), respectively.

Intended outcomes

For each question that asked if participants felt they had met the intended learning outcomes, the responses were positive. A majority of 97.1% (n=166) and 98.9% (n=172) either agreed, strongly agreed or very strongly agreed after the session that they understood how to set a goal and study the system, respectively. Similarly, 92.0% (n=159) and 97.1% (n=168) gave positive responses that after the session they knew how to deliver sustainable value and how to implement SusQI, respectively.

Perceived educational value

Questions which measured the perceived education value of the session for participants also received largely positive responses. Every participant (n=177) either agreed, strongly agreed or very strongly agreed that the session was time well spent, whilst 97.7% (n=172) either agreed, strongly agreed or very strongly agreed that they had learned something valuable. A majority of 87.2% (n=165) of students intended to apply SusQI in their future clinical practice, with 5.8% (n=10) of students disagreeing, strongly disagreeing or very strongly disagreeing. 12.3% (n=20) agreed that SusQI would not be useful to them in the future, although 18 of these appear to be an artifact of the only negatively worded question, as triangulated against the rest of their responses.

Intention to apply learning to practice

Table 3 shows the Spearman correlations between each Likert score and intention to apply SusQI theory to future quality improvement projects. Every correlation reached statistical significance (<0.05 1-tailed), with strong correlations (correlation coefficient >0.4) seen among nine of fifteen questions. The strongest correlations between self-rated outcomes and intention to apply SusQI in the future were seen with understanding the theory of how to deliver sustainable value (0.593, $p<0.001$), understanding how to

implement SusQI in practical terms (0.587, $p<0.001$), feeling they had learnt something valuable (0.557, $p<0.001$) and feeling capable of doing SusQI (0.536, $p<0.001$).

The strongest correlations between self-rated motivations and intention to apply SusQI in future were a personal interest in SusQI concepts (0.424, $p<0.001$) and a desire to be capable of improving the sustainability of healthcare (0.401, $p<0.001$).

Table 3: Correlations with intention to apply

	Spearman Coefficient	Significance (1-tailed)
I understand how to deliver sustainable value	0.593	<0.001
I understand how to implement SusQI	0.587	<0.001
I Learnt something valuable	0.557	<0.001
Capable of doing SusQI	0.536	<0.001
This session was time well spent	0.511	<0.001
I understand how to 'Study the System'	0.500	<0.001
I understand how to 'Set a Goal'	0.474	<0.001
Learning the concepts of sustainability in QI interests me	0.424	<0.001
I want to be capacble of improving the sustainability of healthcare	0.401	<0.001
I enjoy learning sustainability in healthcare for its own sake	0.383	<0.001
Environmental protection is an important part of my non-clinical life	0.375	<0.001
Social justice is an important part of my non-clinical life	0.362	<0.001
I think sustinability in QI will help me progress in my career	0.317	<0.001
I will gain respect from people that I care about for engaging in sustainbility in QI	0.266	<0.001
I don't think sustinability in QI will be useful to me in the future	-0.241	<0.001

Variation across professional groups

We used the non-parametric Kruskal-Wallis to test whether there were differences in any questionnaire responses between occupational groups. There were statistically significant differences ($p=<0.05$) between groups for two questions, both of which asked if students met the intended learning outcomes for the session; 'I understand how to set a goal' ($p<0.001$) and 'I understand how to deliver sustainable value' ($p<0.001$). A secondary analysis of pairwise comparisons between each group confirmed that postgraduate doctors were significantly more likely to agree with 'I understand how to set a goal' than medical students ($p=0.002$) or pre-registration nurses ($p=0.005$) and 'I understand how to deliver sustainable value' than medical students ($p<0.001$) but not pre-registration nurses. The pairwise comparison revealed no statistically significant difference between undergraduate medical students and pre-registration nurses.

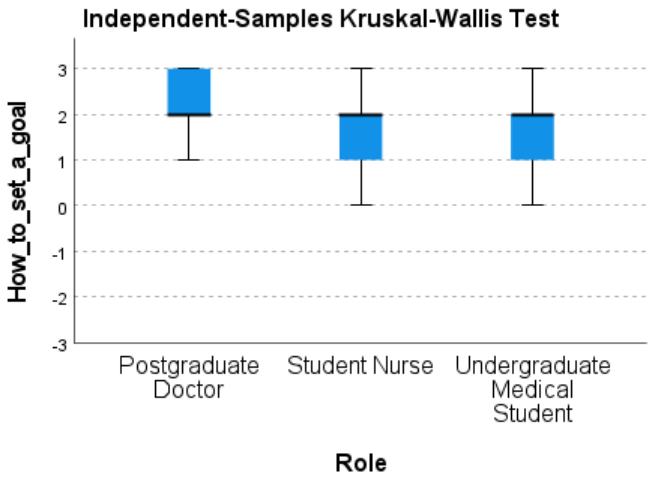
Graphs 2 and 3 show the results of the independent Kruskal-Wallis Test for each question alongside the secondary analysis and whisker plots.

Graph 2: Independent Kruskal-Wallis Test; response variance between occupation groups for the question 'I understand how to Set a Goal'

Independent-Samples Kruskal-Wallis Test Summary

Total N	171
Test Statistic	13.269[a]
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	.001

a. The test statistic is adjusted for ties.

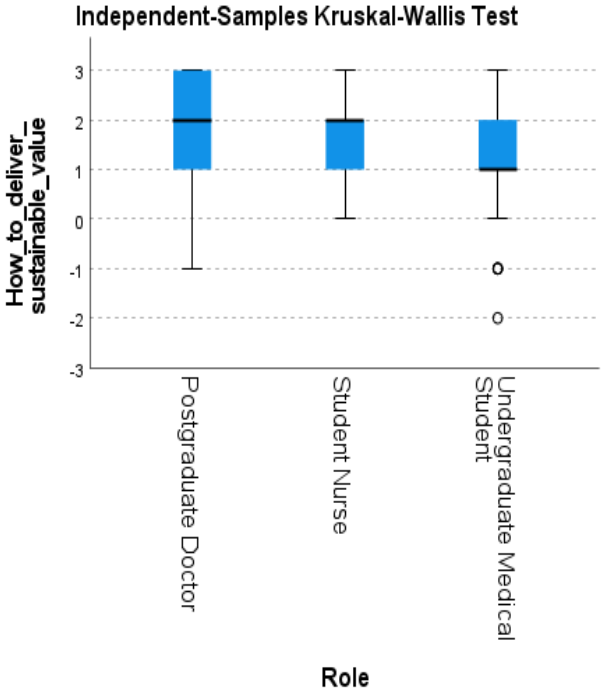


Graph 3: Independent Kruskal-Wallis Test; response variance between occupation groups for the question 'I understand how to deliver sustainable value'

Independent-Samples Kruskal-Wallis Test Summary

Total N	173
Test Statistic	16.066[a]
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	<.001

a. The test statistic is adjusted for ties.



Immediate value - what did participants think of the session?

Participants described a range of immediate responses to the teaching sessions. Positive responses were grouped into the following themes: interesting, informative, useful, helpful, eye-opening, empowering and inspiring:

> *"Eye opening - useful to see the ways in which my future practice could be more 'green'"* R66

> *"Really useful teaching, gave me ideas and inspiration for my own sustainability QI project."* R36

Participants particularly valued content such as pre-reading, case studies and polls which were described as well structured, clear, concise and engaging.

> *"Engaging session breaking down how to think of SusQI projects and how to overcome difficulties"* R125

They found active learning strategies helpful such as smaller group work with structured worksheets and appreciated the opportunity to talk about the topic with other students.

> *"I think the breakout groups were well organised because there was a worksheet which guided structured discussions and reduced awkward silence and also because there was a facilitator present."* R72

> *"Previous QI teaching has been quite dull but having the opportunity to share ideas with like minded people was really helpful."* R107

Participants often commented that this subject was new to them and not covered elsewhere in their education and that further teaching would be desirable.

> *"It was extremely useful to understand more about sustainable QI as this is something that isn't spoken about or discussed whilst working or training at medical school"* R32

> *"It was refreshing to see sustainability and being mindful of our environmental impact being addressed - hope to see more teaching like this in the future!"* R137

Intentional value - what relevant learning happened?

Participants described feeling better equipped to apply the principles of sustainability to QI projects. This was backed up by our quantitative data where participants self-rated their achievement of intended

outcomes. Their qualitative comments indicated plans to measure environmental and social outcomes within QI projects. They described finding data on carbon hotspots within healthcare and the overall impact of healthcare on the environment as shocking, mitigated by feeling empowered to address these issues through QI.

> *"I will consider sustainable projects in my current workplace and aim to improve in particular the highest areas of emissions within the NHS such as pharmaceuticals and instruments through different projects"* R32

> *"Healthcare is such a big carbon contributor! I did not realise! I also assumed that not much could be done about it but this has showed me that there is so much that can be done!"* R56

Some participants commented on how they felt more determined to carry out their QI projects and others commented on how they wanted to start projects to cement their knowledge.

> *"...developed my resolve to push the sustainability agenda in my own practice and QI projects"* R33

> *"I think knowledge gained from this session will be cemented by initiating an active project"* R128

Some described relating the principles of sustainability to a broader context, not just within QI.

> *"It helped me to understand the importance of it, but also how it would actually be applied in multiple settings and organisations."* R1

> *" I would now look into my day to day practice and will think how I can play a part in reducing carbon emission"* R118

The session catalysed some to pass on their knowledge about sustainable healthcare to others.

> *"Now I will be happy to pass on my knowledge to my colleagues on ways that we can protect the environment."* R45

Applied value – how did participants apply their learning?

Some learners were already involved in QI projects and were able to describe how SusQI tools were applicable to those projects. Participants described how the focus on studying the system and using value process mapping tools was particularly helpful.

> *"Fantastic use of flow diagrams and realising the important points of impact and intervention. This allows us to focus our energy efficiently in our improvement projects."* R10

Some described how they applied their learning on carbon footprinting to real world projects such inhaler prescribing.

> *"I did a carbon analysis of a project looking at MDI to DPI switch"* R125

Challenges to applied value

Although most participants expressed strong intentions to apply their learning, some described challenges despite feeling motivated. These included feeling disempowered by their junior status and the transient nature of clinical placements, and despondency at organisational inertia and protocolised pathways which made change feel unachievable.

> *"Some of the projects were really large and potentially beyond our capabilities given the short rotation lengths associated with being a foundation doctor."* R32

> *"I think within a large system, which is overall quite resistant to change, it may be challenging to make a large difference with the projects we complete. But, it is definitely worth trying!"* R11

> *"Sceptical about actual real-translation considering we prioritise safety"* R6

Realised value - what sustainable value was created for services?

Most teaching occurred as a single session, therefore project outcomes were not evaluated through this research. However, where the teaching occurred alongside a practical project, students were able to describe how the principles of SusQI enabled them to generate social, environmental and economic value as well as improve patient care.

> *"I created resources to enable deprescribing of antidepressants and encourage social prescription for a project. The long-term goals are to sustain wellbeing and decrease a financial and environmental burden on the NHS. I incorporated ways of measuring such outcomes into the project so that the medical practise can regularly review them."* R4

Reframing value - how did SusQI transform participants' thinking?

Participants described reframing their role identity to include environmental stewardship.

> *"It showed that I have responsibility to pursue environmental action as a future nurse."* R163

> *"Will massively consider the impact every aspect of my role (even as a student) has! Huge change is needed."* R170

They described how change felt more achievable and identified themselves as agents for positive change.

> *"Made it seem more achievable/less of an overwhelming problem with no solutions."* R97

> *"Everyone can do something, even if it is a little change. Every patient encounter is a chance to change something." R132*

Participants described how SusQI helped to mitigate climate anxiety through giving them ways to practically mitigate healthcare's environmental damage.

> *"It is easy to feel hopeless with news of climate change. SusQI is valuable as it gives concrete ways in which we can make a difference, rather than just learning about the problem."* R79

Participants described reconceptualising QI within their future practice, and sustainability as integral to QI.

> *"To see that people care and that people are taking action for change. To add that I have learned how I can incorporate sustainability into my own QI projects in the future. There is a connection between sustainability and quality improvement. With a goal of sustainability, the quality our patients get can be multidimensional."* R42

> *"Now I think, sustainability should be a part of every QI project"* R118

Others described expanding their thinking about QI to multiple spheres of influence.

> *"Quality improvement can start from an individual level before implementing changes from an organisation level"* R71

"Made me think about environmental change and the wider impact on public health. The figures mentioned in the carbon footprint exercise was very powerful" R12

Discussion

We have presented an evaluation of a novel approach of integrating sustainability into quality improvement teaching, implemented at multiple UK sites within undergraduate and postgraduate medical and nursing education. Our methods were designed to accommodate emergent findings, which we further discuss in relation to the literature.

The questionnaire results demonstrate that this teaching has led to improvements in learners' self-reported knowledge, confidence, and attitudes to both QI and sustainable healthcare. All learners felt that they had met the learning outcomes to some extent, with a strong correlation between the development of SusQI capability and intention to apply their learning to their future practice. Almost all students rated themselves as personally interested in environmental protection and social justice, and there was an unsurprising correlation between the strength of these interests and self-rated engagement in the session. Qualitative comments suggested learning was driven by active pedagogies, peer interactions, and relatable case studies. The teaching was transformative for many, with some developing a 'sustainability lens' that changed the way they saw clinical practices in general; a transformational shift in their thinking about the importance of both QI and sustainability; and perhaps most importantly, reframing themselves as having agency to deliver health system improvements. Although the session was empowering for most, barriers to implementing SusQI in practice were noted, particularly by medical students. These included their junior status within a hierarchical system, the transient nature of clinical placements, and concerns about organisational inertia and inflexible protocolised care. Postgraduate doctors were significantly more likely to report feeling able successfully deliver SusQI projects in practice.

Our findings confirm those from a SusQI case study report by Clery et al. based on third-year medical students at the University of Bristol (Clery et al. 2021). The current study, however, demonstrates that SusQI education is applicable, valued and impactful across multiple professions and contexts.

Healthcare professionals are increasingly concerned about climate change and engaged in climate and health action, with 87% of NHS staff supporting the NHS Net Zero ambition(Kotcher et al. 2021; Issa et al. 2021; NHS England 2017). Our research shows that SusQI education may represent a practical tool for transforming these motivations into engagement with practical health systems change. Having agency to influence the causes of climate change is especially relevant given the substantial numbers of young people currently reporting eco-anxiety (Marks, Elizabeth and Hickman et al, n.d).

In an era of crowded curricula and institutional awareness of student satisfaction scores, it is an important finding that all participants reported the session as time well spent. The Planetary Health Report Card, a student-driven, metric-based initiative to inspire sustainable healthcare education engagement in medical schools, has included the ability for students to enacting a sustainability initiative/QI project as part of their scoring metrics (PHRC 2021). Previous research has found that a lack of curricular space and faculty time constraints are important barriers to the inclusion of sustainability or climate change in health professional education despite high motivation levels (Kotcher et al. 2021; Tun 2019). Embedding sustainability into pre-existing QI education and using this ready-to-go educators' toolkit may be an easy and effective way to overcome those challenges.

Our findings support other studies that have found active approaches are important when linking theoretical learning to real-world applications (DeLozier and Rhodes 2017; Mortensen and Nicholson 2015). We are, however, conducting further research, including an analysis of completed SusQI projects, to fully evaluate translation into practice and to assess the realised impacts on healthcare services. QI and health system change need more than theoretical learning of QI: they require a plethora of change management and leadership skills, which junior health professionals may not have experience of, or perhaps the social capital to enact (Wright, Gabbay, and May 2021; Goldman and Wong 2020; Pronovost 2011). A 2010 review by the Health Foundation found that organisational culture, support and supervision, and working conditions were important factors in junior doctor participation in practical QI projects (The Health Foundation 2011). Despite common barriers, we have shown that certain professional groups, specifically post-graduate medical doctors, gained more knowledge and confidence than others. Further research is needed to disentangle the reasons for this, which may be related to agency within the workplace and/or previous experience of QI projects which are widely integrated into postgraduate medical education.

Limitation of our study include the relatively small number of participants in total and per professional group, with only 20% from a nursing background, as well potential sampling bias with many respondents reporting a personal interest in environmental and social justice. The findings should not be extrapolated to students that either did not attend the teaching or did not engage with the feedback process. Although we have demonstrated strong educational value across different institutions, professions and stages of training, this case study was situated within UK healthcare. Transferability to other industries or healthcare systems will necessarily depend on context (Simons 1996).

Conclusions

The SusQI education approach builds on the increasing motivation among healthcare students and trainees to act on social and environmental issues in their professional settings and empowers them to become agents for positive change. Learners were motivated by knowledge of factors impacting on the sustainability of healthcare and felt empowered by QI tools to make tangible changes within their sphere of influence. SusQI not only fulfils an obligation to teach sustainable healthcare, but also gives students the tools required to contribute solutions to the problems identified. Combining learning outcomes relating to sustainable healthcare with quality improvement education may partly address challenges relating to curricular space. The true value of SusQI will be in how it is applied as a practical tool for transitioning towards a more sustainable healthcare system, whether learners develop a lasting 'sustainability lens', and in its transferability to non-UK contexts. We recommend further research to explore these questions.

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