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Returning knowledge to the community: an innovative approach to sharing knowledge about drinking water practices in a peri-urban community

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ABSTRACT

During previous research into drinking water quality in Peru, it was found that water was becoming contaminated in households, and there was a lack of understanding surrounding this contamination. It was felt that returning these findings to the community could build capacity, enabling people to make more informed choices about drinking water practices. Several participatory methods were explored. Ketso®, a hands-on kit for engagement, was thought to provide the most appropriate approach, and was used to deliver several workshops in the community. Thirty-five participants explored their understanding of drinking water and factors that caused contamination. The method allowed them to explore these factors in depth and to develop several practical and simple solutions. One solution capitalized on a novel finding; participants associated the taste of chlorine with clean water, but were unaware that household bleach could be used as a cost-effective water treatment. Feedback was excellent, with Ketso seen as giving participants space to better understand and question their practices, whilst building capacity for change. This co-production of knowledge also allowed the researcher to gain a better understanding of local knowledge and perceptions. Such innovative knowledge exchange has important implications for future implementation of new water technologies and engineering projects.

Key words | co-production, drinking water, knowledge exchange, participatory methods, Peru, public engagement

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INTRODUCTION

This paper evaluates the development and implementation of a novel participatory method for post-project engagement of the community with research findings. It was funded through the ESRC's Knowledge Exchange Small Grant, which highlights the importance of establishing a flow of knowledge between research and the wider community, and addresses the general call to embed public engagement within UK research (RCUK 2013).

This research adds to the current and ongoing debate on the ownership of knowledge and returning knowledge to its origins. There is a growing body of work around co-production of knowledge 'in the field' (e.g. Eden 2008; Oldekop *et al.* 2011) and through collaborative processes, such as work on flood modelling by Landström *et al.* (2001, p. 1618), which asks: 'how can scientists be brought into effective collaborations with lay public?' Relatively little, if anything, has been written on staging this process to gain a physical artefact of shared understanding, which enables the blending of 'technical' and 'local' knowledge.

The main aim of the original research (Furlong 2009) was to explore the relationship between actual and perceived drinking water quality. A number of discoveries were made in relation to drinking water and contamination, despite this not being an objective of the research. Firstly, water was being contaminated *within* the home, rather than externally, due to established and ingrained drinking

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water practices. There were very high levels of faecal contamination in household samples. Secondly, there was a general lack of understanding of how water became contaminated or re-contaminated. Although several years had passed since this data gathering, these findings were rooted in deep-seated cultural practices that were unlikely to have changed in the intervening period, as there had been no major changes in technology or the social situation in this community. This was verified by discussions with the gatekeeper (the person who granted the researcher access to the community in the original research), the field assistant and the participants.

The aim of the fieldwork described in this paper was to return the knowledge from the original analysis to the community in a participatory way, and to gain further insights into the community's drinking water practices. A method was sought to enable capacity to be built, so that household drinking water managers could make more informed choices when managing water. The possible methods explored for the field work were based on participatory rural appraisal (PRA) (Chambers 1997), due to their emancipatory underpinning, combined with their ability to collect data for analysis.

Previous research had identified the community's aspirations for modernity. The appropriateness of using a manufactured 'modern' tool, compared to constructing a tool from indigenous materials (as is common with many PRA techniques), was confirmed by discussion with the gatekeeper. Ketso (www.ketso.com) was developed by Dr Joanne Tippett to encourage local involvement in planning villages in Southern Africa in the mid 1990s, and was further developed and tested in ESRC, Environment Agency and Sustainable Consumption Institute funded research at the University of Manchester (Tippett & Griffiths 2007; Tippett *et al.* 2007, 2009). The roots of Ketso lie in the hands-on approaches of PRA, combined with creative thinking tools (de Bono 1990) and mind mapping (Buzan & Buzan 1993). The portable kit consists of colourful, reusable shapes that can be written or drawn upon by participants, then placed on a table-top felt workspace. The visual nature of the kit and the way it works with moveable pieces was inspired by Gardner's (2000) 'Multiple Intelligences'.

Before the fieldwork, the two authors of this paper collaborated in developing the Ketso methodology for this particular context. This included thinking through the staging and timing of introducing the results of the previous work into the workshop. This was important to ensure participants felt that their knowledge was not being undervalued in the process, helping ensure that the complexities of local knowledge and behaviour could be explored in an open fashion. A further methodological innovation for Ketso was developing a new way to use the colour-coded leaves to ask questions about drinking water, which helped stage and broaden discussions about technical issues.

Case study area

Bellavista Nanay is a peri-urban community, 5 km from Iquitos in the Peruvian Amazon, with an estimated population of 3,000 people. This section summarizes findings from the original research (Furlong 2009).

The average household consists of seven people. A typical house is constructed of wooden walls and floors and a metal roof. In 2007 96% of households had an electricity supply, 61% had an inside toilet and only 2% were connected to the municipal water supply.

Five sources of drinking water were being used in this community but, due to the sporadic availability of sources, all respondents stored their drinking water for periods ranging from a few hours up to a week. Storage of drinking water was found to be related to its quality, as bacteriological drinking water quality decreased with increased storage time. Other drinking water practices identified in this community included the use of household drinking water treatment, with chlorination being the most common method; however, this method was only practised when chlorine was available at the medical post. The bacteriological quality of water at source and at household levels was examined (Robens Centre for Public and Environmental Health 2004), and it was found that 43% ($n = 64$) of samples taken at source conformed to WHO guidelines (WHO 2011) compared to only 20% ($n = 91$) of household samples. Additionally 68% ($n = 91$) of household samples were considered to be of high risk to health (WHO 2011) compared to only 34% ($n = 64$) of source samples. Due to this and other analysis it was concluded that water was becoming contaminated within the household; furthermore, through household surveys, interviews and observations it was found that there was a general lack of understanding surrounding this contamination.

The five most common medical conditions found in this community were all water-related diseases, including diarrhoeal disease (Furlong 2009). As improved drinking water quality is known to reduce diarrhoea cases by up to 39% (Fewtrell *et al.* 2005), building capacity among household drinking water managers to make informed choices could significantly impact the lives of people in this community.

METHODOLOGY

Participants for this research were recruited by personal invite to an event, which was held to thank people for participating in the previous study. Approximately 60% ($n = 91$) of those who took part in the original research attended this event, at the end of which the lead author briefly announced that she would be running a series of workshops, and asked for participants to sign up to them.

Five workshops were held, each with between five and nine participants. A total of 35 participants attended the workshops, one-third of the total participants in the previous study. The participants ranged in age from 16 to 70 years, and 91% were women, as the workshops were aimed at household water managers.

Prior to each session, written consent was requested to take photographs and record the workshops using a dictaphone. The workshops were led by a local field assistant, who had been trained by the lead researcher. The field assistant explained the main findings of the previous research and why the workshop had been developed.

The workshop process was described using the analogy of a tree, with the trunk being the main focus, 'contamination of water in your house', and the branches being the themes: 'drinking water sources', 'drinking water practices', 'drinking water properties' and 'other'. The 'other' category allowed participants to give answers that did not fall within the predetermined categories. This tree analogy used the basic structure of Ketso, which has a centrepiece for the focus of the workshop and branches radiating out from the centre, with leaves attached to the branches by participants during the workshop.

Four questions were asked during the workshop, starting with easier questions to build participants' confidence. These were: '1. What is good drinking water?', '2. What is bad drinking water?', '3. How does water become contaminated?' and '4. What are the solutions?' The questions were asked one at a time, and approximately 15 minutes was allotted to allow the participants to answer each question. The participants wrote their answer on the colour-coded leaves of the Ketso kit (with the colour-codes used to denote the different questions). They placed the leaves on the felt workspace, pointing them at the branch representing the theme they felt that it related to. The leaves were then moved around the felt, and developed into clusters to show similar meaning. The process of moving the leaves around allowed for exploration of their meaning and participants' perceptions.

Participants were then asked to highlight key issues, using movable icons to indicate the following: the most important drinking water practices; where water becomes contaminated; and anything they found interesting or new (each person was given three different colour-coded icons from the Ketso kit to represent these different issues).

RESULTS AND DISCUSSION

This paper is the first account of using Ketso in knowledge exchange with participants *after* a research project. It is also the first documented use of the toolkit in Latin America. Elsewhere, Ketso has been used throughout the research process, for example developing research questions and methods with stakeholders (Tippett *et al.* 2009), engaging in action with research participants (O'Shea 2012) and gathering data (Cowen *et al.* 2011).

The tree analogy worked particularly well in this context, possibly due to being situated in the rainforest. It put the participants at ease, as they were able to easily understand and relate to the explanation, and it stimulated initial discussion.

Figure 1 shows a 'Meta Ketso', a synthesis of the Ketsos from the different workshops. Some results were contradictory, as throughout the workshops it was stressed that there were no wrong or right answers, the aim was to explore participants' own understanding and

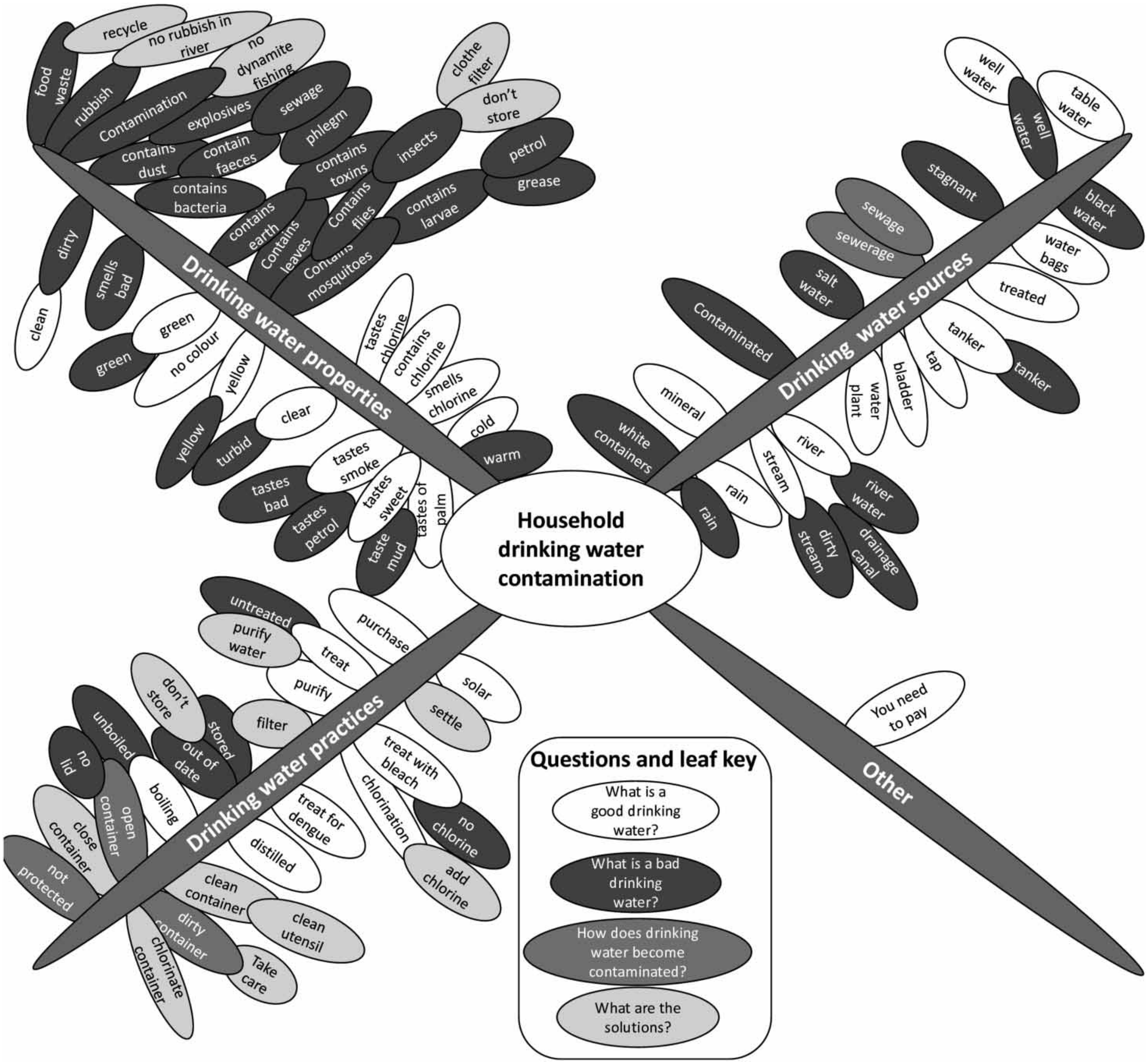

Figure 1 | Meta Ketso from workshops.

perceptions. This initiated exploration of the terms 'good' and 'bad' drinking water within the workshops, as many sources were categorized as both (Figure 1). Participants developed a discourse amongst themselves about the properties of good and bad drinking water sources, which culminated in discussion of the importance of treating water before consumption. Stressing that there were no right or wrong answers was found to aid the flow of discussion and deepen the debate. This ability to explore perceptions without concern for getting 'right' answers, combined with building the discussion in stages, aided the participants to think more deeply about the subsequent, more complex questions.

Figure 2 shows the overall proportions of types of leaves developed by participants. More ideas were generated around the question of 'bad drinking water', which could be due to this being the second question asked (after participants had gained confidence), and the fact that it was a question reflecting upon the first question. The participants were stimulated by the ideas already on the workspace

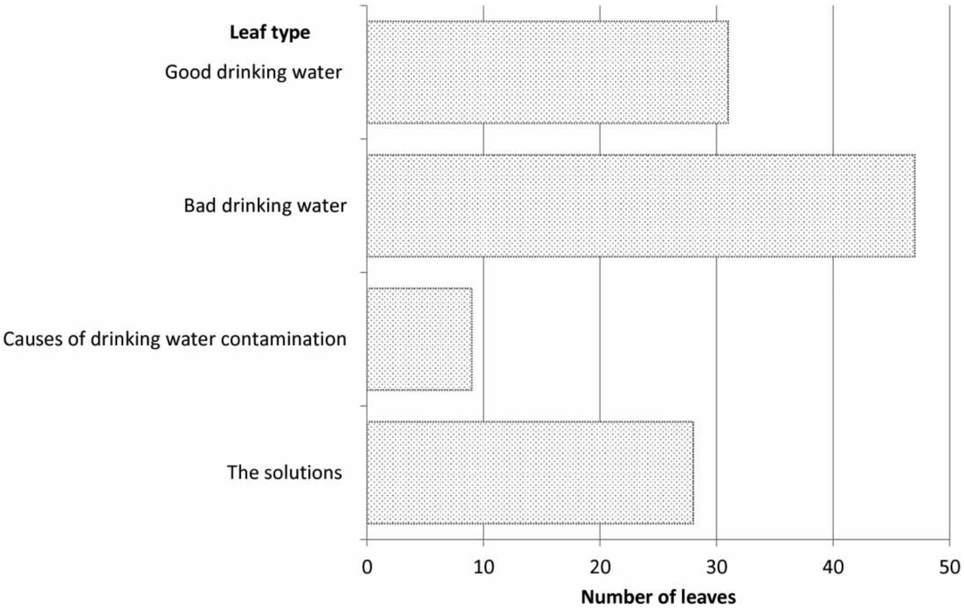

Figure 2 | Number of ideas by leaf type.

and grouped opposing ideas together. They developed their ideas beyond simple opposites (Figures 1 and 2) of 'good drinking water', considering further characteristics specific to 'bad drinking water'. Novel and surprising ideas were generated beyond the opposites, highlighting practices in storing water that could lead to 'bad water' and different types of contamination (Figure 1). This indicates that the participants' thinking was becoming deeper as the workshop progressed, which in turn helped develop answers to the third question, about causes of contamination, as many relevant ideas had already been discussed. The fact that ideas about contamination came up in the discussion about 'bad drinking water' was the reason for the relatively lower number of responses coded with the colour for 'causes of water contamination' (Figure 2). It was felt that it was better to let the participants to develop their ideas whilst thinking about the second question, rather than ask them to wait until the third stage of the workshop, as interrupting the process could impede the flow of ideas and reduce participants' confidence. The ordering of the first two questions was important, starting with a question about 'good water', as it was felt that if the participants' initial focus was on a negative question, a sense of negativity could permeate the workshop and inhibit creative thinking of solutions to drinking water problems.

Good drinking water versus bad drinking water

The participants were asked initially what was good and bad drinking water. They then thought about these questions in terms of drinking water sources, practices, properties and any other factors (i.e. the branches on the workspace).

Good water was considered by the participants to be either treated water (tap water, tankered water, water contained in the communal bladders, which are all supplied by the municipal water treatment plant and chlorinated, bottled treated table water and water purchased in plastic bags), or naturally clean water (stream water, river water, rain water, mineral water and well water). Natural water sources (well water, river water and rain water) were classified both as good and bad water sources, as the quality was dependent on location, i.e. one river may be clean and another dirty. Sources associated with dirt and pollution were also considered to be bad drinking water sources (contaminated water, dirty stream water, drainage canal water, stagnant water and salt water). Another term used was black water, which links the colour of the water to its use, and draws on the assumption that a good drinking water is crystalline in appearance. Two other sources were highlighted as bad sources; these were tankered water and water in white drums. This is of interest, as both of these sources were treated and are generally considered clean (and indeed had been mentioned as sources of 'good drinking water' in the workshop), but then become contaminated in dirty vessels en route to the home. This illustrated that the participants were aware of recontamination of water outside their homes, despite being generally unaware of possible recontamination inside the home. In all of the workshops, bad drinking water was associated with untreated water, which highlights both the importance and awareness of water treatment in this community.

In general it could be said that good drinking water was seen as clear and uncoloured. There was some debate about what water should taste of. Terms used to describe the taste of a good water included sweet, smoky and palm. An interesting finding was that the smell and taste of chlorine were related to good drinking water, as this was the only way the participants had to tell if water was safe to drink. This confirmed the author's previous findings (Furlong 2009), but contradicts other research in this field (Piriou *et al.* 2004; Turgeon *et al.* 2004; Biswas *et al.* 2005).

The source of household water contamination

When participants were asked how their drinking water becomes contaminated, all groups focused on external factors, rather than those within the house. The themes highlighted varied between the groups, but the dominant themes included flies, litter and petrochemicals. What was absent from all of the discussions was mention of water becoming contaminated by poor hygiene and household practices, but this discussion was developed later in the workshops through the stages of developing solutions and identifying good drinking water practices.

Identification of good drinking water practices

The respondents were asked to highlight what they perceived to be good drinking water practices from the ideas already developed on the Ketso. The most popular answer, highlighted in all of the sessions, was household drinking water treatment. This theme encapsulated household methods that were commonly used within the community, such as household chlorination and boiling, and methods that they had heard of from other communities, such as sand filters.

Other practices that were highlighted to a lesser extent were: covering the water container, using the water daily and cleaning the water container. Although covering water containers was discussed in all of the sessions due to its importance as a strategy to stop the spread of dengue, it was surprising that this was only highlighted once during the good practices sessions with regards to water quality. Using water daily (therefore not storing water) was discussed by one group. This was interesting, as water was generally stored in this community for up to one week. The cleaning of containers was also mentioned, although only by one group. A total of 28 possible solutions to drinking water problems were developed (Figure 2). This number reflects a lively degree of discussion about what could be done to improve drinking water quality. The good drinking water practices discussed in these sessions were all household practices that could be readily implemented.

Novel concepts and ideas

At the end of the workshops the participants were asked to highlight ideas they thought were novel or interesting. All the topics highlighted related to good drinking water practices, either preventing contamination or treating water. The topic noted as novel by the highest number of participants across all groups was the need to clean water vessels in the home. This was of interest, as it was something that the lead researcher had not considered as necessary to discuss before, due to its seemingly obvious nature and the assumption that it was already occurring. It is significant to note that the nature of these workshops, with the free flow and sharing of ideas, provided an open and safe environment for the peer exchange of practices and ideas, without fear of judgement from the facilitators (the field assistant and lead researcher). This allowed for participants to discuss the way water was managed in the home in a frank and open manner, and to explore new options, without closing down openness to new ideas due to a perceived need to provide the 'correct' answers and perhaps to hide ignorance or examples of perceived 'bad' practice.

Interesting discussions

The use of rain water for drinking was explored during the discussions of sources of water. It had been noted in the original research that rain water was used exclusively for washing, cleaning and hygiene, as it was considered primitive to use it for drinking. The virtues of using rain water and its various beneficial properties were discussed, as was its potential use for drinking after treatment. These discussions enabled key issues to do with perceptions of water and different practices to be explored.

Another recurring debate in all of the workshops was around household chlorination. The workshop provided a forum for the participants to discuss the use of different types of chlorine, including household bleach, and correct dosage. During these discussions the lead researcher was able to contribute technical knowledge in relation to the ideas that were being discussed, deepening the knowledge without impeding the development of locally grounded ideas. This is an example of the surfacing of a possible low-cost and practical solution from the exploration of options.

The use of Ketso

Participants were asked to give verbal feedback on the process, with the majority of participants saying that they had enjoyed the experience. They positively highlighted the game-like nature of the process and how this made it interesting. Several participants commented that the Ketso tool enabled everyone to participate in the workshop. One respondent stated '… it was good because we have all given ideas'. Participants in each workshop highlighted the uniqueness, in their experience, of being involved in a participatory process. One participant stated '…we are used to being dictated to, but it is nice to be able to give our ideas', while another commented that '…we are not used to thinking about such things, we are normally told what to do'. Participants did not raise any negative concerns about the process, but it is possible that they felt constrained to do so by the presence of the facilitators.

The associated progression of the workshop through stages (as defined by colours of leaves) allowed complicated arguments and discussions to develop. Dialogue was further developed due to placing answers next to the themes (denoted by the branches). The fact that the leaves could be moved and clustered allowed participants to place their leaves in relation to each other. Participants could see further important themes emerging from the grouping of their individual ideas. The analogy of a growing tree and the provision of further leaves meant that they could add new ideas to emerging clusters, in order to explore their thinking in more depth. This helped to solidify a wide ranging discussion into practical actions that participants could take away and use in their homes.

The section on highlighting key issues using icons was generally the most animated part of the workshops. Further debate was engendered as people assessed their initial ideas. Participants spoke of implementing new practices within their households at this stage. The fact that these useful practices emerged from within the groups, as opposed to being interjected by the researcher, demonstrated that peer learning had occurred.

The ability to see and develop patterns promoted a richer dialogue than if there was no physical record of the ideas. It also meant that participants could put down contradictory ideas and explore their meanings. This put less pressure on the facilitators to provide answers, and participants had a format to evolve their own understanding, rooted in their knowledge.

The fact that there was a process to follow meant that participants did not need to have the confidence to interject into a conversation using verbal cues. Instead, there were physical piles of leaves that needed to be placed on the felt workspace that everyone could see. The researcher observed the nature of the process emboldening participants to share their ideas. Two participants encountered problems with writing, due to poor eyesight. They used other group members as their scribes and were still able to participate actively in the discussions. Participants could also draw ideas if literacy was a problem. The accessible design of the kit has been found to be particularly suitable for working with marginalized or disempowered populations (e.g. Kay *et al.* 2012), a finding that is supported by this work.

This method created a unique forum for household water managers to discuss drinking water practices, their ideas and perceptions. No other method used in the previous study had allowed *all* participants to exchange information and to learn from each other. Ketso also enabled the researcher to gain a deeper understanding of drinking water practices, and the complexities and variations in participants' understanding, than with the previous methods used (interviews, questionnaires and observations), despite the fact that these methods had been combined to gain a deeper understanding of the specific context.

Understanding complexities and local perceptions is essential in changing practice and successfully implementing new technologies. A lack of such understanding has been linked to the failure of drinking water improvement schemes (Biswas *et al.* 2005; Singh 2006; Katsi *et al.* 2007). It should be noted that the studies quoted are thought to be the tip of the iceberg, as such schemes are rarely evaluated in the public domain (Prokopy 2005; Singh 2006).

CONCLUSION

Compared to the methods used in the previous study in this community, Ketso enabled the researcher to gain a deeper understanding of drinking water practices and the complexities and variations in community members' understanding.

Exchange of knowledge and in-depth exploration of ideas was encouraged by a combination of factors: building a flow of questions from simple to complex; starting with a positive question before moving to the problems; giving participants time to develop their ideas before sharing them; clustering ideas into similar themes, and allowing ideas to flow as participants thought of them.

A combination of this inclusive process, supported by Ketso, and the kit's tactile nature, with ideas captured in a physical artefact, levelled power inequalities and allowed all participants to share their ideas. The methodology was useful in the co-production of knowledge, in this case part of a feedback loop involving the previous study and the research reported on here. The approach adopted made useful advances in terms of enabling knowledge to be generated and shared simultaneously, such that the process of generating data was in and of itself a useful learning experience for those taking part in the research.

The ability to engage participants in peer-led learning and interactions with scientific knowledge in a non-threatening and open dialogue represents an important advance, as it is well known that lack of knowledge of the local context and lack of consideration of local perceptions often leads to failure of drinking water improvement schemes.

The knowledge gained from this study could easily be incorporated into an appropriate drinking water programme for this community. A household water treatment and safe storage programme could build upon the wide acceptance of household chlorination, and increase awareness that household bleach offers cost-effective water treatment. It could seek to tackle the incorrect but widespread assumption that drinking water only becomes contaminated outside of the house.

The findings from this research highlight the value of a participatory, hands-on process to facilitate co-production and exchange of knowledge around household water contamination and to develop solutions suited to the local context. This has potentially far-reaching consequences in improving drinking water quality (and thus health outcomes) and the adoption of new practices or appropriate technologies more generally.

Further research could explore the relative adoption of new practices that are introduced with this method, as opposed to more traditional knowledge exchange methods.

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