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Kenyan school book knowledge for water, sanitation, hygiene and health education interventions: Disconnect, integration or opportunities?

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ABSTRACT

Background: Schools, depending on their access to and quality of water, sanitation and hygiene (WASH) and the implementation of healthy behaviours, can be critical for the control and spread of many infectious diseases, including COVID-19. Schools provide opportunities for pupils to learn about the importance of hygiene and WASH-related practice, and build healthy habits and skills, with beneficial medium- and long-term consequences particularly in low- and middle-income countries: reducing pupils' absenteeism due to diseases, promoting physical, mental and social health, and improving learning outcomes. WASH services alone are often not sufficient and need to be combined with educational programmes. As pupils disseminate their acquired health-promoting knowledge to their (extended) families, improved WASH provisions and education in schools have beneficial effects also on the community. International organisations frequently roll out interventions in schools to improve WASH services and, in some cases, train pupils and teachers on safe WASH behaviours. How such interventions relate to local school education on WASH, health promotion and disease prevention knowledge, whether and how such knowledge and school books are integrated into WASH education interventions in schools, are knowledge gaps we fill.

Methods: We analyzed how Kenyan primary school science text book content supports WASH and health education by a book review including books used from class 1 through class 8, covering the age range from 6 to 13 years. We then conducted a rapid literature review of combined WASH interventions that included a behaviour change or educational component, and a rapid review of international policy guidance documents to contextualise the results and understand the relevance of books and school education for WASH interventions implemented by international organisations. We conducted a content analysis based on five identified thematic categories, including drinking water, sanitation, hygiene, environmental hygiene & health promotion and disease risks, and mapped over time the knowledge about WASH and disease prevention.

Results: The books comprehensively address drinking water issues, including sources, quality, treatment, safe storage and water conservation; risks and transmission pathways of various waterborne (Cholera, Typhoid fever), water-based (Bilharzia), vector-related (Malaria) and other communicable diseases (Tuberculosis); and the importance of environmental hygiene and health promotion. The content is broadly in line with internationally recommended WASH topics and learning objectives. Gaps remain on personal hygiene and handwashing, including menstrual hygiene, sanitation education, and related health risks and disease exposures. The depth of content varies greatly over time and across the different classes. Such locally available education materials already used in schools were considered by none of the WASH education interventions in the considered intervention studies.

Conclusions: The thematic gaps/under-representations in books that we identified, namely sanitation, hygiene and menstrual hygiene education, are all high on the international WASH agenda, and need to be filled especially now, in the context of the current COVID-19 pandemic. Disconnects exist between school book knowledge and

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WASH education interventions, between policy and implementation, and between theory and practice, revealing missed opportunities for effective and sustainable behaviour change, and underlining the need for better integration. Considering existing local educational materials and knowledge may facilitate the buy-in and involvement of teachers and school managers in strengthening education and implementing improvements. We suggest opportunities for future research, behaviour change interventions and decision-making to improve WASH in schools.

1. Introduction

Many diseases are entirely or partially attributable to inadequate drinking water, sanitation and hygiene (WASH) (WHO, 2019). Therefore it is important to provide safe water and sanitation, and to implement healthy hygiene behaviours.

Schools, as critical settings for the development and the early life of all children as well as for the work of teachers and other school staff, play a vital role here. With many pupils spending a substantial amount of their time on the premises, schools are important for pupils' physical and cognitive developments, as well as for their well-being. Moreover, schools can be critical places for the control and spread of infectious diseases such as gastrointestinal diseases or respiratory infections, including COVID-19, depending on their access to and quality of WASH (Adams et al., 2009; Freeman et al., 2012; Greene et al., 2012; Jasper et al., 2012; Joshi and Amadi, 2013; McMichael, 2019; Munn et al., 2020; Onyango-Ouma et al., 2005; Patel et al., 2012).

Minimum requirements for safe WASH in schools, such as drinking water from an improved source, useable improved facilities and handwashing facilities with available water and soap (WHO and UNICEF, 2018a) are not provided in most rural schools in Kenya. According to a 2017 school-based study (Morgan et al., 2017), 25% of the 198 surveyed schools relied on unimproved drinking-water sources, 38% of the schools had unsafe sources, contaminated with *E. coli,* and 44% of the schools collected drinking-water off-premise. About 25% of the rural schools had unimproved sanitation facilities and insufficient provisions for menstrual hygiene, and overcrowding of sanitation facilities was common in 24% of schools. Handwashing facilities were largely lacking (40%), as were soap (87%) and hand drying materials (81%) (Morgan et al., 2017).

As concerns the WASH situation in households, Kenyan data from 2017 show that 32% of the households (15 million people) lack access to an improved drinking water source at home. WHO and UNICEF define safe drinking water source as one that by nature of its construction, protects the water from contamination and has the potential to deliver safe water. (WHO and UNICEF, 2018a). Nine percent (4.5 million Kenyans) spend 30 min (roundtrip, including queuing) or more to collect water from an improved source (WHO/UNICEF, n.d.). Access to sanitation remains a challenge as well, with 10% of Kenyan households continuing to practice open defecation, and with only 38% having access to an unimproved sanitation facility, such as pit latrines without a slab or platform, hanging latrines or bucket latrines (WHO and UNICEF, 2018a). The lack of adequate handwashing facilities with water and soap in 75% of the households poses additional significant health risks. Domestic WASH provisions are significantly worse in rural areas, despite the slow but steady improvements over the course of the past 7 years (WHO/UNICEF, n.d.).

At schools pupils can learn about the importance of hygiene and WASH-related practice, and build healthy habits, both of which might not always happen at home. Adequate WASH provision for healthy practices at school have beneficial medium- and long-term consequences: WASH interventions in schools, such as - the provision of soap, water treatment or improvements to sanitation - can reduce absenteeism due to diseases, improving pupils' mental and physical health, nutritional status, and learning outcomes (Jasper et al., 2012; Joshi and Amadi, 2013). Improved WASH services, including means for menstrual hygiene management, also improve enrolment and gender parity, increasing girls attendance and well-being (Garn et al., 2013; Sumpter and Torondel, 2013). Negative health practices such as toilet avoidance and poor hydration adversely impact on pupils' attention and cognitive performance in class and on their health and well-being (D'Anci et al., 2006; Lukacz et al., 2011; Merhej, 2019). Besides the environmental provisions for WASH services, WASH education is of importance as well: the risk of parasitic infections, for example, is lower in children with knowledge on hygiene and sanitation practices. Moreover, WASH interventions with an integrated education component are more efficient, and ensure commitment and adherence to healthy practices such as handwashing (Joshi and Amadi, 2013).

WASH provisions and WASH education in schools also have effects on the community, as pupils disseminate their acquired health-promoting knowledge to their (extended) families. Pupils have been described as hygiene and health change agents for their peers and parents/guardians in school and home environments in the past (Onyango-Ouma et al., 2005). The role that pupils can play in helping to break the transmission route of various WASH-related diseases is remarkable, and proven to create significant health improvements (Blanton et al., 2010; Dreibelbis et al., 2014; O'Reilly et al., 2008).

In summary, water, sanitation, hygiene and health education promotes and multiplies healthy behaviour (Freeman et al., 2015; Greene et al., 2012; Joshi and Amadi, 2013; Patel et al., 2012).

For this reason, international organisations roll out interventions in schools to train teachers and pupils on safe WASH behaviour. What we do not yet know is how such interventions relate to local school book knowledge in low- and middle-income country contexts. A knowledge gap is what pupils actually learn during their school curricula with respect to WASH, health promotion and disease prevention, and whether and how this knowledge is integrated into WASH education interventions in schools.

In this paper, we focus on how primary school science text books content supports WASH and health education to promote healthy behaviour by the means of a standard science school book review from Kenya across the 6–13 years age range. We assess whether there is an integration or a disconnect with WASH behaviour interventions in schools in Kenya and beyond, and elaborate opportunities that WASH education in schools holds for interventions.

The novelty of this paper to the scientific community, as well as to WASH- and education-related practitioners and decision-makers, includes:

1. First assessment of water, sanitation, hygiene, health and disease in school books.
2. Mapping over time what and in which level of detail pupils study about WASH and disease prevention in Kenyan primary schools.
3. Analysing the level of integration of school book knowledge into WASH-related education interventions and the potential for sustainable health programming.

2. Methods

Building on a study examining the risk perceptions and behaviours to water-related infectious disease exposure and WASH (Anthonj et al., 2016, 2019), we further assessed what water, sanitation, hygiene and health information was being taught at schools. To do so we used the water-related disease transmission classification by Bradley (1974).

According to this classification, water-related infectious disease transmission can be due to a water-related insect vector (e.g. Malaria), water-based (e.g. Schistosomiasis), waterborne (e.g. Typhoid fever) or water-washed (e.g. Trachoma) – and is overall closely linked to the provision of safe water and sanitation, and the implementation of healthy hygiene behaviours. Since water supply and storage, sanitation, personal as well as environmental hygiene and human behaviour are on the one hand risk factors for the contraction of infectious diseases, yet can function as well as health-promoting factors (Anthonj et al., 2018), we built our school book review on these exact themes. We first conducted a review of text books used to teach science in Kenyan primary schools under the 8-4-4 education system (Ministry of Education of the Republic of Kenya, 1984) to capture the representation of WASH issues. We then conducted a rapid literature review of behaviour change and health messaging interventions and global policy guidance documents to contextualise the results of the text book review and understand the relevance of books and school education for WASH interventions.

2.1. Review of Kenyan primary school science text books

We reviewed primary school science text books in order to answer two questions:

1. How are drinking water, sanitation and hygiene issues represented in primary school science text books in Kenya?
2. Which WASH dimensions are addressed in the books and is there a causal chain relating themes to each other?

2.1.1. Search and screening strategy

Data presented in this paper were gathered in 2016 as part of a research project on water-related infectious disease exposure and WASH in Rumuruti, Laikipia County, Kenya. Based on a rapid screening of teaching materials used in the study area (Anthonj et al., 2016, 2018, 2019), we identified science education as the single source of information related to WASH and disease risks in primary schools. We therefore collected the science text books in use at the time of this study. Eight primary school standard science books used from class 1 through class 8 covering the age range from 6 to 13 years (Table 1) were obtained and analyzed.

We conducted a content analysis and encoded the material into five categories in order to transform the raw data into analysable data. Building on the classification of water-related disease transmission by Bradley (1974), and the factors preventing the transmission of these diseases, we included drinking water; sanitation; hygiene; environmental hygiene & health promotion and disease risks as categories (corresponding to Anthonj et al., 2018) We manually screened the eight books for all information related to our identified categories.

2.1.2. Content analysis

Water supply and storage, sanitation, personal as well as environmental hygiene and human behaviour are on the one hand risk factors for the contraction of infectious diseases, yet can function as well as health-promoting factors. We therefore built this school book review on five themes, that included:

i. Drinking water (water source; water transport; water quality; water safety; household water treatment and safe storage; water conservation);
ii. Sanitation (sanitation facility; toilet; sanitary hygiene; sanitation behaviour);
iii. Hygiene (personal hygiene; handwashing, hygiene item; food hygiene; food storage);
iv. Environmental hygiene with disease prevention and health promotion; and
v. WASH-related disease risks and transmission pathways.

2.2. Rapid literature review of behaviour change and health messaging interventions and global policy guidance documents

We conducted a rapid review of peer-reviewed and grey literature to identify publications on WASH education and how this may affect WASH behaviour change interventions in schools to answer two additional questions:

3. In what ways is school book information integrated in WASH interventions in schools?
4. Which potential does WASH education in schools hold for interventions?

2.2.1. Search and screening strategy

Our a rapid review aimed at identifying publications from (i) grey literature that address WASH education in schools and (ii) peer-reviewed journal articles that address the use of WASH in schools (WinS) interventions. Two comprehensive literature reviews on WASH in schools (Jasper et al., 2012; Joshi and Amadi, 2013) served as a starting point for approaching the topic. We screened them for interventional studies addressing components related to education, health promotion and behaviour change.

Additionally, we deployed the electronic literature database MEDLINE for computer-based searches, to retrieve studies published after the two reviews. The search within titles, abstracts and keywords included the keyword combination of school AND water OR sanitation OR

Table 1
Kenyan primary school science textbooks for classes 1–8 used for book review.

Class	Code used	Name of book	Authors	Year published	Publisher	Place published	Taught at age
1	C1	Science Matters 1. A Science Course for Primary Schools	Ojwang & K'opiyo	2003	East African Publishers Ltd.	Nairobi	6 years
2	C2	Science Matters 2. A Science Course for Primary Schools	Embeywa & Ndungi	2003	Oxford University Press, East Africa Ltd.	Nairobi	7 years
3	C3	Science in Action 3	Embeywa et al.	2004	Oxford University Press, East Africa Ltd.	Nairobi	8 years
4	C4	Understanding Science 4. Pupil's Book 4	Karaka et al.	2005	Longhorn Publishers Ltd.	Nairobi	9 years
5	C5	Primary Science 5. Pupils' Book for Standard Five	Gichuki	2005	Kenya Literature Bureau	Nairobi	10 years
6	C6	Primary Science 6. Pupils' Book for Standard Six	Gichuki	2005	Kenya Literature Bureau	Nairobi	11 years
7	C7	Primary Science 7. Pupils' Book for Standard Seven	Gichuki	2005	Kenya Literature Bureau	Nairobi	12 years
8	C8	Primary Science 8. Pupils' Book for Standard Eight	Gichuki	2005	Kenya Literature Bureau	Nairobi	13 years

hygiene AND intervention.

The results of the search were sorted by "best match", an option on MEDLINE to identify the most relevant publications, and the first identified 100 papers were non-systematically screened in order to identify potentially relevant studies for abstract review. Of those identified, only publications on intervention studies on WASH in school settings that addressed our five categories of the school book review, namely (i) drinking water; (ii) sanitation; (iii) hygiene; (iv) environmental hygiene with disease prevention and health promotion; and (v) WASH-related disease risks and transmission pathways, were included. In case multiple articles were retrieved for the same intervention, only one was considered. For every included study, the list of related articles suggested by the database as well as the list of articles citing the study were screened to possibly find additional studies. Moreover, included studies were hand-searched for additional bibliographical references. Publications in languages other than English were excluded.

Grey literature on WASH education for schools was searched on Google using the following keywords combination: school, water, sanitation, hygiene, and education (manual). The first 50 results were screened to identify potentially relevant materials. Of those identified, only publications on educational programs and objectives on WASH in school settings that addressed our five categories of the school book review were considered.

2.2.2. Content analysis

Of the n = 100 papers screened during the rapid review, 23 matched the search criteria of being an intervention study in a school settings addressing WASH aspects, considering an educational or behavioural change component. This final set of eligible texts was subjected to analysis and synthesis. Corresponding to the analysis of the school book data, the same five categories were used in order to compare the included studies to what we found in the school book data. We extracted and tabulated relevant information, including type of educational intervention, means of provision of education or health promotion, topics addressed, educational materials considered and location of intervention. We interpreted, contextualised and synthesised the results. From the grey literature, n = 5 publications were included and we analyzed suggestions on main WASH topics to be included in WASH education interventions, learning objectives and WASH curricula.

3. Results

3.1. Overview mapping of WASH themes in Kenyan primary school science text books

3.1.1. Drinking water, water safety, household water treatment and safe storage

Drinking water issues are addressed in four of the eight primary school science text books reviewed. These were C2–C4 and C7 (Table 2), a total of 22 text book pages (Table 3) and numerous illustrations (Table 4).

Learning about drinking water starts in class 2 with a reminder to "*always drink clean water*" and information on different ways of removing substances from water. Step-by-step activities navigate the pupils through using different cloth materials as filters (C2).

C3 teaches the pupils how to make water safe for drinking, and introduces step-by-step guides to filtering and boiling drinking water because "*dirty water can make us sick*". The book recommends filtered water to be boiled prior to drinking. The need to safely store water in clean, covered containers is described, with storage options including bottle, tank, jerry can and pot. Moreover, different ways of transporting water are addressed, such as carrying water in a pot, using oxen or a cart, carrying a jerry can on the head, or on the back, using a canal or pipes.

C4 entails more details and specifications on the ways of storing water in tanks, drums, pots, buckets and dams. Different ways of water use are described, including using water at home, in the farm, for recreation, industry or transport. Water use at home includes drinking and health promotion, cooking, personal hygiene, environmental hygiene and sanitation, and others.

C7 highlights the "*proper care and use of water and water sources*" in

Table 2
Overview mapping of WASH themes in Kenyan primary school science textbooks for classes 1–8 by themes.

Class book	1	2	3	4	5	6	7	8
Theme covered								
Drinking water		Water treatment, removal of substances from water	Water transport, household water storage, water safety	Water use, household water storage			Water conservation	
Sanitation		Sanitation facilities and use	Sanitary hygiene					
Hygiene	Personal hygiene, hygiene items, handwashing	Hygiene items, cleaning personal hygiene items				Food hygiene, preservation and storage		
Environmental hygiene & health promotion		Cleaning compound, waste disposal	Medical care, clean surroundings of house		Health education, use and storage of medicine	Prevention of malaria, tuberculosis, waterborne diseases	Control of water pollution, livestock parasites and intestinal worms	
Disease risks						Communicable diseases, malaria, tuberculosis, waterborne diseases	Effects of water pollution, livestock diseases, parasites	Livestock diseases, effects of livestock diseases

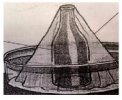
* Pupils's approximate ages per class are: Class 1: 6-7 years; Class 2: 7-8 years; Class 3: 8-9 years; Class 4: 9-10 years; Class 5: 10-11 years; Class 6: 11-12 years; Class 7: 12-13 years; Class 8: 13-14 years

Table 3
Overview mapping of WASH themes in Kenyan primary school science textbook classes 1–8 by number of pages in books.

Class book	1	2	3	4	5	6	7	8
Theme covered								
Drinking water		3	4	11			4	
Sanitation		1.5	2					
Hygiene	2	2				6		
Environmental hygiene & health promotion		0.5	1		6	3.5	5	
Disease risks						8	9.5	2

* The darker the shades in the table, the higher the number of pages in school books addressing WASH themes in school books.
** Pupils's approximate ages per class are: Class 1: 6-7 years; Class 2: 7-8 years; Class 3: 8-9 years; Class 4: 9-10 years; Class 5: 10-11 years; Class 6: 11-12 years; Class 7: 12-13 years; Class 8: 13-14 years.

Table 4
Overview mapping of WASH themes in Kenyan primary school science textbook classes 1–8 by illustrations in books.

Class book	1	2	3	4	5	6	7	8
Theme covered								
Drinking water								
Sanitation								
Hygiene								
Environmental hygiene & health promotion								
Disease risks								

* These illustrations are examples taken from the reviewed Kenyan school books to give the reader an impression on the books' content. The same books contain many more illustrations.
** Pupils's approximate ages per class are: Class 1: 6-7 years; Class 2: 7-8 years; Class 3: 8-9 years; Class 4: 9-10 years; Class 5: 10-11 years; Class 6: 11-12 years; Class 7: 12-13 years; Class 8: 13-14 years

order to "*ensure that water is spared for future use,*". The book also teaches ways of water conservation including rainwater harvesting, recycling water, reusing water, constructing dams and others.

3.1.2. Sanitation facilities, sanitary hygiene and sanitation behaviour

Sanitation issues are addressed in C2–C3 (Table 2), with 3.5 text book pages covering sanitation in total (Table 3).

C2 describes different types of sanitation facilities, including pit latrines and flush toilets. Moreover, a simple manual guides the pupils on how to use toilets: (i) enter the toilet and close the door; (ii) prepare yourself and sit or squat on the toilet seat; (iii) after you finish, clean yourself; (iv) flush the toilet; (v) wash your hands. Guides on the right

use of latrines and urinals are provided as well.

C3 teaches the pupils how to clean toilets, urinals and latrines, and reminds the pupils that "*you will need soap, water and a hard brush*". It also states that "*good health requires clean surrounding*" and that "*toilets, urinals and latrines must be kept clean all the time*".

3.1.3. Personal hygiene and handwashing

Hygiene issues are addressed in C1–C2 and C6 (Table 2), with a total of ten text book pages covering the topic (Table 3).

Learning about hygiene starts in class 1 with a photo story on how to clean and wash hands with soap and clean water. Different items for personal hygiene are presented, including soap, towel, sponge and water. Moreover, the book calls for washing hands at key times, including (i) before and after eating; (ii) before preparing food; (iii) after visiting the toilet (C1).

C2 focuses on different hygiene items such as toothbrush, face towel and handkerchief. It includes a step-by-step guide on how to clean a handkerchief, because "*using dirty handkerchiefs can make you sick*". Moreover, it reminds the pupils "*not share your handkerchief with other people*".

C6 addresses the topic of food hygiene and proper food storage, and describes methods of food preservation.

3.1.4. Environmental hygiene, disease prevention and health promotion

Environmental hygiene and health promotion issues are addressed in five science text books: in C2–C3 and C5–C7 (Table 2), 16 text book pages were dedicated to this issue (Table 3).

C2 briefly touches upon the need of cleaning the domestic compound and to "*put all the rubbish in the rubbish pit*".

C3 refers to the need to keep the house and classroom clean as well. Besides, the book underlines the value of good health, as "*people feel well when their bodies are in good health*", "*good health means the body feeling*" and "*the mind is thinking well*". The book calls for pupils feeling unwell to notify their teacher or parents to take them to a doctor for assessment and cure.

In C5, pupils learn about the proper use and storage of medicines by the means of checklists they can follow.

C6 provides details on how to prevent the following diseases: (i) **Malaria** (i.e. draining stagnant water and covering any water storage containers to prevent breeding places for mosquitoes; sleeping under a mosquito net; protecting windows with mosquito gauze; taking malarial preventative drugs); (ii) **Tuberculosis** (i.e. immunisation; avoiding exposure to a lot of dust through environmental hygiene; well-ventilated rooms; avoiding overcrowded places; high standards of cleanliness); (iii) **Cholera** (i.e. proper disposal of faeces; use of sanitation facilities; sanitary hygiene; handwashing at key times; food hygiene; treatment of drinking water; prevention of water pollution; treatment of infected persons; cleanliness); (iv) **Typhoid fever** (i.e. drinking treated water; food hygiene; handwashing at key times; proper disposal of faeces; sanitary hygiene); and (v) **Bilharzia** (i.e. use of sanitation facility; draining stagnant water; cleanliness; prevention of direct water contact; killing water snails using chemicals.

In C7, different ways to control water pollution are presented, including practicing proper hygiene, using sanitation facilities, and avoiding surface water sources. Moreover, the textbook recommends "*drawing water for animals instead of taking them to water sources. This will prevent them from releasing waste into the water*" and "*controlling the dumping of industrial waste into water sources. All waste should be treated to make it harmless to the environment*". C7 also suggests different methods of controlling human intestinal worms. According to the book, the main ways of breaking the transmission route from one person to another or from an animal to a person is through proper sanitation practices and "*keeping the sources of water such as wells and rivers clean. Animals should not be watered in water sources where people get their drinking water. This ensures that animals do not drop their faeces in the sources of water. This will help to control the spread of the parasites. Faeces and other garbage should not be dumped in rivers or dams where people draw their water.*" Moreover, "*burning or burying garbage to destroy the eggs of intestinal worms*" is recommended, as well as "*using latrines always so that pigs and other animals do not get into contact with human waste. This can help to control the worms*". Besides, food hygiene and regular deworming are advised.

3.1.5. WASH-related disease risks and transmission pathways

Disease risks and transmission pathways related to inadequate drinking water, sanitation, hygiene and environmental health are addressed in C6–C8 (Table 2). A total of 19.5 textbook pages deal with WASH-related diseases (Table 3).

Learning about specific WASH-related disease risks and transmission pathways starts in C6 with very detailed information on communicable diseases. The signs, symptoms and causes, along with explanatory illustrations, are detailed for malaria and tuberculosis as follows:

- Malaria, *"caused by some small parasites which feed on the red blood cells of the human body", with "parasites passed from one person to another through mosquito bites. When a mosquito bites a person who is infected with malaria, the parasites enter the body of the mosquito. When the mosquito carrying malaria-causing parasites bites a healthy person, he or she gets infected with malaria. In this way, malaria is spread from one person to another"*;
- Tuberculosis, *"caused by some germs called bacteria" that "mainly attack the lungs. When a person who has TB coughs, these bacteria get into the surrounding air. If a healthy person breathes in the air carrying tuberculosis-causing bacteria, he or she may contract the disease. In this way, TB is spread from one person to another"*.

Moreover, waterborne diseases are discussed in detail. According to C6, "*there can be many disease-causing germs in the water around us. These disease-causing germs are very small; we cannot see them with the naked eye. A person can get a disease by drinking, walking in or swimming in water containing germs. Diseases that are transmitted through water are called waterborne diseases. Water which contains germs is said to be contaminated.*" The signs, symptoms and causes, along with explanatory illustrations, are detailed for the following waterborne diseases:

- Cholera, *"caused by germs found in contaminated water. It is especially common when there are floods and water gets contaminated with human faeces. Cholera germs are passed on through drinking contaminated water. Flies also carry cholera germs to food. Cholera spreads rapidly from one person to another"*;
- Typhoid, *"a very serious waterborne disease" affecting the intestines and "caused by germs found in contaminated water. A person may get typhoid fever after eating food and drinking water contaminated with faeces or urine from a typhoid carrier. Water which is contaminated with sewage can spread typhoid very quickly*";
- Bilharzia, *"caused by bilharzia worms", "first found in human beings". "They enter into fresh water snails and are later passed through contaminated fresh water. A person suffering from bilharzia normally passes out the eggs of bilharzia worms in his/her urine or faeces. If the eggs are passed into water through the urine or faeces, they hatch into larvae which enter the body of a freshwater snail and get into the water, ready to attack human beings. If one walks in, swims in or drinks contaminated water, the larvae enter his or her body through the skin, particularly the legs"*.

C7 teaches pupils that "*polluted water is not safe for drinking by human beings and animals or for watering crops*", "*because it contains harmful substances that can cause diseases*". It aims at making pupils understand that water pollution, caused by floods, human and animal waste and uncontrolled use of pesticides and fertilisers, could be easily prevented. Moreover, pupils learn about different types of parasites that can affect livestock and that, "*most parasites, both external and internal, that affect livestock, are also a nuisance to human health. Internal parasites are spread*

from animals to human beings through food and water". Safe disposal of sanitary waste and maintenance of environmental hygiene help to control the spread of these parasites.

In C8, the effects of livestock diseases on livestock are described. Some of these include stunted growth, loss of weight, reduced yields, rough coat, coughing and blood in stool. According to the book, "*when livestock are infected with diseases, they affect the farmer and the community*".

3.2. Overview mapping of WASH in schools interventions; rapid literature review

3.2.1. Content of grey literature on WASH education

Several guidelines and manuals have been developed by national and international organisations such as UNICEF, WHO, governmental and development organisations, specifying curricular content and learning objectives for WASH education, including tips and examples of activities. We identified the top five relevant guidance documents in our rapid review (Kenya Water for Health Organization, 2018; UNICEF, 2012; UNICEF Sri Lanka, n.d.; USAID/Splash, 2015; WHO Regional Office for Europe, 2019) (Table 5).

Corresponding to what we found in Kenyan school books, WASH education generally addressed one or more of the following themes (Table 2 vs. 5):

- Drinking water treatment, handling and storage (UNICEF, 2012; UNICEF Sri Lanka, n.y.; Kenya Water for Health Organization, 2018; USAID/Splash, 2015), and hydration (Kenya Water for Health Organization, 2018; WHO Regional Office for Europe, 2019)
- Safe faecal disposal and safe use of toilets and urinals (UNICEF, 2012; WHO Regional Office for Europe, 2019; UNICEF Sri Lanka, n.y.; Kenya Water for Health Organization, 2018; USAID/Splash, 2015)
- Personal hygiene and handwashing with soap (UNICEF, 2012; WHO Regional Office for Europe, 2019; UNICEF Sri Lanka, n.y.; USAID/Splash, 2015), food hygiene (UNICEF, 2012; WHO Regional Office for Europe, 2019; UNICEF Sri Lanka, n.y.; Kenya Water for Health Organization, 2018; USAID/Splash, 2015), male and female hygiene and menstrual hygiene management (UNICEF, 2012; WHO Regional Office for Europe, 2019; USAID/Splash, 2015)
- Environmental hygiene, waste management and water drainage (UNICEF, 2012; WHO Regional Office for Europe, 2019; UNICEF Sri Lanka, n.y.; Kenya Water for Health Organization, 2018)
- WASH-related diseases (UNICEF, 2012; Kenya Water for Health Organization, 2018; USAID/Splash, 2015)

Content on faecal disposal includes a lesson on safe disposal of faeces, and use of toilets. It covers the importance of sanitation for the prevention of diseases such as diarrhoea and worm infections and the F-diagram, healthy voiding/defecation, the use of toilets and sanitary hygiene. For waste management, the content often includes safe handling of waste and importance of keeping the environment clean, or detail about reducing, reusing and recycling waste. For older pupils it covers aspects such as managing infectious waste or dangerous waste.

3.2.2. Content of publications on WASH education interventions

We identified 23 intervention studies addressing WASH or hygiene education in schools in our rapid review. Twelve of the studies were conducted in Kenya and eleven were done elsewhere (Table 6).

WASH education interventions typically targeted entire schools and several **classes**, grades and a large **age range** at a time. Only one study from China targeted only one grade, class 1 (Bowen et al., 2007).

The focus of WASH education interventions was mainly on hand hygiene (n = 21). Half of the interventions targeted drinking water safety (n = 12). One third of interventions addressed WASH-related diseases such as diarrhoea, cholera, influenza (n = 7). Few of the identified intervention studies included education on waste management (n = 4), sanitation (n = 3), cleanliness of the environment (n = 3), and food hygiene (n = 3). Of the WASH in schools intervention studies identified through our rapid review, n = 13 included an **educational component** such as ad-hoc lessons or a specific curriculum.

Less than half of interventions included a **curricular component** (n = 9) (Bowen et al., 2007; Karon et al., 2016; Muckelbauer et al., 2009;

Table 5
Overview mapping of WASH in schools interventions. Content of grey literature on WASH education.

Grey literature	UNICEF (2012)	WHO Regional Office for Europe (2019)	UNICEF Sri Lanka (n. y.)	Kenya Water for Health Organization (2018)	USAID/Splash (2015)
Theme covered					
Drinking water	Water testing and treatment, removal of faecal or chemical contamination	Hydration and voiding matters.	Water treatment, handling and storage, water safety, water mapping, water quality testing	Water use, water treatment methods	Water transport, household water storage, water safety, water treatment measures, hydrological cycle
Sanitation	Toilet and urinal use	Toilet use, sanitary hygiene, healthy voiding/defecation, link to social education and respect	Toilet use, mapping sanitation, de-rehydration	Sanitation practices to keep the home, school and community surroundings clean	Safe disposal of faeces
Hygiene	Personal hygiene and handwashing at key times, genital and menstrual hygiene, importance of food hygiene	Key personal hygiene behaviours, handwashing tips and instructions, importance of genital hygiene, menstrual hygiene management, importance of food hygiene	Importance of handwashing, personal hygiene, importance of food hygiene and safe handling	Hygiene practices and importance of personal hygiene	Personal hygiene, hygiene items, cleaning personal hygiene items, handwashing with soap/ash, building a handwashing station, menstrual hygiene management, food hygiene
Environmental hygiene, waste management, health promotion	Solid waste and water management to reduce mosquito breeding, reduction of diarrhoeal and acute respiratory diseases through WASH, healthy nutrition	Waste management (reducing, reusing and recycling), environmental protection and resulting health benefits, management of infectious waste, WASH-related health benefits	Solid waste and water drainage mapping, sorting solid waste	Environmental hygiene practices, waste management	Environmental hygiene: animals, disinfection, disposal of waste, wastewater, food hygiene practices to prevent food-borne contamination
Disease risks	Water-related diseases, e.g. malaria, risks related to contaminated food	Health risks related to poor WASH conditions and practices, food-borne disease risks	F-diagram and disease risks related to poor sanitation, risks related to unsafe food handling	Water pollution and waterborne diseases, difference between clean and safe water, food-borne disease risks	Faecal-oral transmission of germs, risks related to faecal contamination and open defecation, effects of pollution

Table 6
Description of included studies on WASH education interventions in schools based on n = 23 publications identified by rapid review.

#	Study	Study setting	Class and age range	Intervention(education/ behaviour component)	education topics							curricular				book	
					water	sanitation	hand hygiene	food hygiene	cleanliness	waste management	disease	clubs	curricular	extracurricular	unclear	ad-hoc material	not considered
Studies conducted in Kenya																	
1	Blanton et al.	Nyanza Province	Classes not specified, ages 8-19	Training on hygiene as well as instructional books.	x		x				x	x		x		x	
2	Caruso et al. (2014)	Nyando, Kisumu, Rachuonyo Districts, Nyanza Province	Classes and ages not specified	Head teacher and health patron training behaviour change component: (i) Making & using soapy water, (ii) handwashing techniques at critical wash times, (iii) latrine cleaning and monitoring instruction.	x		x		x					x			x
3	Freeman et al. (2012)	Nyando, Kisumu & Rachuonyo, Suba Districts, Nyanza Province	Classes not specified, average age 13	Training of teachers on health promotion, behaviour change and water treatment methods and regular follow-up visits throughout the school year.	x										x		x
4	Garn et al. (2013)	Rachuonyo, Suba, Nyando, Kisumu Districts, Nyanza Province	Classes 1–7, ages not specified	Hygiene promotion (no details).	x	x	x								x		x
5	Greene et al. (2012)	Nyanza Province	Classees 4 through 8 (typically ages 6–16)	Teacher training on maintenance of drinking and handwashing facilities and behaviour change promotion lessons with pupils through health clubs or other venues.			x					x		x			x
6	La Con et al. (2017)	Western Kenya	Classes 1 through 8, ages not specified	Teacher training and provision of educational materials.	x		x					x		x		x	
7	Onyango-Ouma et al. (2005)	Bondo District, Western Kenya	Classes 2,3 and 5, ages range 9–15	Action-oriented and participatory health education and follow-up phase with pupils working as health communicators in school, community and families.	x	x	x	x	x	x	x		x			x	
8	O'Reilly et al. (2008)	Nyanza Province	Classes 4–8, ages not specified	Teacher training on SWS use and proper six step handwashing practices, provision of training materials for classroom, form safe water clubs with pupils, teach SWS and hygiene.	x		x					x	x	x		x	
9	Pasewaldt et al. (2019)	Kenya & Uganda	Classes 3–8, ages not specified	Hand hygiene curriculum consisting of various lessons and activities to educate pupils about handwashing and healthy handwashing behaviour.			x				x		x			x	
10	Patel et al. (2012)	Nyando Division, Nyanza Province	Classes 4–8, ages not specified	Teacher training on handwashing and water treatment, provision of instructional materials for pupils.	x		x								x	x	

(*continued on next page*)

Table 6 (*continued*)

#	Study	Study setting	Class and age range	Intervention(education/ behaviour component)	education topics							curricular				book	
					water	sanitation	hand hygiene	food hygiene	cleanliness	waste management	disease	clubs	curricular	extracurricular	unclear	ad-hoc material	not considered
11	Saboori et al. (2013)	Nyanza Province	Classes 4–7, ages not specified	Teacher training on handwashing prior to implementation.			x					x		x			x
12	Schlegelmilch et al. (2016)	District of Kinango, Coast Province	Classes and ages not specified	Health and hygiene promotion education to communities and schools, employing Community Led Total Sanitation (CLTS) methods.		x	x				x			x			x
Studies conducted outside Kenya																	
13	Bowen et al. (2007)	China	Classes 1, ages not specified	Handwashing programme.			x				x		x			x	
14	Chard et al. (2019)	Laos	Classes 3–5, ages not specified	Behaviour change component: hygiene action led by pupils in schools implemented after the installation of WASH hardware components.	x		x		x	x				x			x
15	Freeman and Clasen (2011)	Southern India	Classes and ages not specified	Teacher and pupil training, and provision of basic hygiene and water treatment information.	x		x							x			x
16	Karon et al. (2016)	Indonesia	Classes 4–5, ages not specified	Hygiene promotion with activities including capacity development of children, teachers, headmasters, parents and community members for improved hygiene behaviour among school children.	x		x	x		x	x		x	x		x	
17	Lau et al. (2012)	Chigaco	Classes pre-kindergarten to grade 8, ages 4–14	Short repetitive instruction in hand hygiene every two months.			x							x			x
18	Muckelbauer et al. (2009)	Germany	Classes 2–3, average age 8	Teachers presenting prepared classroom lessons to promote water consumption.	x								x			x	
19	Schulte et al. (2012)	North Texas	Classes and ages not specified	Sustained instruction in handwashing and monitoring of hygiene practices among pupils.			x							x			x
20	Shrestha et al. (2020)	Nepal	Classes not specified, ages 8-17	Health promotion activities.			x	x		x			x	x		x	
21	Talaat et al. (2011)	Egypt	Classes not specified, average age 8	Intensive campaign to promote hand hygiene, requiring pupils to wash their hands at least twice during the school day for 45 s, followed by proper rinsing and drying with a clean towel.			x							x			x
22	Tidwell et al. (2020)	India	Classes not specified, age 8-13	Teacher training and curriculum for students on handwashing.			x						x			x	
23	Vally et al. (2019)	Philippines	kindergarten to grade 6, ages 5–12	Children Hygiene and Sanitation Transformation (CHAST) methodology, using exercises and educational games to teach children about the links between personal hygiene and health.			x				x		x			x	

Onyango-Ouma et al., 2005; O'Reilly et al., 2008; Pasewaldt et al., 2019; Shrestha et al., 2020; Tidwell et al., 2020; Vally et al., 2019). Interventions mainly promoted **extracurricular educational activities** (n = 14) (Blanton et al., 2010; Caruso et al., 2014; Chard et al., 2019; Freeman and Clasen, 2011; Greene et al., 2012; Karon et al., 2016; La Con et al., 2017; Lau et al., 2012; O'Reilly et al., 2008; Saboori et al., 2013; Schlegelmilch et al., 2016; Schulte et al., 2012; Shrestha et al., 2020; Talaat et al., 2011) and **health clubs** (n = 5) (Blanton et al., 2010; Greene et al., 2012; La Con et al., 2017; O'Reilly et al., 2008; Saboori et al., 2013). Such extracurricular educational activities were often health promotion programs or campaigns or behaviour change interventions rather than a structured education program with written curriculum/lessons, frontal lessons, and specific content/learning objectives.

The interventions with an **educational component** were usually limited in time – ranging from 1 day at the minimum to 2 months at the maximum - and included ad-hoc developed materials for teachers and children and lesson programmes (n = 12) (Blanton et al., 2010; Bowen et al., 2007; Karon et al., 2016; La Con et al., 2017; Muckelbauer et al., 2009; Onyango-Ouma et al., 2005; O'Reilly et al., 2008; Pasewaldt et al., 2019; Patel et al., 2012; Shrestha et al., 2020; Tidwell et al., 2020; Vally et al., 2019).

Three interventions did **not provide enough information** on the type of intervention (whether curricular or extracurricular) (Freeman et al., 2012; Garn et al., 2013; Patel et al., 2012).

Notably, none of our identified WASH education interventions (n = 23) explicitly considered evaluating or using the existing school curriculum or integrating the intervention lessons into the school books in use (Table 6).

4. Discussion

4.1. Why what is in the books matters: primary school teaching material from Kenya supports WASH and health education and promotes healthy behaviour

WASH education is not only important to improve knowledge about healthy behaviours, but it can also improve attitudes and generate commitment to healthy conditions which eventually drive change, making students improve their hygiene practices through health-protective actions (Jasper et al., 2012; Onyango-Ouma et al., 2005; UNICEF, 2012; WHO, 2019).

The reviewed Kenyan science textbooks address water, sanitation, hygiene, environmental hygiene, health promotion and disease risks in a total of 71 book pages over the course of eight years of primary school education (Table 3). The topic addressed in most detail is drinking water (22 pages), with pupils learning about different ways of treating, safely storing and using drinking water. The books discuss the need for and value of water conservation strategies, such as rainwater harvesting. Altogether, the information provided by the school textbooks present a comprehensive understanding on the value and benefits of drinking safe water, while contextualising drinking water in the bigger hydrological water cycle and various, competing uses (Table 2).

WASH-related disease risk factors and transmission pathways are well covered across school years (19.5 pages) and suitably developed in the Kenyan school books. Specifically, various waterborne (Cholera, Typhoid fever), water-based (Bilharzia), vector-related (Malaria) and other communicable diseases (Tuberculosis) are presented. The books well explain several aspects of the causal chain and interconnection of (the lack of) WASH and exposure to these diseases such as the adverse effects of water pollution on human health and risks related to lack of hygiene when interacting with livestock. This link is also discussed in the context of environmental hygiene (16 pages), which in the books covers the need to keep the domestic compound clean and dispose waste properly, or control water pollution in order to prevent disease.

Drinking water-, WASH-related disease risk- and environmental health-related topics are therefore comprehensively covered in the Kenyan 8-4-4 primary school science textbooks. However, given that **WASH** includes the three dimensions of water AND sanitation AND hygiene, outstanding gaps were identified in lack of detailed educational content on sanitation (3.5 pages) and hygiene (10 pages). Hygiene and handwashing, a key measure to prevent water-related and other infectious diseases, are only taught briefly in C1-2 (4 pages). The content solely covers the importance and implementation of personal hygiene, handwashing and cleaning of hygiene items. Vital hygiene issues such as food hygiene could be added in earlier classes, as well as biological and epidemiological concepts on the need for hygiene and disease prevention. To favour long-lasting behaviour change and healthy practices, it is recommended to provide sustained hygiene promotion, as negative habits re-emerge over time even after initially successful interventions (Neal et al., 2015). Sanitation education only covers the different types and use of sanitation facilities, as well as the importance of sanitary hygiene, with a brief reference to WASH-related disease risks. Further details on risks related to poor sanitation are not addressed. Open defecation, a major risk factor to WASH-related infectious disease, is not addressed at all even though 12% of the Kenya's population still practice it. Menstrual hygiene management, a key topic in WASH in schools, is not addressed at all in any of the eight science school textbooks reviewed either. This is a key gap in the core teaching material given the importance of menstrual hygiene to prevent infections and reduce girls' absenteeism in school.

Another challenge in fully understanding the causal chain of (lack of) WASH and health risk – or health promotion – results from the fact that the different themes are not consistently covered through the primary school classes. While hygiene, for example, is addressed in class 1 and 2, there is a gap until class 6, when pupils continue to learn about hygiene. Likewise, sanitation is only covered in C2-3, and not at all before or thereafter. Finally, pupils do not learn about disease risks until C6.

In summary, the depth of content of educational materials varies greatly across the primary school classes. While Kenyan primary school teaching material greatly supports WASH, health education and promotes healthy behaviours, there remains room for improvement for them to serve as entry point to strengthen WASH.

A comparison of our assessment of WASH, health and disease knowledge and the mapping over time on what and in which level of detail pupils study about WASH and disease prevention in Kenyan primary schools (Tables 2–4) with the WASH-related education intervention studies (Table 6) showed the following: Similar to school book education on WASH, that mainly focuses on drinking water aspects, most school-based WASH interventions in Kenya also include drinking water components, covering water treatment (Freeman et al., 2012; Patel et al., 2012), teacher training on maintenance of drinking water facilities (Greene et al., 2012), and student water clubs (O'Reilly et al., 2008). Sanitation interventions in schools in Kenya according to our review are limited, just as sanitation issues were also only discussed in school books (Tables 2–4) in a limited way, and include sanitation behaviour components (Onyango-Ouma et al., 2005) as well as community-led total sanitation methods (Schlegelmilch et al., 2016). Hygiene and related behaviour education, on the other hand, which come up short in our reviewed school books, are well represented in the school-based WASH interventions, covering hand hygiene training (Blanton et al., 2010; Garn et al., 2013; Greene et al., 2012; Patel et al., 2012; Schlegelmilch et al., 2016) including the preparation and use of soapy water, handwashing techniques and handwashing at critical times (Caruso et al., 2014; Pasewaldt et al., 2019; O'Reilly et al., 2008). While vastly addressed among older primary school students (grades 5–7, Tables 2–4), environmental hygiene and waste management for health promotion are included in few intervention studies in Kenya only (Caruso et al., 2014; Onyango-Ouma et al., 2005). Likewise, disease risks that were addressed in detail in Kenyan school books for older pupils (grades 6–8, Tables 2–4), are considered only in very few WASH in school education interventions in Kenya (Onyango-Ouma et al., 2005).

Similar to the school books that cover drinking water-, sanitation-, hygiene-, environmental hygiene-, and disease risk-related themes not in every grade in a similar depth and detail (Tables 2–4), WASH in schools education interventions in Kenya do not either. Such interventions typically target entire schools and several classes, grades and large age ranges at a time. Of our identified WASH in school education intervention studies from Kenya (n = 12), half do not specify grades or age ranges of targeted pupils (Caruso et al., 2014; Freeman et al., 2012; Garn et al., 2013; La Con et al., 2017; Schlegelmilch et al., 2016). The remaining studies cover multiple age ranges and classes, e.g. from 4 through 8 (Greene et al., 2012; O'Reilly et al., 2008; Patel et al., 2012).

4.2. Local school book knowledge versus global WASH education interventions: disconnect or integration?

The WASH in school education intervention studies that were included in our rapid review (Table 6), did not consider using locally available education materials prior to or during the intervention. Only few studies (e.g. Blanton et al., 2010; Karon et al., 2016; Pasewaldt et al., 2019; Vally et al., 2019) evaluated the pupils' knowledge prior to an intervention as a baseline value. They included limited general questions on hand hygiene or water treatment, and only one study included questions specifically asking about the education received in class (Karon et al., 2016). Similarly, none of the intervention studies conducted in Kenya (Table 6) made use of the content available in the primary school science textbooks. A possible reason for this could be deficient WASH infrastructure in areas where the studies were conducted. The interventions thus centred mainly around infrastructural improvements instead of educational dimension. However, where educational materials and traditional lessons-style interventions were used, ad-hoc materials were generally developed and used instead of existing school books.

This observation shows a disconnect and lack of integration of WASH interventions with the local educational systems and characteristics. This may affect the success and the sustainability of any short-term behaviour change interventions. It is important to consider that international organisations rolling out interventions in schools to improve WASH services and train pupils and teachers on safe WASH behaviours are usually responding to a funder-determined need. Such projects are usually implemented in response to requests by, and with involvement of, ministries in the target countries (Garn et al., 2013).

Integrated interventions, addressing education as well as infrastructure needs, are known to be more efficacious than purely infrastructure-focused interventions. Integrated interventions have the potential to last in the long-term, especially when they include approaches that stimulate and/or facilitate the development of attitude and ownership among school users, beyond the mere gain in knowledge or access (WHO Regional Office for Europe, 2016). An integration of WASH education into standardised school curricula ensures that capacity on all topics of relevance is built among all teachers in the system and that all pupils receive the same evidence-based information and lessons developed specifically to favour the development of habits. WHO and UNICEF have long recommended countries and schools to integrate hygiene and WASH education in the national curriculum to ensure sustained and standardised hygiene promotion across all schools. Integration of WASH content in the school curriculum, and training teachers in the course of their standardised college education, is considered most sustainable and efficient. Teaching materials must also be available and accessible for all teachers and pupils at reasonable prices.

4.3. Implications for WASH-related interventions, health programming and messaging

Our analysis suggests that integrating local school book knowledge into WASH education interventions is not common. Considering, on the other hand, that the inclusion of school book content into interventions is no indicator for its effective uptake in practice, and that many WASH interventions are designed as extra-curricular programs to either address gaps in implementation or augment existing curricula, integrating WASH education interventions into existing school dynamics and educational programs holds an evident potential for future projects. This will enable interventions to complement and strengthen the health messaging around WASH and health outcomes.

According to our literature review of WASH in schools education interventions, such interventions typically target entire schools and several classes, grades and large age ranges at a time (Table 6). Considering the breadth and depth – but also gaps - of WASH themes covered in primary school textbooks in Kenya, interventions complementing the school book knowledge with skills-based and participatory education could further support the development of healthy habits among pupils.

In many schools, health or hygiene education are an integral part of the curriculum, although in some countries and regions, the number and breadth of WASH-related topics in schools is limited only to some classes or is not comprehensive (WHO Regional Office for Europe, 2016). Considering and building on such curricula, existing local educational materials and knowledge may facilitate the buy-in and involvement of teachers and school managers in strengthening education and the implementation of improvements. As school books represent in part the knowledge that exists and is provided to children as well as the national priorities, their long-term consideration is key.

To facilitate translation of the information in the school books into life-long skills that empower children to take healthy choices, an interactive, child-centred, participatory approach that engages the pupils in the learning process is of great importance (WHO Regional Office for Europe, 2019). Complementary hygiene or WASH clubs and extracurricular activities which are often considered in interventions (Table 6), have proven effective, although integration of such educational messages and behaviour change measures into school curricular activities is the most sustainable option (WHO Regional Office for Europe, 2019).

New approaches should best be developed around existing knowledge and educational programs to ensure the relevance and uptake at the local or the national level, particularly when implemented in collaboration with educational authorities. Finally, to link WASH education and real hygiene needs and priorities of the communities in which the pupils live, dialogue and participation of local actors is vital.

The thematic gaps/under-representations in books that we identified in our work, namely sanitation, hygiene and menstrual hygiene education, are all high on the development and WASH agenda, and altogether challenging topics which require breaking cultural taboos. Menstrual hygiene has long been recommended by UNICEF and WHO to be better integrated into education to ensure the equity, well-being and dignity of girls in schools (Alexander et al., 2018; Sommer et al., 2016; WHO Regional Office for Europe, 2019). Likewise, healthy hydration as well as proper voiding and defecation and learning about the health of bowel and bladder need to find their space in the books (WHO Regional Office for Europe, 2019). Finally, it is important that teachers' materials stress the importance and suggest approaches of building on child centred and skills-based education to facilitate the development of healthy attitudes and habits (WHO Regional Office for Europe, 2019).

4.4. Contextualisation of our findings with the reality in the local settings, with the unprecedented COVID-19 pandemic and potential of WASH in school education for future public health emergencies

The Kenya Environmental Sanitation and Hygiene Policy mandates the Ministry of Health to promote health and hygiene education as part of the curriculum at nursery, primary and secondary school levels (GoK, 2016). Results of our school book review, however, showed critical gaps in health and hygiene topics in primary school books. Hand hygiene, for example, was only covered in the lower C1 and C2 books and was not developed in the subsequent classes. In the context of the current

unprecedented COVID-19 pandemic that the woeld is facing, the lack of sufficient and continuous education on basic hand hygiene - one of the key preventive measures for COVID-19 – is particularly problematic. According to Ritchie et al. (2020), there has been a steady increase in COVID-19-related mortality overall in Kenya, and as schools are reopening across the country, many have reported positive coronavirus cases (Yusuf, 2020).

Besides, there is a theory versus practice gap:

As previously mentioned, combined measures addressing both infrastructure and education are most effective in building healthy WASH habits. Kenya's National School Health Policy states that:

- adequate, safe drinking water points shall be available in each school;
- hand-washing facilities including soap shall be provided in each school within the vicinity of the toilet/latrine (Republic of Kenya, 2009).

The reality in Kenyan schools however, looks different: In 2014, only 43% of public primary schools had access to reliable water from taps or boreholes, 48% of the schools relied on rain or river water and 9.5% did not have access to any water source (Ministry of Education of the Republic of Kenya, 2014). Moreover, 40% of rural schools in Kenya do not have handwashing facilities and more than 80% of those that have them lack soap (Morgan et al., 2017). Thus, even though the pupils gain a comprehensive understanding of water-related health risks and healthy behaviours through the text books, putting this gained knowledge into practice is impeded by inaccessible WASH infrastructure. WASH, economic and social conditions are highly heterogenous in the country, depending on the local realities. Various geographical factors, including environmental conditions like climate, weather, water availability, may play a role in the level of depth that pupils are familiar with WASH infrastructure and healthy practices and in the level of access of these services in schools. WASH conditions, perceptions and cultural preferences or taboos may differ depending on the region and local settings and influence perceptions, practices and knowledge (Anthonj et al., 2016, 2019).

The Kenyan Ministry of Education is responsible for implementing WASH in school programmes and ensuring that all schools are provided with adequate sanitation and hygiene facilities and services, while taking into account the special needs of girls and children with disabilities (GOK, 2016). Although the policy clearly recognised these special needs, none of the science books covered topics related to menstrual hygiene, uncovering also a science education versus WASH policy gap.

In the face of the ongoing COVID-19 pandemic particularly, there is an urgent need to improve and standardise approaches for WASH education and WASH infrastructure in schools. Kenya's Ministry of Education health and safety protocols for reopening of basic education institutions in the context of the pandemic require provision of adequate handwashing points at strategic locations, sufficient clean running water (at least 5 L per person per day), and adequate liquid soap at all hand washing points (Republic of Kenya, 2020). In order to meet these requirements, stakeholders in the education sector need to upgrade WASH facilities, ensure continuous supply of hand washing soap and promote hand hygiene as part of COVID-19 control measures in all schools. Financial aids and efforts to control and reduce the spread of COVID-19 could become the drive to review hygiene curricula and conditions in schools to provide more comprehensive and participatory education programmes, including hands-on practice experience, and ensure access to basic WASH provisions. This would turn in long-term improvements to protect the health of students and teachers and prevent future public health emergencies.

4.5. Limitations

Our school book review was limited to Kenya. Within Kenya, only one region was sampled to access a set of school books which were commonly used in Laikipia County, according to head teachers consulted prior to the data collection and analysis,. These science education books represent what was being taught in the study area at the time of the study (2015–2016). These books do not represent the entirety of school books approved for primary schools in Kenya, many of which are dated well after 2005 (the latest publication date of the books used in the area) (Table 1) (Ministry of Education of the Republic of Kenya, 2015). What is being taught on WASH and environmental health in schools may have changed since the time of the study (Table 1). We acknowledge that this dataset is not be comprehensive – neither for Kenya, nor in general but it does capture topics covered during primary school. While in our research area WASH and disease risk was only taught in science class, elsewhere, it may be covered also by arts or social science text books. Nevertheless, it enabled us to gain a good understanding on what level of WASH- and water-related disease information pupils at primary schools may have access to; how this relates to WASH education interventions; and how this knowledge can be better used for WASH in school programming. Our rapid review of peer-reviewed and grey literature of behaviour change and health messaging interventions on WASH in schools and global policy guidance documents was not aligned with the PRISMA criteria for systematic literature reviews (Moher et al., 2009). Instead, we identified our included publications strategically via "best match", an option on MEDLINE to identify the most relevant peer-reviewed publications, and grey literature via first and most relevant results on Google. This review of literature was restricted to publications that were available in English, which may have affected the studies identified and included.

The intervention studies included from Kenya underlie a reporting bias, with eight out of twelve studies conducted in Nyanza province (Table 6), where a large-scale research and intervention project designed to develop, test and promote improved water treatment and hygiene through schools and communities was rolled out in response to a high diarrhoeal disease burden and poor drinking water access by an international non-governmental organisation over the past years (Caruso et al., 2014; Freeman et al., 2012; Garn et al., 2013; Greene et al., 2012; O'Reilly et al., 2008). Interventions in the larger part of the country is therefore not represented in the review.

Finally, the Kenyan 8-4-4 educational system is currently transitioning towards a competence-based curriculum (CBC). The roll-out of the new curriculum started in 2018 with children who started their primary school in that year, while the other classes continue with the 8-4-4 system as the new curriculum is phased in (Kenya Institute of Curriculum Development, 2017). This CBC will also use different teaching materials. While this could be considered a limitation of our analyses of 8-4-4 system teaching materials, it can also serve as an entry point for continuous improvement of the existing and newly developed teaching materials.

5. Conclusions

Kenyan school books provide pupils with a comprehensive understanding of drinking water sources and management - including quality, treatment, safe storage and water conservation -, water-related disease risks and transmission pathways, and the importance of environmental hygiene, disease prevention and health promotion. While this serves as an entry point for strengthening WASH, there remains room for improvement. Topics in particular needed for improvement with respect to thematic and school years coverage are: personal hygiene and handwashing, menstrual hygiene management, and sanitation education, as well as related health risks and disease exposures. These themes are all high on the development and WASH agenda, which urges for integration in school books, making an effort to breaking cultural taboos (WHO Regional Office for Europe, 2019).

In the Kenyan context, WASH improvements still require efforts addressing both accessibility of services and behaviour change to ensure

healthy practices, as though education is included in school books, services do not meet national requirements in many schools. This analysis revealed a gap between policies and implementation as well as a disconnect between local education curricular programmes and WASH education interventions, a missed opportunity for effective and sustainable behaviour change. There is still need for scaling-up improvement interventions and integrating WASH education interventions into existing school dynamics and educational programs holds an evident potential for future projects. Considering and building on existing local educational materials and knowledge may facilitate the buy-in and involvement of teachers and school managers in strengthen education and lasting implementation of improvements with sustained beneficial effects.

Efforts are needed now more than ever, due to the challenges of schools and communities in the context of the current COVID-19 pandemic.

To our best knowledge, this is the first study addressing the coverage of WASH in school books and the consideration of curricular materials for WASH in interventions.

6. Recommendations and future research

Thus we recommend researchers, practicioners and educational authorities to

- integrate WASH in school books and educational curricula, besides WASH infrastructure;
- investigate how the WASH content of schools books is used and taught to the pupils, and to what extent knowledge is retained and multiplies in their households and communities;
- promote implementation research with integrated interventions, that better consider school book knowledge.

We recommend international organisations working on WASH in schools behaviour change interventions to

- work even closer with ministries of education to jointly address gaps in implementation and augment the existing curricula;
- integrate text book knowledge for specific classes and age ranges into their programs, adapted to thegeographical and cultural contexts that pupils live in.

We recommend political decision-makers in WASH and education to consider

- working closer with local communities to help provide suitable and sustainable WASH programming;
- working closer with international organisations providing WASH programming in their country to coordinate and scale-up improvement and monitor integration of interventions with existing materials and local dynamics;
- regularly reviewing evidence-based guidance and recommendations on WASH education and update curricular programs and learning objectives - the current revision of the school system provides a good entry point;
- implementing approaches for child-centred participatory teaching and skills based education to integrate in regular curriculum and school materials;
- reviewing school books and teaching methods to cover the gaps between policy and implementation and ensure comprehensive coverage of topics such as sanitation and hygiene;
- adapting school learning materials to be comprehensive and applicable in all the realities of different regional and environmental conditions (e.g. climate, weather, water availability), settings (urban vs. peri-urban vs. rural vs. informal) and necessities, all of which are important drivers for WASH practices, behaviours, perceptions, and knowledge.

Our future work will continue to build on these analyses, extend them to other countries and contextualise them with the COVID-19 pandemic and the implications, challenge and solutions of WASH in schools.

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