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Kit "Energy, Environment and Sustainability": An Educational Strategy for a Sustainable Future. A Case Study for Guinea-Bissau

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Abstract: Increasing the scientific knowledge of the population through education is a development strategy towards a sustainable future. However, there is no equity in the access to science education and scientific knowledge. The aim of this paper is to present and analyse a science kit named "Energy, Environment and Sustainability" (KEAS). Based on research conducted in Guinea-Bissau, it explores strategies to promote science education for a sustainable future. The strengths and limitations of the KEAS were studied using different data collection methods, including interviews, observation, survey, focus groups and document analysis. The participants were teacher trainers from the Guinea-Bissau School of Education. It is concluded that the KEAS is a feasible and suitable teaching strategy appropriate to the context, having the potential to contribute to learning about the environment and sustainability. Further, it addresses real problems for which students should acquire knowledge and skills in order to be able to make informed choices.

Keywords: energy; environment; local knowledge; science kit; sustainability

1. Introduction

Sustainable development can be defined as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations General Assembly, 1987). Taking this into consideration, sustainable development can only take place if poverty can be eliminated/mitigated and the environment protected, because poverty and environmental issues play a key role in increasing the inequalities [1]. Two of the main challenges that sustainable development faces are safe energy supply and climate change mitigation, particularly in Africa.

To face these challenges, science education is one of the key issues. Science education can contribute to unlocking the potential of African countries, promoting cultural, social, economic and political development [2]. One way to popularise science is to disseminate a science education that allows the introduction to scientific culture and new forms of thought. This will allow students to experience one of the greatest achievements of the modern world: science and its technological applications. Science education should also be an education for sustainable development and promote a conscious change in educational philosophy in Africa, involving teaching and learning in local contexts [3,4] and throughout life [5]. In the African continent, to educate in science for sustainable development is necessary to increase access to education but also the quality and relevance of education [5–9].

Considering this and the fragilities of the Guinea-Bissau education system as well as the poor life quality of their population, a science kit named "Energy, Environment and Sustainability" (KEAS) was developed. This paper presents and analyses this educational strategy to promote interdisciplinary relationships between indigenous knowledge and science education, with particular emphasis on energy, gender equality, water, poverty and well-being.

1.1. Energy and Development

Energy is deeply embedded in the economic, environmental and social dimensions of human development [10,11]. Energy is also an important factor in reducing poverty and improving the quality of life, with a strong impact for the most vulnerable populations [10,12]. Two of the main challenges that sustainable development faces are safe energy supply and climate change mitigation [13]. The African continent has the lowest level of electrification in the world [14]. The access to electricity, in absolute terms, is outpacing population growth everywhere, but it has not happened in the African continent (excluding North Africa) [14].

Around 80% of the population in Africa relies on solid fuels, such as wood, charcoal, crop wastes and dung, for cooking [15]. The Sahel region is the African area with the lowest energy consumption in the world and lacks access to sustainable sources of energy. These factors contribute to population poverty and are strongly linked to environmental degradation, causing deforestation in many areas and contributing to climate change [16]. The lack of access to electricity and dependence on traditional biomass makes it impossible to eradicate poverty and to meet the sustainable development goals, with impacts on health and well-being, education, gender equity and environment [13,14,17]. As a consequence, poor and vulnerable people spend a significant amount of their family income on energy for basic survival activities, mostly for cooking. It is estimated that in sub-Saharan Africa, a large number of women and children (especially girls) spend up to 10 h a week gathering wood for fuel, which has detrimental impacts on access to education and to generate income opportunities [13,18].

Access to electricity in schools allows for electric lighting and the use of various equipment necessary to improve teaching/learning conditions. In this way, the use of modern forms of energy contributes to universal and quality primary education, particularly for girls, because it will potentially increase access to information on gender equity and reduce the hard-working time of girls in domestic tasks.

1.2. Science Education in African Countries

Science has a strong link to various issues, such as access to water, food, energy, health, shelter, biodiversity conservation, sustainable development or climate change. However, the benefits of science are not globally distributed in an equitable way.

Increased access to quality education in primary education in sub-Saharan Africa is essential to achieve the overall objectives of education for all and is an important condition for reducing poverty and achieving the sustainable development goals [7,8,19,20]. However, science education is not contributing to the continent's development, mainly because of a lack of adequate teacher training, teaching methods, educational materials and school infrastructure [8,21–23], and the conflict that exists between the worldviews of local/indigenous science and Western science [24,25]. For non-Western teachers and students, the interaction between two such different worldviews builds barriers to the teaching and learning process [4,8,25–27].

These challenges can be overcome, assuming the cultural relevance of science teaching by using resources from the community in class, such as using the local/indigenous knowledge [2,28–31]. The local/indigenous knowledge operates based on a worldview that provides the framework for individuals or groups of individuals to understand themselves in interrelation and interdependence with their natural environment. This will allow them to mobilise knowledge to solve community problems and improve their lives [32,33].

The local/indigenous knowledge is passed/learned to the next generation through oral tradition—e.g., stories, songs, prayers, dances, paintings, artefacts, writing and participation in rituals and spiritual ceremonies [34]. This knowledge allowed communities to maintain the environments preserved over time [2]. In science education, local views should not be a barrier to knowledge but a challenge and an opportunity to learn more and better science, increasing student's motivation and interest [4,26,32,35]. Taking this into consideration, the teacher should be a cultural mediator who considers the students' ideas and visions of the world and introduces another cultural context, Western science [22].

In science education, the practical work plays a key role in the relevance and improvement of the quality of education [36,37]. The brainstorming, the games, the roleplay and the manipulative and investigative activities are emphasised in the literature as the most appropriate strategies [36,37]. Within primary education, one of the most used investigative activities is the fair test. It is an activity in which students are actively involved and have to define variables in order to answer a central question [38]. These strategies need to be implemented using various types of materials and equipment that represents a challenge because of resource shortages in various contexts. Several authors emphasise that the use of digital materials [39–43] and science kits [44–48] are adequate ways of organising practical work resources.

1.3. Guinea-Bissau: A Brief Overview

Guinea-Bissau presents an energy crisis with deep impact in terms of economic, social and environmental factors. It was one of the countries with the lowest clean fuels access rates in 2014 [11]. The main energy poverty indicators are limited access to electricity and heavy reliance on the traditional use of solid biomass to cook. Only 17% of the population has access to electricity (33% in urban and 4% in rural areas) and 87.06% uses renewable energy, which reflects the high reliance on traditional biomass (79.34%) of the final energy consumption [11]. This energy crisis prevents country development and decreases population quality of life [1,49–52], as the people become dependent on forest resources and more vulnerable to the impacts of climate change [11,15,53].

Most of the population uses open fires or low-efficiency stoves that are inefficient and unhealthy due to incomplete combustion of fuel [54]. Women and girls who are customarily responsible for cooking are most exposed to risks such as burns and high levels of air pollution, including carbon monoxide and particulate matter (PM). In poorly ventilated homes, indoor pollution can be 100 times higher than acceptable levels for particulate matter smaller than 2.5 μm that penetrate deep into the lungs [18]. Household air pollution is responsible for diseases including stroke, pneumonia, ischaemic heart disease, chronic obstructive pulmonary disease and lung cancer [18].

In this demand for fuel, women are more exposed to accidents, violence and other risks to their physical integrity [10,55–58]. Women are suffering most of the energy poverty's harmful consequences [17,18,50,59]. Gender equality regarding energy is a key issue to promote social, environmental and economic development [60].

The quest for fuel decreases the vegetation area, increasing the distance, the time, the difficulties and risks to find wood. When the main species become scarce, people have to use substitutes, usually species with lower calorific density, such as cashews [61]. This increases ecosystem pressure and impacts the price of wood, consequently promoting harder daily life conditions for families. The use of energy resources from the forest contributes to the reduction in forest areas and increased desertification. In this sense, the solution to reduce the environmental impacts should be based on population awareness and environmental education, for teachers, school children, women and communities of protected areas.

To reduce these problems, the WHO [17,62] recommends (i) the promotion and dissemination of household energy technologies such as improved cookstoves, (ii) avoid the use of unprocessed coal and kerosene, replacing it with Liquefied Petroleum Gas (LPG) because it is clean and easy to use, burns efficiently and reduces emissions, (iii) the dissemination of safe and affordable renewable energy resources such as solar, wind or hydro and (iiii) the application of measures to facilitate the transition of current practices to the use of clean fuels and household energy technologies, specially designed for families with lower income and more rural homes dependant on solid fuels

Analysis of literature and direct observation of Guinea-Bissau schools evidenced weak preservice and in service teacher training that use transmissive and decontextualised teaching methodologies [63,64]. The majority of the primary schools in the country have poor conditions, without laboratories or other places prepared to carry out laboratory activities, and lack access to electricity [63,64], which prevents the use of information and communication technologies.

2. Kit "Energy, Environment and Sustainability" (KEAS)

To act within the Guinea-Bissau education system, we set up an educational strategy of action based on: (i) the preservice and in service teacher training, (ii) the lack of teaching materials and (iii) the teacher centred methodologies. In this way, we opted for the formulation, implementation and evaluation of a scientific-educational kit named Kit "Energy, Environment and Sustainability" (KEAS), designed for teachers and students from grades 1 to 6. This kit was developed to be low-cost, student centred, with activities based on the students' everyday events.

KEAS is an educational strategy to promote interdisciplinary relationships between indigenous knowledge and science education, with emphasis on contemporary and relevant issues such as energy, gender equality, water, poverty and well-being. KEAS privileged some forms of action that are in balance with the activities used by local environmental organisations, which imply learning with the community and the value of the role of Guinea-Bissau women.

The major Guinea-Bissau energy challenges were selected for the KEAS activities. To prepare the KEAS, it was necessary to identify and analyse energy-related content, the local environmental practices and indigenous knowledge. After analysing the existing syllabus and proposals for inclusion of environmental education in the curriculum, and taking into consideration that theme-based science kits can be more user friendly for teachers than level-based kits [65], three cross-cutting themes were selected: Energy for Cooking, Energy and Water Quality and Energy and Decision Making.

Underlying the discussion of the selected themes is a participatory approach for science education in primary schools that promotes African sustainable development [3,8,66,67]. This involves the community's knowledge as a starting point for experimentation and the acquisition of new knowledge [5].

2.1. KEAS Concept

The kit activities were designed to allow to understand and solve real problems of the students related to the use of energy resources and its impact on the environment and well-being of communities.

The KEAS is based in the following principles:

- Culturally appropriate, suggesting inquiry activities supported by the indigenous knowledge and working with the community;
- User friendly for teachers and students;
- Low cost, avoiding concerns about its use;
- Easy to duplicate with local, familiar and simple materials;
- Easy to carry, even by children;
- Sensitive to gender issues. The activities are intended to be apart from gender stereotypes.

The KEAS can be used without access to electricity.

It contains activities that explore the interdependencies between science, culture, society and local environment; this means to take into consideration the values associated with environmental education and to look for low cost, effective solutions to local problems [2].

The KEAS was developed to be used across the curricula from grade 1 to 6, using energy and environment as a global theme. This aspect allows the KEAS use regardless of curricular changes because these themes are always present in national and global agendas, particularly in an educational system marked by the strong influence of donors [67]. This also allows the use of the KEAS in schools with different teacher training models. The KEAS can also be used in non-formal contexts, such as civil society organisations.

2.2. KEAS Materials

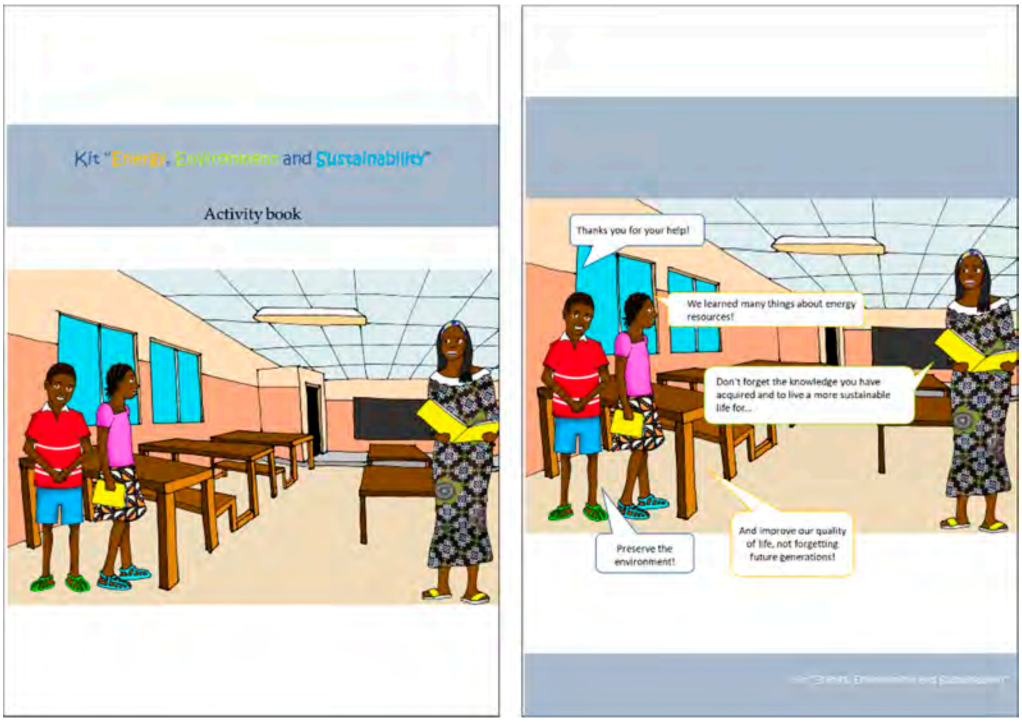
The KEAS include:

- An activity book with proposals of different types of practical work;
- Laboratory and everyday materials needed to complete the activities suggested in the activity book;
- A box produced in Guinea-Bissau from the recycling of aluminium cans collected in the streets.

The box has capacity to store all the materials of the kit, with side handles that facilitate the storage and stacking, allowing it to be carried by one or two people. This box allows to store and assemble the KEAS materials, reducing the risk of loss and protecting them from external conditions such as rain, humidity, sunlight and animals.

In order for the KEAS to be low cost, it was imperative to make a compromise between their scientific precision and price. Thus, some laboratory materials were replaced by day-to-day materials [36], but it was decided to include some laboratory materials such as beakers and alcohol thermometers. These materials are more difficult to substitute from day-to-day materials and allow to perform more rigorous activities. In addition, they provide the KEAS greater credibility among users because they will feel that they are using a material with higher quality [68].

The activity book is based on the basic education syllabus in place and in the curriculum proposals for inclusion Education for Citizenship and Environmental Education (Figure 1).



(**a**) (**b**)

Figure 1. Activity book: front cover (**a**) and back cover (**b**).

It features characters and scenarios that introduce and guide activities. There are four characters representing students, teachers and elders, a symbol of knowledge in the communities. Their names, appearance, dialogues and attitudes were designed to promote contextualisation of the activities. Three distinct scenarios were designed, inspired by photographs and perceptions of landscapes and local buildings: the teacher classroom and two different tabanca (in Guinea-Bissau it means village) (Figure 2).

Figure 2. Character and scenario designs for KEAS: the teacher classroom and one tabanca.

The activity book contains suggestions for different practical activities that can be used inside and outside of the classroom. These can be adapted by the teacher according to the syllabus and cognitive development of their students, even without textbooks or other instructional materials [42]. All the activities presuppose work and discussion in small groups. It is intended to motivate students to understand the concepts, processes and content related to energy and environmental sustainability, encouraging them to think, communicate, exchange ideas and make informed decisions.

Different types of activities are proposed, such as brainstorming, games, working with the community (Figure 3), roleplay (Figure 4) and hands on and inquiry activities.

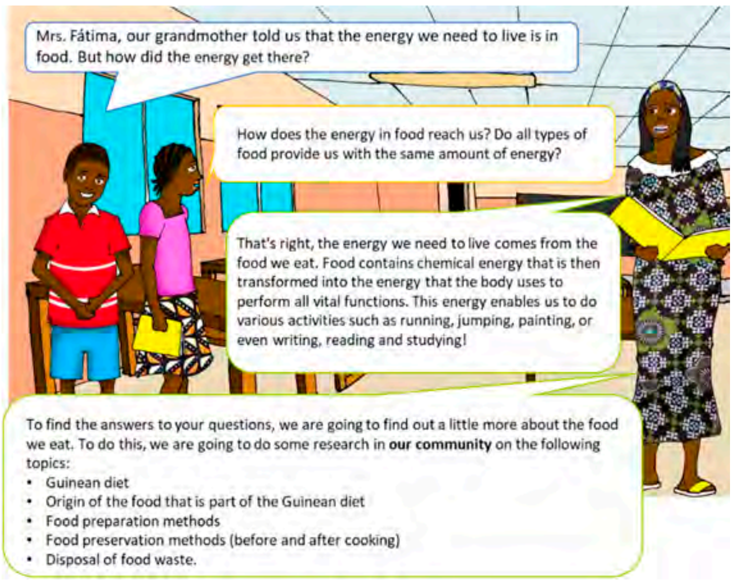


Figure 3. Example of an activity that challenges students to find some answers by asking their community directly.

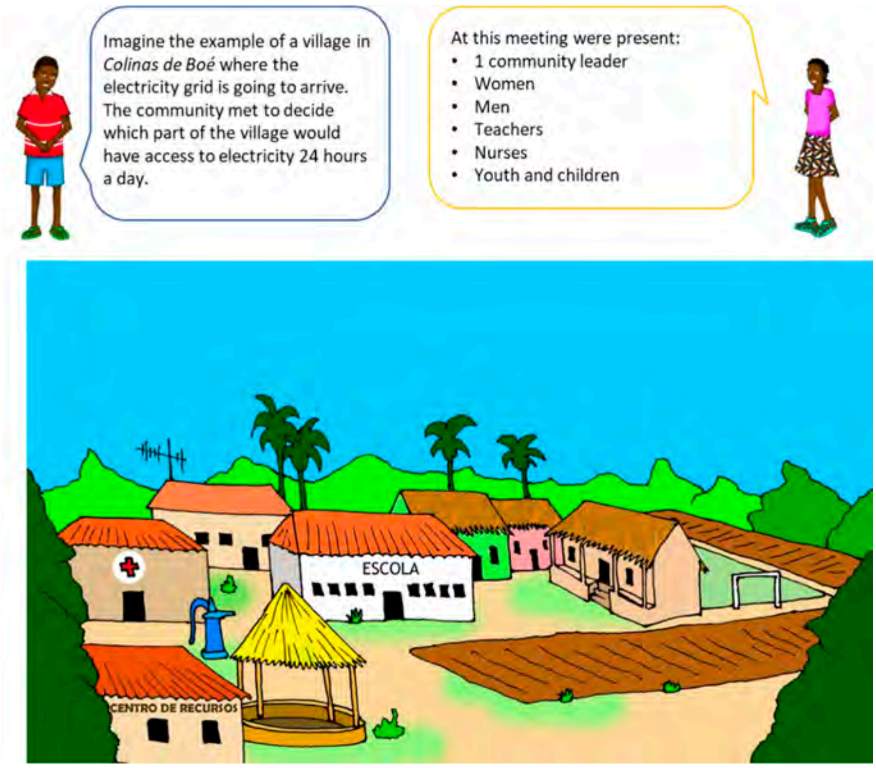


Figure 4. Starting point for a roleplay.

All inquiry activities begin with a problem situation (Figure 5). Dialogue between characters is intended to reflect on day-to-day problems for which students should find an answer, while acquiring scientific knowledge and procedural and manipulative skills.

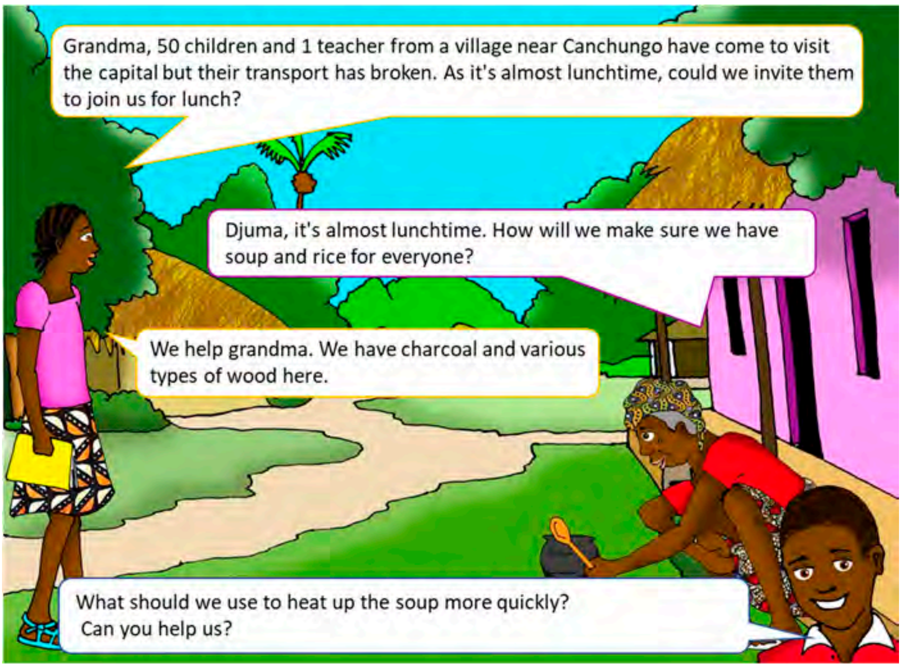


Figure 5. Example of a problem situation related to the different types of fuel used to make food in Guinea-Bissau.

After analysing and discussing the problem situation, students should follow the steps of the experimental protocol in order to find answers. Before the experimentation, the variables under study should be defined, the predictions recorded and the materials and procedures listed.

After the experimentation, the results should be recorded and analysed. The results can be registered in different ways (Figure 6).

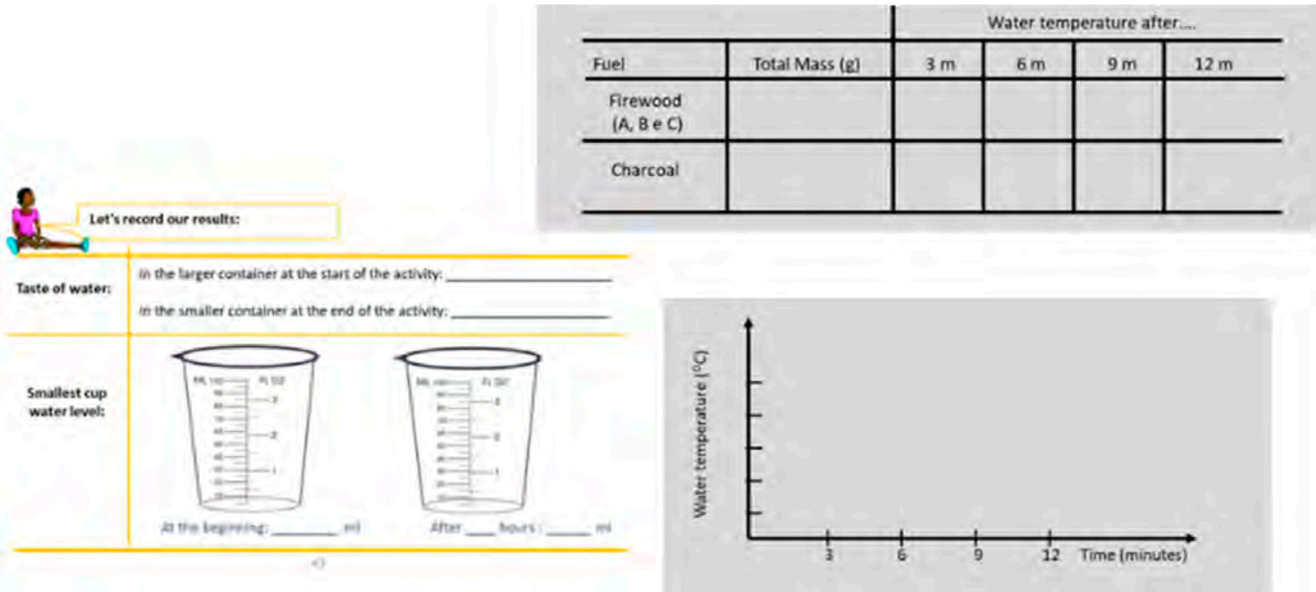


Figure 6. Different ways to record the results.

After reflecting about some questions to apply the learned content to real-life situations, the activities end with writing the answer to the problem question.

During the activities, the students can teach and learn from each other, building more meaningful learning. In this way, students must (i) reflect critically on the program content, (ii) identify the independent variables, (iii) think of how to measure the outcome, (iv) explore and discuss what might happen, (v) plan and perform research, (vi) make observations and measurements, (vii) record, interpret and evaluate the data, (viii) communicate results, (ix) draw conclusions and (x) engage in brainstorming activities to find possible solutions to everyday problems and to act on them [36,38,69,70].

The activities aim to bring local context to the classroom in search of informed and creative solutions to real problems and demonstrate that the students can use the resources in order to save money, time and improve quality of life [71]. The integration of concepts and scientific processes arises from the exploration and discussion of practical activities.

3. Methods

A case study approach was used. The data were collected during 4 periods of field research in Guinea-Bissau. The case study was mainly qualitative and aimed to develop and assess KEAS relevance for science and environmental education for grades 1 to 6 in Guinea-Bissau. The kit design was based on field notes held in Bissau from informal talks with different education actors and document analysis. We intended to define a set of contextualised, sustainable and motivating activities based on scientific knowledge. After defining the activities, we selected, adapted and tested the materials.

KEAS was assessed in three teacher training sessions, with the participation of 30 teachers involved in the supervision of teaching practices of students from Teacher Training School of Bissau. The participants included all the teacher supervisors in Bissau from 1st to 6th grade. The majority were male (63.3%) and, on average, had 29.6 years of experience in teaching.

The training sessions allowed the teachers to experience KEAS, analyse its relevance regarding the science education in the country and to present improvement suggestions.

In training sessions, teachers had the opportunity to perform different kinds of practical activities presented in the activity book. Considering the importance of peer interactions, most practical activities occurred in groups, allowing the exchange of experiences.

During the training, data were collected that allowed to better understand, assess and contextualise the KEAS. The data collection methods used included participant and non-participant observation, interviews, survey (before and after KEAS' teachers training), focus group and document analysis. In the development of the survey and focus group questions, we used clear, simple and understandable language, avoiding confusing or ambiguous terms. We also considered differences, diversity, language ability, cultural translation (literal and figurative) in terms of concepts and research ethics in order to avoid embarrassment with cultural and social norms [72]. The survey and focus groups aimed to collect (oral and written) teachers' views and suggestions about KEAS, namely the presentation, structure and appropriateness of the activity book and materials for the Guinea-Bissau context. The combination of these methods allowed a critical look at the data. This eclectic data collection strategy allowed a more effective participation of the participants because Portuguese, despite being the official language, is not the mother tongue of the population and the oral culture is stronger than the written.

4. Results

In the three teacher training sessions, the participants had the opportunity to explore the KEAS (activities and materials). Working in groups, they performed activities related to (i) wood fuels efficiency (Figure 7), (ii) heat conservation using different coatings, (iii) solar oven (Figure 8), (iv) water pasteurisation (Figure 9), (v) water desalination (Figure 10) and (vi) community decision making in the form of a roleplay.

Figure 7. Activities of the sub-theme "Impacts of our food on the environment", related to the efficiency of wood fuels: use of the cooker (**A**) and temperature measurement of the heated can (**B**).

Figure 8. Activity of building a solar oven: teachers wrapping the cans in a bag with a zipper (**A**) and the appearance of the solar furnaces in the sun (**B**).

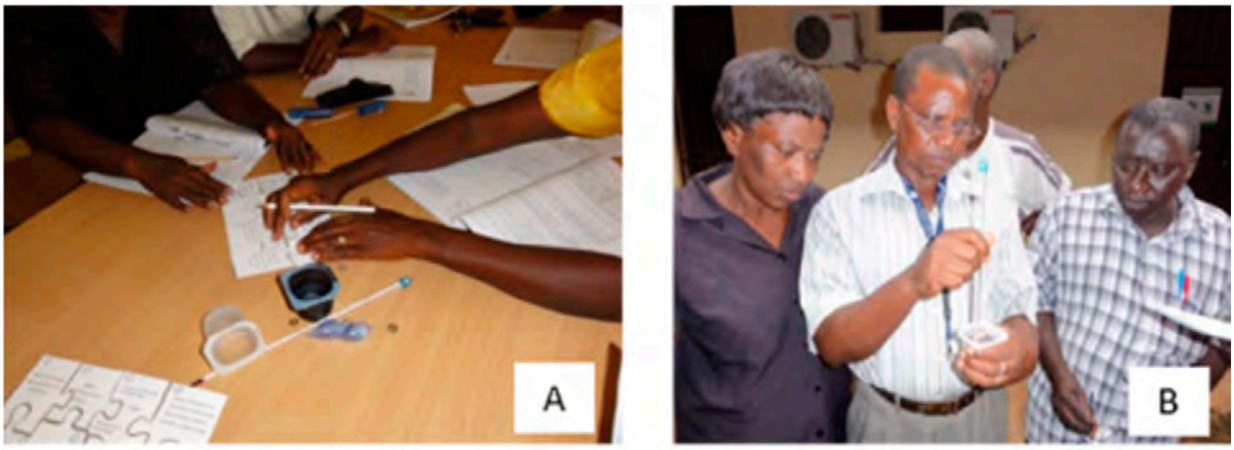


Figure 9. Activity of the sub-theme "Energy and Water Quality": construction of a puzzle (**A**) and measurement of water temperature (**B**).

Figure 10. Activity of sub-theme "Water desalination": construction of a distiller (**A**) and distiller's appearance in the sun (**B**).

Teachers considered that the KEAS is educational material appropriate and relevant to Guinea-Bissau science teaching in the first six years of schooling. All teachers considered that the activities are appropriate and allow a greater reflection on the interaction between science, population and the environment. The majority (96.2%) noted that activities facilitate understanding of scientific content and 92.3% indicated that they are in line with the contents of the current program in the first six years of schooling. Most teachers (96.2%) agreed that activities value community knowledge since they consider the daily problems of managing energy resources in Guinea-Bissau (84.6%) and the poor water quality. Teachers agree that activities stimulate curiosity (92.3%), are relevant (92.3%) and challenging (73.1%). All activities were considered very good by 35.2% and excellent by 46.4% of the teachers; however, the activities considered more relevant were the ones that engage them with the community, inquiry and roleplay activities (Figure 11).

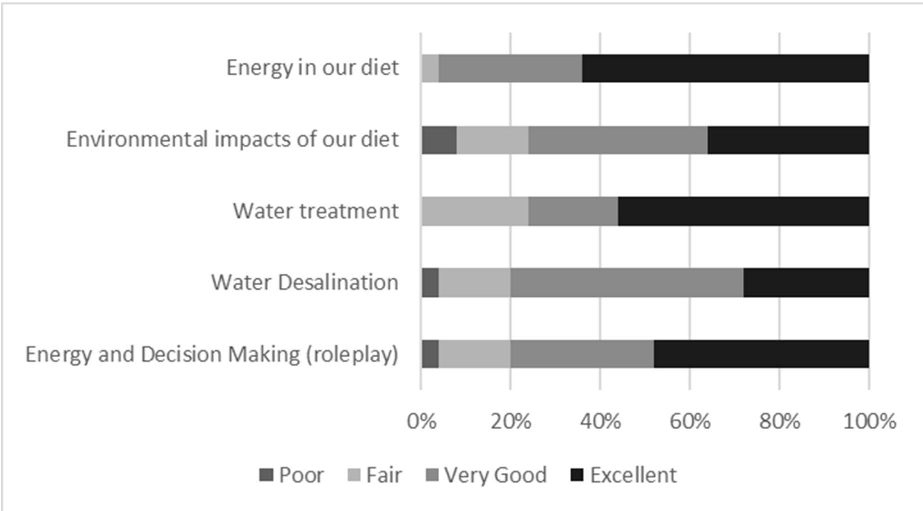


Figure 11. Teachers' opinions on the relevance of script activities.

From the teachers' perspectives, the activities from the activity book explore, in a scientific way, the real problems of the students to mobilise knowledge to solve community problems and contribute to community well-being. This opinion confirms one of the KEAS assumptions and several author suggestions regarding science education in developing countries [2,3,5,6,8,34,73].

Roleplay has proved to be a fascinating activity because it intertwines with the participants' daily knowledge and attitudes and enables them to mobilise that knowledge to find consensus and possible solutions to a problem situation. It reflected the life, the solutions, the culture and the way of thinking of the participants. As teachers stated:

> "It also leads children in their decision-making to solve certain problems in the community or at school."

> "These kinds of debates always take place in our communities in making decisions about a subject o a donation to the community."

> "Because it helps the kids. Everyone in the community has the right to give their opinion; this (. . .) is not what happens! Children have no voice. And women have no voice. The men all have. This helps to work and cultivate in the child the mentality that all the children in our house, even the smallest child has their opinion and we must respect."

All teachers consider that the dialogue between the characters provides greater interaction between the contents and the user and 92.4% agreed that the presentation of the activities, always starting from problem situations, is motivating. According to the opinion of all the teachers, the characters and their names suffered some changes, since:

"The country is multi-ethnic and we would like to have names that say something about some ethnic groups in the country. We suggest changing names. For example, Mussa should continue. To Djuma, the group suggested that it be another name: Apili and Grandmother Dam."

"Given the cultural mosaic, these characters must have names that fit this aspect."

Mussa is a Muslim name of the Fula ethnic group, Apili is a name of the ethnic group Papel and Dam is a name of the ethnic Balanta. In this way, KEAS has characters from three of the most representative ethnic groups in Guinea-Bissau [74,75].

The characters were drawn showing different expressions and gestures to convey more movement and resemblance to reality (Figure 12).

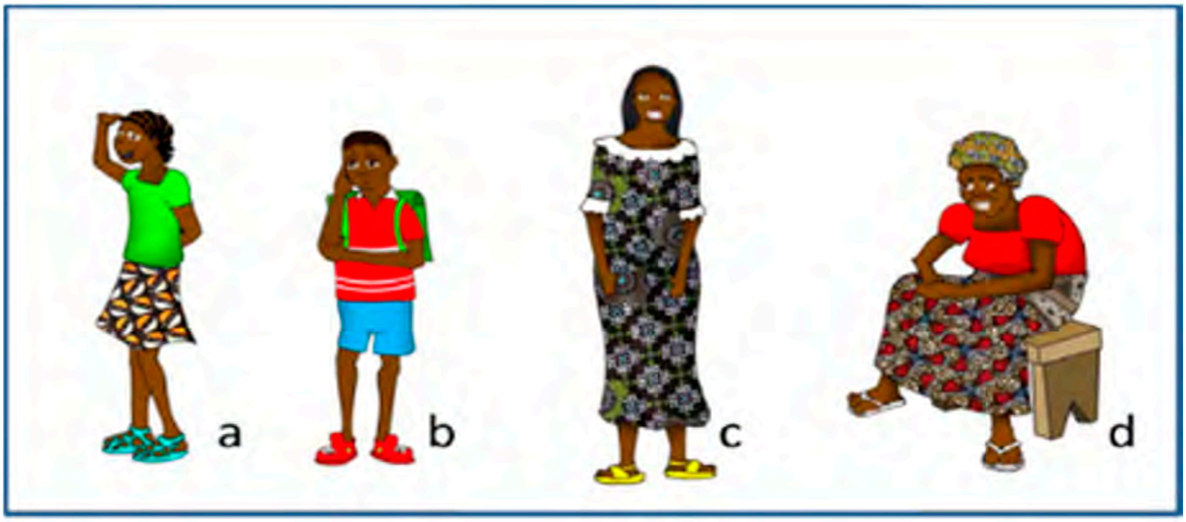


Figure 12. Final characters: the students Apili (**a**), e Mussa (**b**), the teacher Fátima (**c**) and grandmother Dam (**d**).

Another recommendation was to give "life" and movement to scenarios. In this sense, the initial scenarios were also changed (Figure 13).

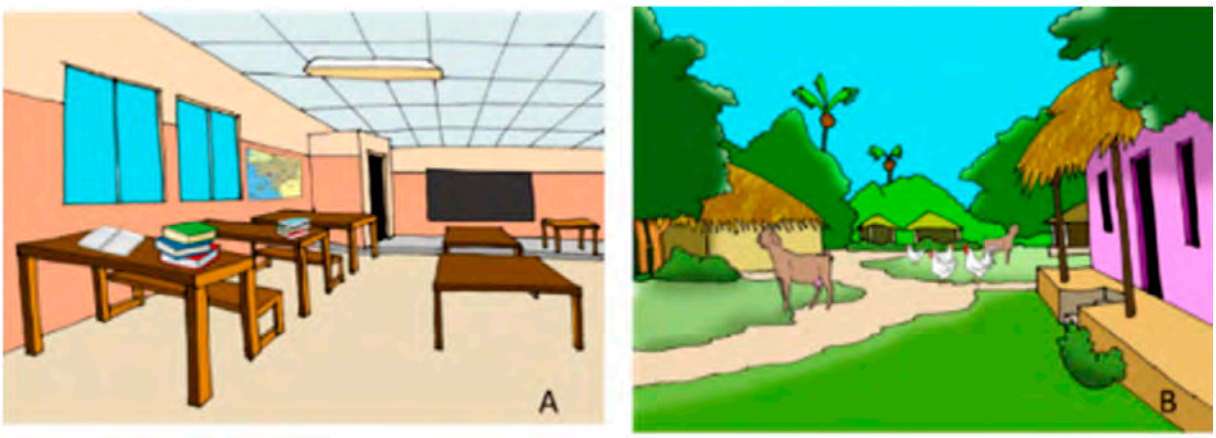


Figure 13. KEAS' final scenarios: classroom (**A**) and the tabanca from grandmother Dam (**B**).

Regarding the activity book, they considered that contributes to increase the student's Portuguese language skills and encourages students to engage in discussions and promote the student's active role in their learning. These results are in line with other studies [22,30,66].

The results highlight that, despite that the participants agree it is feasible to implement practical activities included in the KEAS, most were considered impossible without some of the materials.

> "The procedures are appropriate at the level of the students, because they are activities of great interest to the students, they are participatory activities. I would use some such as the discussion in Boé's tabanca about where we can place the electric outlets, but the others, such as many experiments we did, would not do because the school lacks materials."

This view is in line with the responses in the initial survey (Table 1.), which indicated that this is the main obstacle to the implementation of practical activities in class (66.7%) and are in line with other studies [2,7,9,76].

Table 1. Reasons given by teachers for not doing practical work in science classes. (n = 15).

Category	Reasons	f	%
School conditions	My school does not have the materials and equipment to do practical activities.	10	66.7
	I do not have books to help me prepare practical classes.	8	53.3
	The classroom is not suitable for this type of work.	8	53.3

This reinforces the importance of including materials that allow implementation of the hands-on inquiry activities proposed by the activity book. These materials in the KEAS are designed to be free or low cost to increase the number of components and maintain the overall low price of the KEAS. Taking into consideration several authors [39,77] and our experience, we decided to choose local materials that teachers can obtain for free or at low cost. This option seems to be in line with teachers' ideas. One of the teachers mentioned the importance of carrying out activities with materials for daily use, without there being monetary expenses with the acquisition of material, indicating that:

> "I learned things that I can really pass on to my students because they are everyday things that we can do without any economic expense."

The teachers also noted that it was important that the kit was not too heavy. This facilitates its transportation, by a teacher or a student, and use in different classrooms of the same school.

All teachers agreed not to remove any theme or activity from the script and indicated that it would be important to add more:

> "We still need to have more: wind energy [since] many people are unaware of this energy."

> "I think the issues should be deepened. Speaking specifically about drinking water, do people know when water is good for drinking? Decide which water is good for drinking and not good water. Everyone consumes any water and is dangerous. Even the tap water that we take from here can have many bacteria. Therefore, I think they could go deeper into water quality."

All the participants stated the need to develop and include in the KEAS a scientific-pedagogical book. This book will allow the teachers to have more confidence in promoting more participatory, challenging and student-centred teaching. This result is in line with other authors [37,45,77–81]. It was also referred that the KEAS should include posters and other activities with focus in the community.

Although the KEAS is considered adequate, its use requires teacher training and initial scientific and educational monitoring. Training and monitoring can help to increase scientific knowledge and reduce the reluctance of teachers to carry out practical activities in their classrooms [45,46,48,68,78–80,82].

We consider that it is important that the KEAS is integrated in the teacher training schools to allow trainee teachers to have access to science teaching methodologies that integrate scientific and didactic knowledge. This will allow teachers to take ownership of the KEAS and feel confident to adapt, redesign, add or remove activities [42,79].

Since the KEAS is built to be used across the curricula from grade 1 to 6, future teachers' training should focus and strengthen the KEAS curriculum framework in order to allow the teachers to feel confident to use the kit and prevent perceiving it as a tool that does not follow the syllabus [46,48].

5. Conclusions

To act towards the creation of sustainable societies, we chose to build a science and pedagogical kit (KEAS) based on indigenous knowledge and participatory approaches for science education in primary schools. The KEAS is an educational strategy that involves communities' knowledge as a starting point for experimentation and the acquisition of new knowledge. It also promotes public understanding of science and student's interest, enabling them to develop skills related to critical thinking and problem solving to be able to make relevant and informed choices. This means to take into consideration the values associated with environmental education in contemporary issues, such as energy, gender equality, water, poverty and well-being, to look for low cost-effective solutions to local problems.

The participant's perceptions confirmed the importance of acting quickly in primary education to promote scientific, didactic and sustainable knowledge.

The data analysis allows us to conclude that the KEAS is appropriate for science teaching across the curricula from grade 1 to 6, using the energy and the environment as a global theme. It also allows us to conclude it has the potential to contribute to a more relevant science education. The participants stated that the KEAS activities stimulate curiosity, are challenging, motivating and value the community knowledge. The activities also have the potential to contribute to a more relevant and modern science teaching and learning. It seems that the KEAS has the potential to bring to schools the scientific knowledge and the real problems of the people related to the use of energy resources.

The KEAS proved to be appealing to teachers, who stated that they would like to apply it in their classes. However, a condition for the implementation of the activities is the presence of materials. This result validates the choice of a scientific kit and not only the development of an activity book. To allow the acquisition and implementation of the KEAS in the Guinea-Bissau schools, the kit should be low cost and have locally available materials.

It is imperative to develop, and include in the KEAS, a scientific-pedagogical book with clear and simple information about the theoretical concepts associated with energy. This scientific-pedagogical book will aim to assist teachers in preparing and implementing the activities, making them more autonomous to use the kit, even if they have not attended any training. However, the results show that for teachers to use the KEAS efficiently and accurately, it is vital to have the opportunity to take part in teacher training.

Considering the potential of the KEAS as a vehicle to promote contextualised local vs. global scientific and pedagogical knowledge, it could be integrated into teacher training institutions.

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