Policy responses to the decline in the number of students choosing biology beyond compulsory school level in Mauritius

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Abstract

The number of students opting for science subjects, particularly biology, beyond compulsory school level has been decreasing substantially in recent decades in Mauritius. This decline is of major concern in an era when scientific literacy and the need for science-based employment are considered fundamental to face both local and global challenges. Although several studies have identified a range of factors to explain students' choice of subjects and the low number of students opting for biology at post-compulsory level, there is little known about how policies respond to the issue. In this article we explore how policies are responding to the decline in the number of students opting for biology at the post-compulsory education level in Mauritius, drawing on 25 biology education policy documents and focus groups with twelve students, ten educational officials and six parents. The findings of this study suggest that the actions undertaken in attempts to address the issue of poor uptake of biology could have been undertaken in a more coherent way, with an appropriate overarching policy frame to inform the actions. We argue that current policy actions are too state-centred, with policy makers adopting a top-down approach where policies are simply meant to be implemented by schools. We argue that more needs to be done to acknowledge and incorporate inputs from other stakeholders, including students.

Keywords: biology, uptake, participation, policy responses, post-compulsory education, Mauritius

Introduction

Today, science has diffused and pervaded into every sphere of society in such a way that everything directly or indirectly depends on science. It is therefore imperative to enable the public to be scientifically literate, as insufficient understanding of science excludes people from the discourse of modern society, from understanding the world within and around us, from understanding and responding to challenges and global issues (Atchia 2019), such as climate change, the energy crisis, and the emergence and re-emergence of epidemics. However, analysis of data derived from the Mauritius Examinations Syndicate, the institution responsible for the organisation of national and international examinations in the country, reveals that the number of students studying science subjects at post-compulsory secondary level has been decreasing at an alarming rate and that the decline is most acute in biology. This decline has serious implications as Mauritius is without major natural resources and so is completely dependent on its human capital.

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The literature reveals that the issue is not limited to the Mauritian context and that the causes of such disinterest towards science, and biology in particular, is multifactorial (Fraser and Walberg 1995; Levy and Murnane 2005; Lyons and Quinn 2010; Stewart 2010; Wilmarth 2010). The common causal factors are widely held to be (i) the excessive content within biology syllabuses, (ii) the perception that biology is a subject with a high level of difficulty, (iii) limited career opportunities in the field, (iv) use of outdated and inappropriate teaching strategies by biology teachers, (v) limited practical and other hands-on activities, (vi) low performance of students in biology at national examinations, and (vi) lack of opportunities for developing inquiry skills (Rughooputh 2003; Randler, Osti, and Hummel 2012).

However, although much research has been devoted to the identification and effects of such factors on students' interest in biology, there are very few studies that have examined the relationship between policy and low intake of post-compulsory biology. Indeed, there is no study that has been undertaken to situate the policy responses on the decline in biology participation in the Mauritian context, despite researchers such as Lyons and Quinn (2015) showing that such declines and the dynamics of subject choice at secondary education are related to policy and structural changes. It is from this perspective that this study seeks to examine the policy responses to the decline in intake of biology at post-compulsory level in Mauritius.

The context

The Mauritian Education System

During the last few decades, the Mauritian education system has witnessed many educational reforms, the most recent one being the 'Nine Years Continuous Basic Education (NYCBE)', which started in 2017. This marks an important event in the history of the Mauritian education sector as it adopts a systemic and holistic approach to the transformation of the education system in line with the United Nations Sustainable Development Goal 4, which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all by 2030. Figure 1 illustrates the educational pathway from early childhood, through the nine years of continuous basic education, up to the upper secondary education level.

Science education in Mauritius

The growing recognition in Mauritius and elsewhere of the importance of science and scientific skills in all realms of life, both at individual and societal levels, has led to the recognition of scientific literacy as a major goal of education (Mauritius Research Council 2001; Organisation Economic Cooperation and Development 2009). Such recognition sparked the 'Mauritian move', comprising both formal and informal dimensions, towards the development of skills needed to transform the current society into a scientifically informed and literate populace. The policy document *Inspiring Every Child* (Ministry of Education 2017b), which sets the basis of the NYCBE reform, lays much emphasis on both formal and informal science education to develop knowledge, skills and attitudes so as to build the human capital that will spearhead the transformation of the country into a knowledge-based, skills-driven economy.

In Mauritius, school science is compulsory up to Grade 9, after which students on the academic pathway are required to choose a specific strand which includes a science stream. However, students opting for the science stream may choose only 2 science subjects out of biology, chemistry and physics. Thus, many students do not continue with biology after the compulsory level. Furthermore, after the Cambridge School Certificate (Grade 11), students in the science

stream choose their subjects for A level. Thus, this represents another point where biology may be excluded in the students' choice for subjects.

Students' choice for biology at post-compulsory level

Though science education is considered crucial in the development of an informed society, several studies have shown that the number of students opting for science is declining over time (Barmby et al. 2008; Owen et al. 2008; Bennett and Hogarth 2009; Turner and Ireson 2014). The number of students who continue with biology has decreased in a number of countries, including Australia (Randler, Osti, and Hummel 2012), Israel (Vedder-Weiss and Fortus 2011), Oman (Potvin and Hasni 2014), Slovenia (Devetak et al. 2009), Taiwan (Hong and Lin 2011), Turkey (Cavas 2011) and the USA (Gottfried et al. 2009).

Mauritian data obtained from the Quality Assurance and Inspection Division (QAID), the Mauritius Examinations Syndicate (MES) and the statistics unit of the Ministry of Education (MOE) show that the decline is alarmingly high in Mauritius (cf. Maulloo and Naugah 2017). The number of entries for biology has dropped at School Certificate and Higher School Certificate level from year 2013 to 2019, as shown in Figures 2 and 3 in relation to chemistry and physics. Inspection of the available data reveals that student interest is shifting away from the three traditional sciences to other disciplines, including travel and tourism, computer science, enterprise, and business studies. Though the decline is apparent for all three traditional sciences, the focus of this study is on the decline in biology uptake at upper secondary level.

Factors affecting the number of students opting for biology at upper secondary level

Various research initiatives have been undertaken to understand the reasons why today's youth is not interested in science subjects (Seymour and Hewitt 1997) and especially biology.

Analysis of the literature reveals that the causal factors for the decline in the number of students opting for biology at upper secondary level vary from one country to another. For instance, Barmby et al. (2008) showed that the decline in the UK was due to the fact that biology was 'not perceived as practical', 'not made relevant' (2008, 9) and 'not being well explained by teachers' (2008, 10). George (2006) concluded that self-concept, peer attitudes, teacher encouragement and student participation in activities were key factors that helped explain the decline in the USA. Naugah (2011) identified several factors informing the choice of subjects in Mauritius, specifically self-identity (self-esteem and confidence), pedagogic reinforcement (teaching and learning), social roles (of teachers, parents, peers), philosophical clash (modernity, nature and culture of science) and national imperatives (scientific literacy, skills needed at the country level). Naugah and Watts (2013) explored why few girls opt for science subjects after compulsory schooling in Mauritius and concluded that "there need to be radical changes in approaches to teaching to retain young girls' interest in the sciences" (p. 265). It is also reported in Mauritius that "overt parental influence on the choice of subjects is not a strong factor in the choice of science subjects" (Naugah, Reiss and Watts 2019, p. 14) and that parents' occupational background does not influence students' choices for subjects.

Policy in education

Education policy represents an important site for the 'playing out' of political control and authority over the very nature of education, its purpose and how it manifests through structures and practices, for example through schooling, curriculum and pedagogy.

One factor that forms part of the analysis of the research-policy relationship in education relates to the capacity of educational systems to make use of research and be receptive to it. Research findings provide the ground data that guide policy makers in setting educational policies. Indeed, policies formed based on grounded data are key to the improvement of the education system and the economy of a country. However, educational policies in Mauritius have been borrowed from western countries and international organisations such as UNESCO and World Bank, without considering the voices of local stakeholders. Thus, rather than being viewed as actors in the education system, the stakeholders are constructed as part of the problem that needs to be fixed (Smyth 2007). This study therefore seeks to capture the voices of a sample of relevant stakeholders, namely students, teachers, school administrators, educational officials, parents and the Quality Assurance Officers, which represent the sources of the ground data needed to inform policy responses related to the decline in the number of students opting for biology at post-compulsory level in Mauritius and to capture their involvement in the policy-making process.

Policy response is a dialogical interaction between policy makers and policy implementers. The nature of this engagement has been explored by researchers from a socio-cultural perspective and three dominant paradigms have been identified, namely the 'problem-solving model positions policy', the 'process model positions policy' and the 'theoretical eclecticism model positions policy'.

Policy as problem solving relates to the conception of policy as an event and/or a guide, concerned fundamentally with the act of setting out solutions to problems. This view originates from the 'state-centred' approach and its inherent traditional and rationalist foundation of policy processes which focuses on the locus of power (Dale 1989; Smyth 1994). This approach falls under the category of regulatory policy responses (Sheldon 2016), which measure the impact of policy on citizen interests, project policy consequences with accuracy and affect the decisions of identifiable clients, who use policy and its analyses to solve problems. It reflects a positivist idealism of an objective worldview waiting to be explored (Denscombe 2002; Neuman 2004; Gephart 1999). The problem-solving approach tends to reduce education policy to a set of principles, actions and routines related to educational issues to bring about desired goals. It reinforces a managerialist rationality of policy (Vidovich 2001) and endorses a 'client orientation' view of policymaking whereby the policy-making process is seen as advice to clients rather than as a contribution to the broader political discourse.

The second paradigm, that is the 'process model' policy approach, adopts a more postmodernist orientation to policy (Ball 1994; Ball, Maguire, and Braun 2011). It highlights the complex and contested nature of policy as a process rather than a product (Vidovich 2001). The contested nature of this approach is evident at two levels: the initial stage of the process, referred to as the encoding level, and the interpretation/disputed level, referred to as the "decoding" level (Nudzor 2009, p. 88). In this model, policy is a dynamic process where the problem-solving agenda embedded in the traditional/rationalist approach to policy unduly limits understanding of the dynamics of the entire policy process. The third paradigm, that is the 'eclectic approach' of policy response, draws upon both problem-solving and process conceptions of policy. It is considered to include all the required qualities of a useful conceptual framework for policy analysis (Vidovich 2001). According to Ball (1994) in the analysis of complex social issues, two theories are probably better than one. Both the traditional problem-solving and process models complement each other and together they provide more insights about policy processes. In this study, the 'eclectic approach' (Nudzor 2009) of policy response is used to address the issue of policy response to the decline in the number of students opting for biology at post-

compulsory level in Mauritius. Among the different eclectic approaches to policy response that are available, the sociocultural policy analysis approach is used as the underlying framework to guide the study.

The sociocultural policy analysis approach

The sociocultural approach to policy analysis is used as it is grounded in the presumption that policy should be analysed with respect to its intention and implementation, and the stakeholders' roles, actions, and reactions, as shown in Figure 4.

This approach was selected as it provides opportunities to (i) analyse the issue using a number of dimensions, including the social, educational and cultural, (ii) analyse the problem at multiple policy levels, namely official policy, institutional policy and covert policy, (iii) identify and generate the ground data needed by policy makers to negotiate with existing educational policies related to the problem and (iv) produce relevant policy to guide the implementation of action plans.

Aim of the study

The study seeks to understand how policies are responding to the decline in the number of students opting for biology at the post-compulsory education level in Mauritius. It has three research questions:

1. What are the existing policy responses to the decline in the number of students choosing biology as a subject at the post-compulsory education level in Mauritius?
2. What are the processes which inform the formulation and enactment of these policies?
3. How are these policy responses translated into practice?

Methodology

The present research is qualitative and uses data obtained from diverse sources including a range of participants (Flick 2014). The methodology, which fit within an interpretivist paradigm, is summarised in Figure 5.

Stage I focussed more on the analysis of existing data and documents to situate the responses towards the issue, while stage II is the empirical qualitative data production stage. The latter comprised a series of three focus group discussions (FGD) used to capture the voices of the different stakeholders, using a stratified sampling methodology, as depicted in Figure 6.

The first focus group discussion, lasting approximately one hour, consisted of 12 students, selected to represent the different categories of secondary schools in relation to (i) gender (boys', girls' and mixed schools), (2) performance levels (high, medium and low achieving schools), (iii) school location (urban and rural) and (iv) whether the school is private or state. After grouping schools into the different categories, each school was given a number and randomly selected using a random value generator software. Schools were then contacted to send a student to represent their institution. Consent forms signed by parents of students selected by schools together with a duly-signed approval letter from school were collected before organising the focus group discussions. The students' voices are deemed important in this research as they provided important and insightful information about their own experiences in the choice of subjects beyond compulsory level.

The second focus group discussion of approximately two hours comprised 10 educational officials representing the different strata of secondary schooling as shown in Figure 5. The third

focus group discussion, lasting one hour, consisted of six parents, as parents have an important role in students' choice of subjects in Mauritius. The rectors of the randomly selected schools provided the name of a parent from their parent-teacher association to represent their schools. We ensured that the selected parents were not those of students who participated in the first focus group discussion, to bring wider perspectives in the discussions.

All discussions were audio-recorded with the consent of the participants; discussions were principally conducted in English though participants switched to French and Kreol Mauricien at times. The recordings were transcribed, and the transcript of the second focus group discussion was sent to the educational officials for checking to ensure accuracy and validity of the data captured. The transcripts were then thematically analysed as per Clarke et al. (2019). The research was undertaken in conformity with the latest British Educational Research Association research ethics guidelines (BERA 2018).

Findings and discussion

Existing policy documents on education

Official policy documents emanating from the Ministry of Education over the past two decades (2000-2020) were examined. These documents are listed in Table 1 where the arrows represent the period of their implementation.

Analysis of these policy documents in addition to data collected through the FGDs revealed that there are a series of existing policies and actions to address the issue of the decline in intake of biology at post-compulsory level. The FGDs were also used to probe further into these responses and actions.

Policy response analysis

Using the sociocultural approach to policy analysis described above, policies related to the issue being investigated were analysed at the levels of 'Official policy prepared by the state', 'Institutional policy prepared by schools' and 'Covert policy owned by persons'. The sections which follow discuss the findings in the same sequence. The official policy prepared at the state level refers to the regulatory responses, whereas the institutional and covert policies are considered as non-regulatory policy responses (Sutton and Levinson 2001).

Official policy prepared by the state

Curriculum policy: Through the National Curriculum Frameworks (MOE 2016a, 2016b, 2016c), which articulate the vision of the national education system and representing the means of implementing an educational reform (Batra 2005; Thapar 2005), science is infused through different approaches and at different levels of the Mauritian education system, starting from the level of early childhood education as '*réveil scientifique*' ('scientific awakening') through to upper secondary education. Biology is not a subject on its own in the early years, primary (Grade 1-6) and lower secondary (Grades 7 and 8). At lower secondary level, biology is taught by biology teachers in a thematic approach within science. At post-compulsory level, biology is offered as a distinct subject up to O and A level with Cambridge International Examinations (CIE) as the examining body. Thus, the UK CIE syllabuses, adopted by all Mauritian secondary schools, both public and private, are used. Moreover, these syllabuses and the resultant examinations are not contextualised, as they are designed without representation from such Mauritian stakeholders as the biology teachers association, civil society dealing with biology issues and higher education institutions.

Teaching methods: At primary level, emphasis is laid on the development of scientific skills, as highlighted:

> … encourages scientific inquiry through simple exploration and investigation of phenomena closely related to the learners' everyday experiences … and sets the foundation for further learning. (MOE 2016a, 85)

As primary school learners do not explicitly learn science between Grades 1 to 3, a gap is created within their *réveil scientifique*, keeping them in a 'sleeping mode' until they reach Grade 4 where science is officially offered as an examinable subject up to Grade 6. This gap is a policy limitation which impacts negatively on students' interest towards sciences, especially at this crucial stage of learners' development. Tiglner (1990) reported that the lack of *explicit* science in elementary science curricula has a major impact on students' interest towards science. Our argument is that unless the *réveil scientifique* elicited at early years is nourished and nurtured, students will not orient themselves toward science at higher levels.

Institutionalisation of Quality Assurance: The Quality Assurance and Inspection Division (QAID) in Mauritius is mandated to support quality education in secondary schools and is a key policy actor. The setting up of the QAID and the Quality Assurance and Inspection Framework (QAIF) remain important national policy decisions that have the potential to be used as a platform to restructure policies related to biology education and support its implementation at school level. The QAID, consisting of a director, a senior quality assurance officer and twenty quality assurance officers, has a major focus on the quality of science education and thus has the potential to play an important role in addressing the decline in students' interest in biology and other scientific subjects. In fact, the QAID, which works in close collaboration with different stakeholders of the Mauritian Education System, focuses on schools' improvement, which include the improvement of biology education at secondary level. The support of the QAID for improving biology education includes (i) the setting up of internal quality assurance mechanisms to support biology educators within the school context, (ii) training of biology educators and laboratory attendants at national level through workshops, (iii) monitoring and evaluation of the teaching and learning of biology through class observations to identify needs and support improvements, and (iv) ensuring that the infrastructure to support quality biology education is available.

The setting of the subject team: As a response to the low performance of students at secondary level, in 2009 the Ministry of Education established subject teams which comprise representatives from the Ministry of Education, the Mauritius Institute of Education (MIE), QAID, school administrators and teachers. The biology subject team investigated the low performance of students in biology and the drastic decline in the number of students opting for biology at post-compulsory level. In 2017, the QAID team produced a report documenting the situation, with emphasis on (i) students' performance at Grade 9, School Certificate and Higher School Certificate levels, (ii) the decline in biology intake over time, (iii) schools where the situation is particularly alarming, and (iv) actions to be implemented at school level. Based on the report, the biology subject team set the target of monitoring strategies for addressing the issue by engaging teachers in continuing professional development so that teachers are empowered to address the issue in their respective schools. However, it should be noted that the subject team committee lacks representatives of the higher education sector, such as the MIE and universities, teacher associations such as the Society of Biology, which is an active NGO in Mauritius, career office and biology-related companies/industries.

Teacher development: As per Government policy (Pay Research Bureau Report 2008), teachers need to follow pedagogical courses at the MIE. The 'teacher science education programme' provides trainees/teachers with the relevant conceptual and pedagogical knowledge. The rationale for such initiatives is to use, tap into and improve teachers' capacities to use innovative classroom practices and to provide meaningful learning experiences to elicit and sustain student interest in science subjects, including biology, to encourage students to opt for science subjects at post-compulsory level. Teachers at secondary level are encouraged to attend these pedagogical courses and both the private secondary school authority (PSEA) and the Ministry of Education have asked the MIE to offer these courses after school hours, to ensure access to them.

Resources to support biology teaching and learning in schools: In line with the implementation of official policies such as *Inspiring Every Child* (MOE 2017b) and the previous educational strategic plans, which lay emphasis on providing innovative ICT resources to facilitate teaching and learning, the Ministry has initiated several actions in relation to resources: (i) provision of a laptop and projector to each science laboratory of all state schools, (ii) provision of tablets with vetted science content to all Grade 10 students and their teachers, (iii) training of teachers to use the tablets and to familiarise themselves with the subject content included in the tablet, and (iv) provision of capacity-building workshops on the use of ICT in the teaching of specific subjects including biology. The following were highlighted by participants in the FGDs:

> Though laptops have been provided to science teachers and the use of tablets introduced in schools, there is a real problem of internet connection in school. The SharePoint for tablet use is awaited since 2014. Tablets were introduced in schools following a visit of a former Minister of Education in a foreign country. The Minister then proposed to embrace the idea. What was the rational of this decision was not clearly understood and was confusing. (Educational official)
>
> The science contents developed for students' tablet do not tally with the teaching and learning syllabus and is not contextualised. In fact, examples used to illustrate concepts are borrowed from India which are relevant to the Indian context rather than the Mauritian context. (Educational official)
>
> Though briefing sessions were held to familiarise teachers of the use of these tablets, unfortunately there was no Continuous Professional Development to support us in engaging our students on using tablets. Moreover, practical sessions could have been uploaded. (Teacher).
>
> Teacher support in using innovative strategies and resources is limited to one-off training workshop without follow- up and access to resources are limited, and if, in some cases, they are made accessible, these resources are not adapted to the context. (Teacher)
>
> … that teachers who joined the service long back faced major difficulties in using ICT based resources … and without continuous support, they end up in not using the resources … and as HoDs, they do not monitor the use of the resources by other members of the department. (Rector)

From the above voices, resources to support biology teaching and learning are felt to be far from relevant and appropriate to the context.

Informal biology education to assist school teaching and learning of biology: The Rajiv Gandhi Science Centre organises a range of activities which aim to popularise science, including biology, among young people and the public. It supports Government initiatives to encourage young people towards science, technology, engineering, and mathematics (STEM) subjects.

The educational officials in the FGD stated that informal education does arouse students' interest towards biology. However, they highlighted that there is limited collaboration between the different partners/stakeholders in decision making and setting of targets related to science education. This has led to disparities between 'what is being done at school level' and 'what partner institutions do to support biology education' through informal science education. Another key partner institution of the Ministry of Education for the promotion of biology is the Society of Biology, established in 1996. This organisation, comprising biology educators from both schools and higher education institutions, aims at promoting biology education at schools through a range of activities including workshops for teachers and activities for students. The organisation sends its reflections and position papers to the Ministry on issues related to biology. However, the activities of other non-governmental organisations having an interest in biological education have not been fully drawn on by schools to further the teaching and learning of the subject. This is at least partly the result of the bureaucratic procedures which these organisations must go through.

Broadening the curricular base: The Ministry of Education in collaboration with the MES and the Cambridge International Examination (CIE) formulated a policy in 2009 to introduce '21st Century Science' (renamed as 'Science for All') at 'O' level, as a new subject compulsory for all students not opting for science beyond the compulsory science education level. Marine science was also introduced at post-compulsory level, which became a competitor for biology as far as choices are concerned. Though we acknowledge that this policy decision to introduce marine science as a subject at upper secondary supports the government's vision of promoting the blue economy, this has a detrimental impact on the intake for biology at post-compulsory education level.

Assessment policies: Removal of practical examinations for all sciences at School Certificate level in 1981 was a policy decision to address the issue of leakages about the content of the examinations before they were taken. However, this assessment policy decision had undesirable consequences for the teaching and learning of science including biology. It contributed to the transformation of biology into a bookish and 'soft' subject. The following views were put forward by participants in the FGDs:

> Biology, as a subject, is too much loaded with factual information. (Student)
>
> Biology is like literature subjects where they need to rote learn and regurgitate at exams. (Parent)
>
> … biology lost its practical implications, relaying it on a second position compared to other practical subjects. (Educational officials)

Another issue is the disparity between the content in the Cambridge School Certificate ('O' Level) and Higher School Certificate ('A' level) syllabuses and the contextualised daily experiences related to biology of Mauritian students. Though the Cambridge Certificate examinations, to some extent, meet the requirements of the local contexts, it appears that the adoption of such examinations reflects the colonial historical heritage, which lags behind the

current assessment culture of the former colonial power (Hunma 2002). Mauritius' colonial heritage, coupled with its compliance to international protocols and agreements, limits the autonomy of its educational policies and practices.

Scholarship schemes: Though Mauritius obtained its independence in 1968, it still resorts to its colonial power (Great Britain) in relation to the country's high-stakes examinations. Mauritius' national examinations still mainly operate under the (old) British system of Cambridge 'O' and 'A' levels.

These high-stakes examinations culminate into the award of national and state scholarships for students who excel in the 'A' level examinations. The scholarships, funded by the Government of Mauritius, sponsor students for education in prestigious tertiary education institutions including ones in the UK. The scholarships are awarded to the best students in different streams including the science stream and the scholarships which fully sponsor two students to complete medical degrees are available to the science stream only. These scholarships therefore help maintain the interest of highflyers towards the sciences.

However, this policy of providing state scholarships to the most academically able students does not cater for other students. Thus, in line with the Government Programme 2010-2015 for greater equity and inclusiveness in the current scholarship schemes, the Government agreed in November 2011 to grant scholarships to a larger number and broader range of students. There are now 18 science scholarships, which helps maintain student interest towards science subjects.

Institutional policies prepared by schools

In the Mauritian education system, schools do not have the autonomy of setting institutional policies. However, schools are responsible for planning subject choices at the post-compulsory level. Different schools have different option structures. Option forms are distributed to all students in Grades 9 and 11 to enable them to choose for the stream and subjects to be taken at Grades 10 and 12 respectively. Most schools allow students to take all three sciences at Grade 10. However, some schools require students to choose between biology, economics and accounts at Grade 10.

> We need to comply with instructions from ministries and private secondary school authority to secure students in subjects offered. Otherwise, some subjects won't have students. (Rector)

This option structure severely impacts the number of students opting for biology, as economics and accounts are popular subjects. This has led to some cases where a school has literally no students taking biology at Grades 10 and 12.

Covert policy owned by persons

The role, functions and responsibilities of teachers including science teachers are regulated through national and institutional policies. Despite teachers preparing termly schemes of work, weekly plans, daily lesson notes and lesson plans which are approved by school administrators, being visited by rectors to identify pedagogical and other limitations, and being provided with support by school administrators, their HoDs and QAOs, the problematic of low student interest towards biology will never be successfully tackled if teachers are not personally and enthusiastically involved in the teaching and learning process. Policy owned by persons is the key to motivating students, as highlighted by parents and students:

> As parents, we have noticed the liking of our wards (children) towards biology is linked to the way teachers operate with the students in class. (Parent)
>
> Teachers have a crucial role in motivating students. There are some teachers who discouraged students from opting for biology simply to maintain a low number of students to manage in their classes. (Students)
>
> As students, my interest towards biology had been influenced by the passion shown by the teachers for the subject. (Student)

Several factors are needed for a successful reform of school science. These include technological developments, societal changes, organisational issues, high-quality assessment, teacher preparation, continuing professional development and advances in the scientific disciplines themselves (Semali and Mehta 2012).

Science education has many stakeholders and many education policies have been developed in Mauritius over the years and international studies have shown that such policies often change as stakeholders (and their authority) shift over time (Fensham 2009; Ryder and Banner 2011). In the case of biology, the different stakeholders laid much emphasis on (i) encouraging students to choose biology beyond the compulsory education level, (ii) developing students' abilities to think and act creatively to solve problems and (iii) developing an interest in students in attaining good performance grades in high-stakes attainment tests.

In fact, teachers are 'positioned' in different ways in policy discourse where their role is sometimes to 'deliver' (whole policy without any change), to implement (the policy as a whole and make things happen) and to enact (shaping the policy) within their working contexts (Ball, Maguire, and Braun 2011). Teachers can also be 'co-producers' of policy, having an equal role in making policy in their schools and classrooms (Pring et al. 2009). In the Mauritian context, policy conceptualisation is 'pre-formed' and intended to be 'teacher-proof'. Thus, teachers, given that they have few 'official' ways of effecting policy change, can only really resort to rejecting or subverting education policies determined at levels above them. There can be surface, or symbolic, responses that relate to the policy, but do not result in significant changes in teachers' practices (Coburn 2004; Cuban 1995).

Policy in science education has a major role in the working lives of science teachers and more broadly in the operation of teaching within, and for, Mauritian society. Teachers are, in some way, responsible for not responding appropriately to curriculum reform. However, at the same time, they are also responsible for many other reforms and to many other stakeholders, such as the school inspectorate, quality assurance, national curriculum for their subject and high-stakes accountability for their students' performance in examinations.

We argue here that policies aimed at supporting teachers in the teaching of biology need to promote an appropriate balance between responsibility and autonomy of teachers. Features of policy contexts likely to support this balance include: recognising the multiple policies to which teachers have to respond; seeking coherence across these policies; enabling the exercise of local flexibility in the enactment of teacher development policies; and building structures that encourage teachers to take control of their professional development. Our teachers are not sufficiently empowered to relate and respond to all these features, thus undermining the balance required between responsibility and autonomy.

Policy initiatives are often met by responses at other levels of the education system which may not be aligned with the rhetoric of the reform. The intentions of initiators at one level in

the education system may be reinterpreted to a greater or lesser extent by the implementers at the next level, subsequently down the line, resulting in an adaptation and alteration of policy. Furthermore, there may be commonalities across external contexts, but variation soon emerges within internal school contexts and within the personal biographies and beliefs of the teacher (Ryder, 2017).

Students' voices: Students were critical of the procedures that existed to help them make their subject choices. In their FGD, they highlighted the following:

> We do not have the support of career officers and specialists in this exercise. Therefore, we have to resort to the counsel of parents, friends and sometimes teachers. (Student)

> Despite a preference for a specific subject, our choice is often rejected on the basis of our results obtained in biology at Grade 9 or on administrative issues such as the number of seats available at the next level, that is, Grade 10. (Student)

> We often feel that the choice of subjects is more a parent choice than our own. (Student)

In Mauritius, as elsewhere with increasing high-stakes accountability, standardised test data are often prioritised over other forms of data, including narrative assessments and the reflections of students and teachers themselves (Wood and Freney 2007). This narrow focus ignores some insightful information that students themselves can provide, such as their learning experiences and how to improve them. Exploring youth experiences can help to uncover sources of problems and ultimately lead to solutions for reforming school experiences (Mitra, 2009).

Conclusions

This article has as its focus the nature of the policy responses made in Mauritius with regard to the decline in the number of students choosing biology as a subject at the post-compulsory education level in Mauritius, the processes which inform the formulation and enactment of these policies, and the translation of these policy responses into practice. We highlight the distinction between regulatory responses (official policies by the state) and non-regulatory responses (at both institutional and personal levels) in the Mauritian context. Our findings demonstrate the power and dominant influence of the state policy responses. There have been attempts at state level to improve matters by holding consultative meetings with various stakeholders of biology education, yet the policy responses and formulation towards this issue still manifest a top-down approach where decisions seem, in reality, already to have been taken, with the consultations serving more for the provision of information. There is a need to have something of a paradigm shift from a top-down to a bottom-up approach in policy response, and this needs to be supported by research-based arguments. However, research is only a 'determining' or 'contributing' factor in education policy content and processes, as well as in professional practice (Lingard 2013). It would be valuable to adopt a bottom-up approach for policy formulation in Mauritius. There is also a need to use empirical research-based data on the situation in Mauritius and data derived from international studies to inform policy formulation and implementation with regard to science education, so that both the voices of relevant stakeholders and the international evidence are considered.

The focus groups revealed a number of issues that contribute to the poor uptake of school biology once it is no longer compulsory, i.e. after Grade 9. We note in particular the absence

of student voice in policy making, including policies related to the choice of subject. More generally, students need to be supported to access relevant information to help them engage in decision-making processes related to subject choice. The consultations which state policy makers have with other stakeholders are held at a downstream level which strengthen the top-bottom approach, and which tend to demonstrate policy-making process without being backed up by empirical research.

A growing body of research has examined the potential of increasing student voice in schools. Referred to as student participation and youth empowerment (McQuillan, 2005), the concept of student voice relates to ways in which young people have opportunities to share in the school decisions that will shape their lives and the lives of their peers (Cerini, Murray, and Reiss 2003; Fielding 2001; Goodwillie 1993; Levin 2000). Likewise, students' voices have key roles in policy making. Their voices can range from the most basic level of youth sharing their opinions of problems and potential solutions to allowing young people to collaborate with adults to address the problems in their schools and to youth taking the lead on seeking change (Mitra, 2005b). All types of students' voices, from limited input to substantial leadership, are considerably different from the types of roles that students typically perform in schools. And students' voices, which represent the voice of the most important stakeholder in the education system, can constitute the ground for educational policy making. Choice of subjects is meant for students themselves, as reported also by Naugah et al. (2020), and thus these students, who are the key actors in this process, should be heard when it comes to policy making in choice for subjects at post-compulsory level; this would certainly reflect a student-centred approach right from the subject choice stage. This does not, of course, mean that every point of critique made by the students and other stakeholders should unquestioningly be accepted and used to formulate policy. Further research would need to be undertaken to validate (or refute) such critiques.

Research that has the most direct and immediate effect on policy is that commissioned by policymakers for a purpose and framed by a problem-solving disposition. This is research *for* policy. Interest groups often sponsor this type of research as well. However, the more academic exercise, research *of* policy, the approach taken in this article, fits within a critical framework and seeks to deconstruct the problem as constructed by policy and to disaggregate any 'taken-for-granted' presumptions attending the issue at hand. In the case we examine, such research of policy provides contextual knowledge that can assist teachers of biology and others in becoming advocates, change agents and partners with policy makers at the level of the Ministry with the intention of reversing the trend in the declining status of post-compulsory biology popularity in Mauritius.

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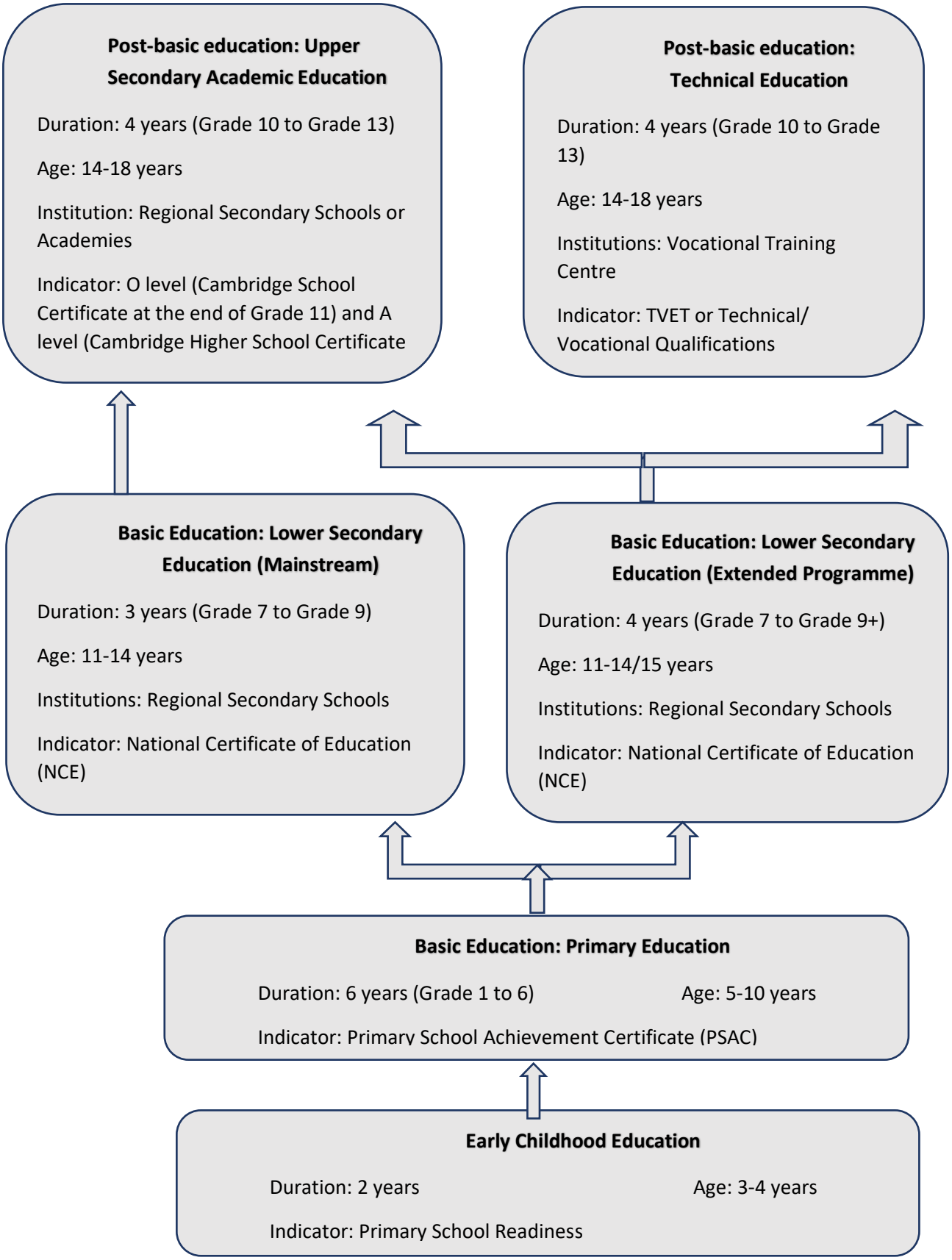
Document	2000-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018	2019	2020
Initiating and Conducting an Experimental Peer Review Exercise in Africa:Mauritius											
Official circulars from the Ministry of Education											
Education Reform in Action											
Education & Human Resources Strategy Plan (2008-2020)											
NCF Primary											
Cambridge International 'O'reports											
Cambridge International 'A' Level reports											
Grade 9 (Form III) National Examination reports											
NCF Pre-primary											
NCF Lower Secondary											

Table 1: Official policy documents



Rumjan, A. B., Atchia, S. & Reiss, M. J. (2022) Policy responses to the decline in the number of students choosing biology beyond compulsory school level in Mauritius. *Journal of Biological Education*. DOI: 10.1080/00219266.2021.2012226.

Figure 1: Educational pathway provided by the NYCBE reform (2017)

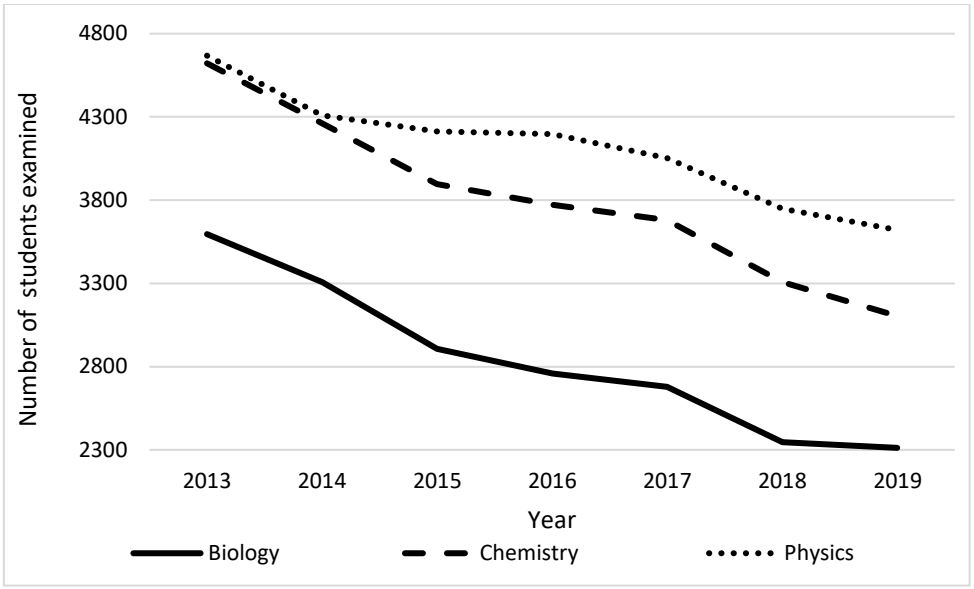


Figure 2: Number of students examined in biology, chemistry and physics at 'O' level.

(Source: Mauritius Examinations Syndicate, 2013-2019)

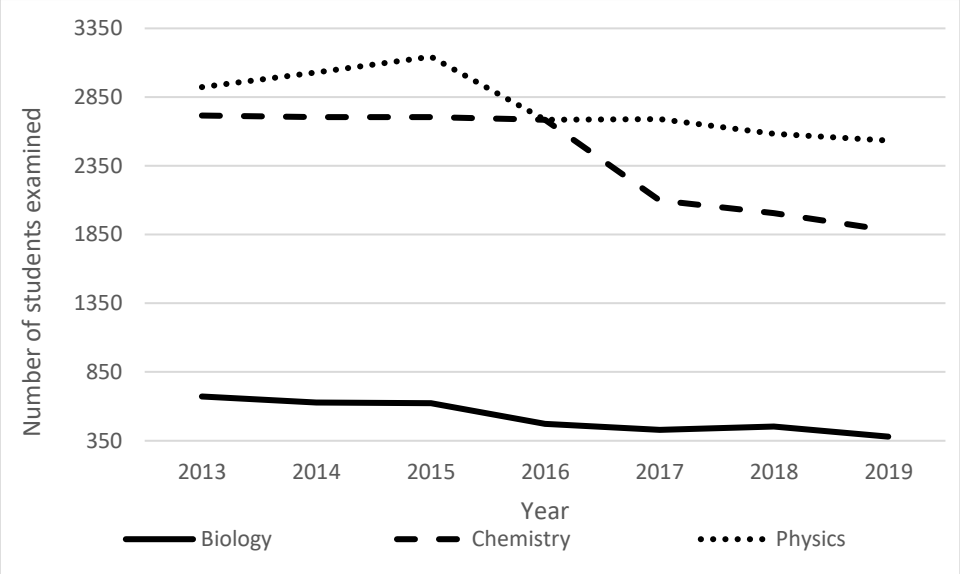


Figure 3: Number of students examined in biology, chemistry and physics at 'A' level.

(Source: Mauritius Examinations Syndicate, 2013-2019)

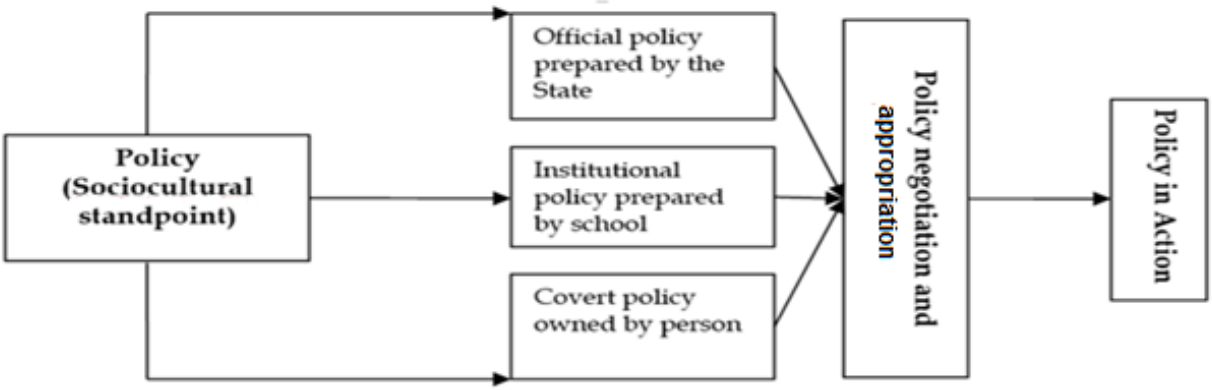


Figure 4: Sociocultural approach to policy analysis (Sutton and Levinson 2001)

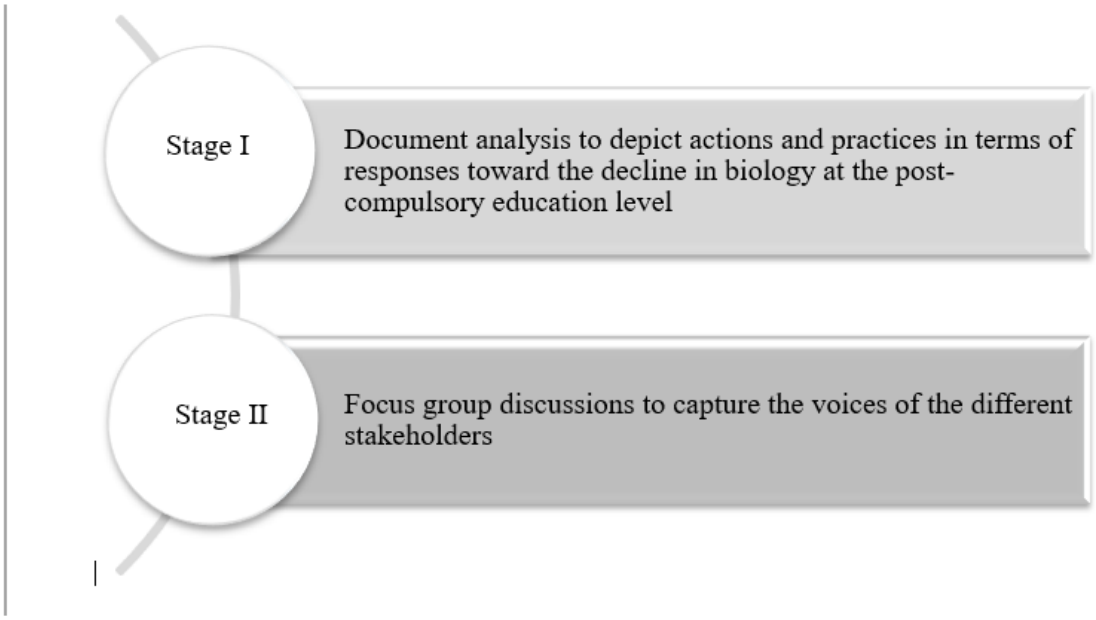


Figure 5 Stages of the study

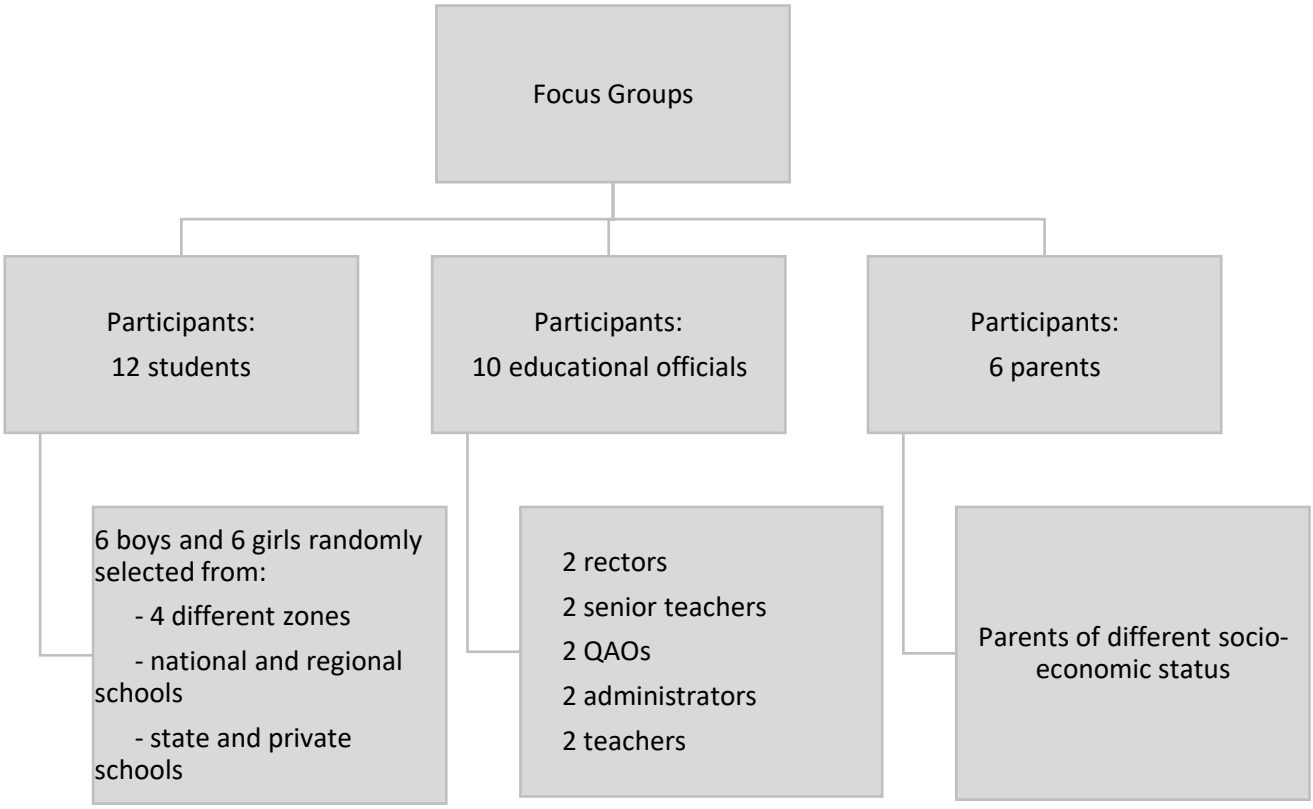


Figure 6 Participants of focus group discussions