Research Article
American Journal of Science Education Research

Classroom Conditions: Impacts on The Teaching and Learning of Science in Samoa Primary Schools

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Citation: Suaalii F and Niupulusu N (2024) Classroom Conditions: Impacts on The Teaching and Learning of Science in Samoa Primary Schools. American J Sci Edu Re: AJSER-220.

Received Date: 04 December, 2024; **Accepted Date:** 11 December, 2024; **Published Date:** 17 December, 2024

Abstract
Classroom conditions found inside any formal teaching and learning context play crucial roles in shaping the quality of science education. The strong interconnectedness amongst these various conditions or elements affects students' learning development that ultimately leads to poor science achievement. This study explores classroom conditions and the impacts on the teaching and learning of science in Samoan primary schools.
Using a qualitative research approach, data were collected through questionnaires administered to four students and one science teacher from a private co-ed primary school in an urban area of Samoa. The study identified that a student's learning development is influenced by a series of interconnected classroom conditions, ranging from the physical (e.g. classroom, class size), social (trust, relationships and emotions) to psychological (e.g., critical thinking, problem solving). This is critical for educational leaders, science educators and the government to consider the findings from this study as Samoa is investing heavily in science and technology education in the hope of promoting quality education and economic development in the country.

Keywords: *Classroom conditions, science, teaching, learning, social, physical, psychological, teacher support, resources, conducive learning environments.*

Introduction

The impacts of the classroom conditions on teaching and learning have long been a subject of inquiry in educational research. There have been numerous studies stressing their significance in shaping academic outcomes and student engagements. From the science education perspective, particularly in Samoan primary schools, effective classroom conditions play a pivotal role in determining the quality of teaching/learning strategies, improved student engagement, and the overall learning experiences of students. These will eventually lead to raising student achievements in science education. Science is a subject that requires practical, hands-on learning, is particularly driven by variations in classroom conditions, making it an ideal focus for this study.

Inquiry-based learning in science education involves the "process of posing questions about the world in which we live and then investigating and evaluating possible answers to the questions" [1]. Creating environment with conditions where inquiry and collaboration take place is essential for successful inquiry-based learning. Indeed, fostering a culture that encourages questioning, exploration, and teamwork, teachers can inspire students to take ownership of their learning and work collaboratively towards a common goal. Learning in this sense is through active participation in class activities [2] with the support of constructive and contextualised instructional strategies [3] and positive learning environments [4]. However, evidence from western literature shows that there is very little inquiry occurring in today's school science classrooms and many students lack inquiry skills such as asking questions, investigating and drawing conclusions [5]. These limitations become a norm, an undesirable culture created within the classroom (formal education context) is repeated at home and elsewhere (informal education context) where they are supposed to become active learners. Having ineffective and intimidating classroom conditions contribute to the speedy outbreak of this abnormal learning culture. Learners passively receive information without further engagement as they withdraw themselves from the lesson and become engaged with activities either private (individual) or semi-private (with peers), of which some may not be about the science lesson [6].

Given the importance of classroom conditions for quality science education, improved student engagement leading to raising student achievement, the researchers decided to explore Samoan primary schools as this is the level where the basics of any subject is taught. At this level science is practiced as a method of asking testable questions based on observation and making sense of ideas. Classroom conditions as used in this study includes physical, social and psychological factors found inside the classroom learning environment that significantly affect students learning (table 1).

Table 1: Elements within each of the classroom conditions.

Physical conditions	***Social conditions***	***Psychological conditions***
teacher/student qualities	peer relationship	intelligence
class size	teacher behaviour	personality
desks/tables/chairs/boards	teaching strategies	attitude
science resources/storage/display	learning strategies	interest
classroom decorations	seating arrangements	aptitude
learning charts/resources	learning activities	motivation
lighting/sound	experiments	reinforcements
indoor air quality/temperature	teacher support	
Technological resources, computers, internet, etc.		

Investigating these factors provide a comprehensive understanding of how these elements (table 1) interact to shape science education in Samoan primary schools. In doing so, the following research questions guide this investigation.

1. What are the classroom conditions found in a Samoan primary school science class?
2. What are the impacts of classroom conditions on science teaching and learning in Samoa primary schools?

The findings of this study will contribute to the growing body of literature on the impacts of classroom conditions on educational outcomes, offering awareness into the specific challenges and opportunities faced by educators and educational leaders in Samoa. It is also important to recognize that this research will activate some deliberations to identify strategies that can be implemented to improve learning environments in Samoan primary schools.

Literature Review

This literature review synthesizes relevant ideas from various studies about the impacts of classroom conditions on science education. These ideas will be used as foundational knowledge to help in establishing a theoretical framework for this study. In particular, the review highlights factors relating to physical, social and psychological (table 1) within a science classroom context. In this sense the review will be organised according to the following sections:

- ***Physical conditions of a science classroom***
- ***Social conditions relative to the teaching/learning of science***
- ***Psychological conditions in teaching/learning of science***

Physical conditions in a science classroom

The physical conditions of a classroom or any learning environment exert an influence on the social interaction and learning capabilities of students [7]. These conditions are supposed to be conducive, safe, clean and orderly, well ventilated, spacious and adequately lighted, acoustically sound, good air circulation with adequate temperature [7] and other environmental factors which do not disturb the mental health of the child and in turn provides a productive learning [6]. It also includes the availability of quality furniture, well-resourced with learning charts, pictures, 3D models and plants.

A number of international literatures based on various classroom contexts suggest that most of the physical classroom conditions are caused by class size [8-11]. Where the number of students is high as opposed to the number of people that a room or space can safely accommodate, rise in temperature, stuffiness, unsafe, disorderly, overcrowded often transpire. In these conditions students often refrain from actively participating in activities but switch to passive mode of learning where they just listen, copy and memorise information [6].

The fast-growing population of children in Samoa [12] relative to the restrictions of classroom capacity [13], very likely meant that large class sizes are found in Samoa primary schools. Therefore, classroom condition such as increased temperature could impact students learning of science. In addition, large class sizes also bring some challenges to classroom management, seating arrangements as well as proper allocation of teaching/learning resources.

Resource availability is one of the key factors influencing the teaching and learning of science. Studies suggest that the physical environment of the classroom, such as teaching and learning resources and facilities need to be available and accessible to all students in any classroom [14]. This is because the availability of learning materials/resources as well as the overall learning environment directly affect students' ability to grasp scientific concepts. In science education, science resources include equipment and chemicals for experiments and science textbooks for students and teachers, while facilities refer to the laboratory rooms. These resources and facilities must be relevant to what students are learning or are expected to learn. Minimal classroom interactions often occur when classroom resources and facilities are limited [14,15]. For instance, such limitation affects the ability of teachers to provide practical science education, a problem exacerbated in larger classes with its one-on-one strategies compromised.

Technological resources are the tools, machines, systems, and devices that are used to generate, store, and process information, as well as to perform tasks and accomplish goals. In fact, technology has revolutionized classroom methodologies and education experiences [16], providing digital tools and online platforms that enhance teaching and learning experiences [17]. It allows for a more interactive and engaging learning environment where information is transmitted and actively constructed by students. Teachers can use multimedia content, such as videos, podcasts, and interactive simulations, to make their lessons more interactive and engaging. They can also use tools like discussion forums and virtual office hours to facilitate student-teacher interaction and support student learning [18]. In fact, the generation of today known as alpha (α) generation—born between 2010-2025 [19,20]—are exposed to so many technological resources, some of which they own and become accustomed to. For instance, the rise of generative AI (GenAI) that reshapes educational methodologies as well as the workforce landscape [21]. The fast spread of GenAI today allows the user to create original content—such as text, images and videos.

The physical layout of the classroom or classroom arrangement also plays a significant role in shaping an effective teaching/learning environment for science. Weinstein (1979) [22] confirms that well-organized and stimulating classroom layouts can improve student focus and engagement.

When students are engaged, they do more than just attend class; they self-regulate their behaviour, challenge themselves, and enjoy challenges in learning [23]. In essence, a student who is engaged in learning generates a feeling of belonging and connectedness to the learning environment and therefore strives to gain all the learning given. In addition, Hattie (2009) [24] validates the idea that visible learning environments allow students to see and interact with learning materials. Constant exposure to learning materials motivate students to actively participate in activities and slowly become autonomous learners. Therefore, an improvement in the physical layout of the classroom/classroom arrangement transforms environments and become more conducive to active learning and student engagement [17].

Social conditions relative to the teaching/learning of science

The classroom social conditions are comprised of students' perceptions about how they are encouraged to interact with and relate to others (e.g., classmates, the teacher, curriculum, teaching process), and encompasses dimensions of: (i) teacher support, (ii) promoting mutual respect (teacher-student relationship), (iii) promoting student task-related interaction, and (iv) promoting performance goals. Recent research has indicated that these various elements are separate, and relate significantly to students' motivation, self-regulated learning, classroom behaviour (both positive and negative), social relationships, student engagements and achievement [25,17]. In fact, Chen *et al.*, (2020) [26], believe that student engagement is positively associated with student enjoyment when teachers use productive classroom talk, thus creating space for students to think and reason. Furthermore, the study claims that literature shows implications of links between teacher-supportive behaviour and student emotions, interests, and motivation. Literature states that students feel engaged in learning when they have a sense of belonging and connection to their teachers [25,17]. When student-teacher relationships are fortified, the problems hindering student talk (e.g. fear of being mocked, fear of the teacher) will likely be eliminated.

Teacher support

Teacher support refers to the help and perception of autonomy, emotion, and ability that students acquire through teachers [27]. Researchers have found positive associations between perceptions of teacher support and students' adaptive motivational beliefs and engagement behaviours [28,29,16]. For example, when students view their teacher as supportive, they report higher levels of interest, valuing and enjoyment in their schoolwork [28,30], a more positive academic self-concept [31], and greater expectancies for success [29]. Perceiving the teacher as supportive is also related positively to asking for help with schoolwork when needed, use of self-regulated learning strategies [25], and a desire to comply with classroom rules [32].

Teacher support is a direct factor in the development of student academic achievement [33], and students' perception of teacher support stimulates autonomous learning motivation and interest in learning [34]. A series of comparative studies showed that students who perceive more teacher support perform significantly better academically than those who perceive less teacher support [35]. Students with a greater perception of teacher support have stronger learning motivation, leading to better academic performance. In contrast, students who perceive less teacher support tend to focus on avoiding criticism, which negatively impacts learning effectiveness and academic performance [34].

Mutual respect (teacher-student relationship)

The teacher-student relationship is another critical component of the classroom environment, influencing both engagement and academic outcomes [28,29,16]. Roorda, Koomen, Spilt and Oort (2017) [36] conducted a meta-analysis demonstrating that positive teacher-student relationships significantly enhance student engagement and achievement. Social constructivists' perspective of learning considers the interactions between students, their environment as well as with individual students [37]. Knowledge and understanding are constructed when individuals engage socially (with peers) involving persons-in-conversation [38]. Learning therefore is shaped by social interaction with peers [39-42,6]. Moreover, knowledge develops and exists in a cultural context, which include both the culture of science (and science education) and the cultures of the people that science (and science education) is intended to serve [43]. This is mostly important in Samoa because cultural values emphasize respect and communal relationships which can be leveraged to strengthen teacher-student bonds. Pianta and Stuhlman (2004) [44] also highlight the importance of nurturing supportive teacher-student relationships, mainly in the early years of schooling, as these relationships have a long-term impact on students' academic trajectories. Fostering these relationships in Samoa can help mitigate some of the challenges posed by large class sizes and resource limitations, providing students with the emotional support needed to succeed in science education.

Student task-related interaction

Vygotsky's sociocultural theory about child development says that cognitive development occurs because of social interactions [45] while working on a learning activity. In this way, learning is innately collaborative. He believed social negotiation was essential for building knowledge and understanding concepts. Additionally, interactions among students can also be referred to students' collaborative discussion, which helps students not only to acquire knowledge but to enhance friendship with classmates.

Moreover, teacher–student or student–student interactions inside the classroom may be considered as a form of scaffolding [46]. Essentially, "scaffolding makes the learning more tractable for students by changing complex and difficult tasks in ways that make these tasks accessible, manageable and within students' zone of proximal development" [47]. In any classroom, there are individual "differences … and therefore effective learning is only likely to be possible when there is constant matching of current learning to learning needs" and their existing conceptual structures [48].

The positive effects of cooperative learning in science go beyond the immediate gains in achievement, motivation, self-esteem and acceptance of difference. Students learning in cooperative goal structure also develop skills in communication, leadership and conflict resolution that are basic to productive, working teams. There is more to cooperative learning than a seating arrangement or sharing lab equipment [49]. Cooperation requires a sense of positive interdependence and a 'sink or swim together' perception, where one person's contributions are celebrated by all group members.

Classroom tasks reflect teachers' expectations and goals for students' physical or mental activity, especially academic assignments, but also include expectations for conduct [50]. Within any classroom, demands are imposed on students to perform tasks according to acceptable standards; part of learning to fulfil the student role is learning how to respond to task demands.

Performance goals

A performance goal in a science classroom refers to a specific, measurable target or objective that students are expected to achieve within a certain period. These goals focus on the outcomes of student actions, assessments, and progress in science learning [51]. Performance goals typically aim to encourage students to develop skills, knowledge, and competencies in various areas of science, including understanding scientific concepts, conducting experiments, and applying scientific reasoning. Moreover, Mucherah and Frazier (2013) [52] stated that performance goals in a science classroom are essential because they guide student learning, enhance engagement, support the development of scientific skills, and create a structured environment that fosters accountability and growth. These goals ultimately contribute to a deeper understanding of science and help students develop essential skills for future academic and professional endeavours [53].

Psychological conditions in teaching/learning of science

Psychological conditions in the science classroom play a critical role in shaping how students approach learning, engage with content, and perform academically [54,55]. Basically, these conditions influence motivation, emotional well-being, cognitive processes, and the overall classroom environment [56,55]. For instance, making science real, exciting, relevant and rigorous for young children can help them be more successful [57,58]. Research on motivation to learn shows that children are attracted to ideas that address both their cognitive and affective needs. Young children are typically already interested in nature, the environment and how things work. It serves elementary science teachers well to take advantage of the students' interests as a source for engaging and motivating students to high levels of achievement. Motivation can be an antecedent to and an outcome of learning. Thus, students must be interested and motivated to learn before learning will take place [59], and this success can lead to motivation to learn more [59]. Sorting through students' interests can make teachers' job a bit easier in connecting the needed science concepts and skills to students. When teachers address these conditions thoughtfully, they create an environment where students feel motivated, confident, and engaged in learning science, ultimately improving their academic performance and long-term interest in the subject.

Research Methodology

This research employs a qualitative research method to explore people's beliefs, behaviours, experiences, perspectives, attitudes, interactions and challenges [60]. As suggested by Denzin and Lincoln (2011) [61], qualitative research allows the researcher to study phenomena in their natural context. Qualitative study lends itself to what is going on within a specific topic, as well as presenting a detailed view of the topic as it takes place in its natural setting [60,62]. Whatever is being observed and studied is allowed to happen naturally [61,63]. The selection of a qualitative approach for this study ensures that it is a situated activity that locates the observer in the real world [61]. This enables the researchers to observe the workings of the investigation [64], and to understand the situations in their uniqueness (Creswell, 2013), as part of a particular context and the interactions occurring within the real world [61]. With the discussion above, this research methodology is suitable in exploring how primary school students with varying learning abilities and teachers interact inside the science classroom in Samoa.

Methods of data collection

Questionnaires were selected as the data collection method for this study. It provides an effective way to gather detailed, structured responses from research participants while allowing flexibility to express thoughts in a comfortable and reflective manner. In this study the questionnaire consists of a set of open-ended questions that aims to collect information from the research participants. In this sense, the open-ended questions were used to collect rich, thick qualitative data for understanding the perspectives of both students and teachers.

In addition, questionnaires allowed research participants to respond without being pressured with face-to-face interviews, which can sometimes influence responses [65,66]. Emotions and feelings such as being shy and lacking confidence are common to Samoan and other Pasifika students [67,68]. As a result, the students (young people) often discouraged themselves from speaking to adults (as in the interviews). Therefore, using questionnaires in this study allows the research participants to respond at their own pace which also offered moments to be thoughtful and honest with their responses.

Questionnaires also maintain consistency in the data collected, as all student participants, excluding the teacher participant were presented with the same set of questions. This is critical in the analysis as they will be responding to the same questions based on their own viewpoints [69].

Research Participants

The student participants were purposefully selected so that the diversity of abilities, experiences as well as perspectives relevant to the focus of the study are reflected [70]. The participants in this study included four students (2females, 2males) and one teacher from a private co-educational primary school in an urban area of Samoa (refer to table 2).

Table 2: Demographic information of research participants.

Research participants	***Class level***	***Age***	***Ability***	***Sex***	***Teaching Experience***	***Research identification***
Student 1	7	12	Advanced	M	-	S1
Student 2	7	11	Advanced	F	-	S2
Student 3	7	14	Autistic	M	-	S3
Student 4	7	12	Average	F	-	S4
Teacher 1	6	-	-	F	6 years	T1

Ethical Considerations

Ethical considerations were paramount throughout the study. Before the data collection began, informed consent was obtained from all participants and, in the case of student participants, consent was solicited from parents or guardians. Participants were informed about the purpose of the study, their right to withdraw at any time, and the measures that would be taken to ensure confidentiality of responses. To protect the privacy of the participants, codes were used in place of their real names (table 2).

Steps for data collection

The data collection process was structured to ensure the comfort and convenience of all participants. The student participants completed the questionnaires during a one-hour session after school. The time was chosen in consultation with students' parents, who provided consent for them to participate in the study. Conducting the data collection after school ensured that the student participants were not distracted by their regular academic responsibilities but to focus entirely on completing the questionnaire. The teacher participant's questionnaire was given two days for completion at home to ensure participation in the study was not rushed or pressured.

Once all the questionnaires were completed and collected, the analysis process of collating and re-arranging the data to generate relevant themes started.

Data Analysis

The data was analyzed using a thematic approach for "identifying, analyzing, and reporting patterns or themes within [qualitative] data" [71]. It is a flexible and accessible method that allows for the systematic examination of the data while remaining open to new insights that may emerge during the process. In this study the researchers followed a series of steps (figure 1) in order to develop relevant themes to assist in answering the research questions.

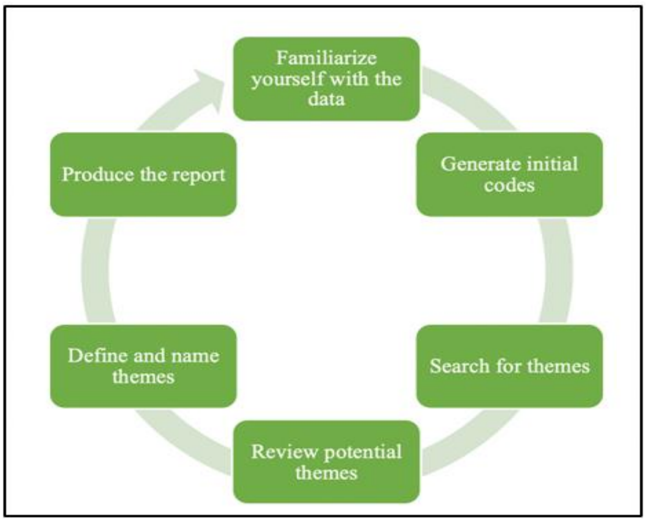

Figure 1: Process of thematic analysis.

Discussions of Results

The analyses of the data generated four themes that are relevant to the focus of this research investigation. The four themes include:

- ***Effects of class size and seating arrangement,***
- ***Importance of learning resources,***
- ***Creating a democratic environment,***
- ***Strategies to support teaching/learning of science.***

Individual themes are discussed in the subsequent sections with the support of the data collected from the research participants.

Effects of class size and seating arrangement

One of the most significant aspects that emerged from the data was the impact of class size, seating arrangements and classroom layout on the teaching and learning of science. In terms of large class size, S1, S3 and S4 respectively argued that: *"… a lot of disruptions … some students make noise; some talk to others while some want the teacher's attention … lesson stops while teacher attends to them and try to control them … I want to ask for more information from the teacher but … others are also trying to ask … hard to get a chance to talk … I just lose interest in lesson".*

"… too many students … I do not like it, it puts me off when I enter overcrowded classroom … feels hot all the time … in the afternoon, feels stuffy and sometimes bad smell".

"when it is too hot, I cannot concentrate, I just cannot think at all … I just feel sleepy, tiring, boring … I just try to fan myself with a book, but no thinking at all … the teacher tries to talk to us … but I just cannot respond at all".

The responses from S1, S3 and S4 highlight a number of various conditions due to large class size or overcrowded classrooms. These include:

- too much noise,
- attention seeker,
- less opportunity to seek clarification from the teacher,
- overcrowded, hard to control,
- overwhelmed, uncomfortable,
- feels hot and stuffy, smelly.

It is completely understandable that sitting in an overcrowded classroom might make a student feel uncomfortable or overwhelmed. Crowded spaces can sometimes cause stress or anxiety, especially when there's limited space in very hot surroundings. Park, Behrer and Goodman (2021) [72] stated that students who experience hotter temperatures during the school year exhibit reduced learning at temperatures around 90ºF (≈32ºC) or above. Although warm blooded animals (i.e. adults humans) regulate and maintain constant internal body temperature at a normal rate (24-30ºC in Samoa), these children when exposed to high temperatures their bodies try to activate thermoregulatory mechanisms within safe limits due to slow reactivity rate [73-75]. The different rate of reaction/regulation confirms that young children have the disadvantage of heating up easily due to their smaller body sizes. In addition, the students tend to have lower sweat rates and higher core temperature responses compared to adults. In this sense, children get very hot (compared to adults), before sweat is released to help the body cool down. Situations of extreme thermal stress over prolonged periods may cause organ dysfunction such as increased heart rate, which can affect other biological systems, such as the brain and respiratory system [76,73,77,75].

The student participants explained that a large class size is difficult for the teacher to control and manage students and their behavior, hence the increased noise and distraction during lessons. While trying to manage a noisy, overcrowded classroom by focusing on individual students rather than addressing the entire group, it often encourages students to continue disruptive behaviour [78]. This is a problem as science learning requires students' full attention and the teacher's entire support. As stated in the Samoa science curriculum 2006-2015, "science learning is enhanced when teachers:

- engage students in active learning,
- place learning in relevant contexts,
- use the students' background knowledge and understandings as the starting point for new learning,
- deconstruct the knowledge that makes up a science concept and select learning activities that build up the students' knowledge and understanding in steps,
- use a variety of teaching strategies; and
- provide a variety of learning activities".

(Ministry of Education, Sports & Culture, 2004, p. 19) [79]

In contrast to the notion of science curriculum and with the actual happenings in the classroom, explanations by T1 seem to be consistent with the ideas stated by Peters (2010) [78] about large class sizes. It emphasizes that no matter how hard the teacher tries there is always a limit in one's ability to give quality support to all individual students in order to gain their attention. The teacher stated that:

"… not enough time to get to all of them … cannot provide support for all … 49 students are too many … students inattentive … distracted and no motivation to learn at all". (T1)

Certainly, the inability to provide quality teaching inside the classroom due to the reasons stated, limits quality social interaction between experts (teachers) and learners [80,81]. This can significantly impact learners' appropriation of knowledge [82]. Basically, knowledge and understandings are constructed when individuals engage socially (with peers or with adults) in talk and activity about shared problems or tasks. Making meaning is thus a dialogic process involving persons-in-conversation [38]. However, class size more than the minimum number of students per class (primary school) as calculated on a base formula of one teacher to every 30 students [13] is considered an unhealthy learning environment [83].

Seating arrangements were also revealed as one of the prominent issues in this research site. The teacher participant confirmed that seating students based on their needs and behavior is challenging as it may result with either students interacting with or distracting others.

"… some who are seated together are ok ... they encourage each other, help one another … advanced students sit next to the weak ones … but … others discourage, distract … some just sit there pretending that they are doing work … when too much noise builds up … I immediately try to cool things down by reshuffling seats … after a while … the noise repeats". (T1)

It seems that the teacher participant tried to have the gifted students sit next to the weak ones so that they can support each other along the way. However, the student participants indicated mixed views about the effects of their allocated seats in the classroom upon their learning abilities. For examples:

"… positively affects my learning because I am seated far away from my friends. They usually want to play and talk to me during lessons … very distracting". (S2)

"… from where I am seated … cannot really hear … the teacher … makes me confuse when we do work … It gets really loud sometimes … which makes learning a lot harder … same students who are seated together only stop making noise when the teacher calls out … after a short while … start again … I think because they are seated together … sometimes they finish their activity very early … then start making noise …". (S4)

"… don't like where I am seated … I want to play with my friend … talk to him, sit with him … we help each other learn … we do things together, but I am separated from him, why? I don't want to do anything … I just want my friend …". (S3)

"It affects my concentration in class when there is too much noise … too much noise I cannot focus … everything in my head gets all blurry". (S1)

The analysis in this theme suggests that both class size and seating arrangements influence students' learning experiences. Large class size can become noisy and make it difficult for teachers to manage students and provide individualized attention. On the other hand, seating arrangements can either support or hinder students' ability to focus and engage in lessons.

The findings revealed that the classroom environment, particularly class size and layout, has a significant impact on both the teaching and learning of science in Samoan primary schools. Large class sizes, often exceeding 40 students, were found to be a major challenge for teachers. Managing a large number of students reduced the teacher's ability to provide individual attention, especially during science lesson that require close observation and interaction with students. This aligns with research by Blatchford, Bassett & Brown (2015) [84], which emphasized that larger class sizes negatively affect student engagement and limit opportunities for personalized teaching. The lack of individual support in larger classes may hinder students' understanding of scientific concepts, especially those requiring hands-on activities.

Classroom layout also played a role in the effectiveness of science education. In some classrooms, the seating arrangements made it difficult for students at the back of the class to hear the teacher clearly or participate fully in discussions and activities. This issue is particularly relevant in science, where student interaction and participation are key to understanding experimental processes. Fraser (1998) [14] stresses that the physical learning environment, including how desks and workstations are arranged, can influence learning outcomes. In Samoan primary schools, limited space and inadequate seating arrangements were identified as obstacles to creating an inclusive learning environment, with some students unable to fully engage in lessons. The implications of these findings are significant for the development of science education in Samoa primary schools. Physical conditions such as overcrowded classrooms and poor seating arrangements as revealed in this theme hinder both teaching and learning, limiting the ability of teachers to effectively engage students in science lessons.

Importance of science learning resources

This particular theme came out very strongly in the analysis of the responses from the research participants reflecting conditions relating to physical, social and psychological. The resources identified in the analysis include equipment and chemicals for experiments and science textbooks for students and teachers, while facilities refer to the laboratory rooms. These resources and facilities must be relevant to what students are learning or are expected to learn and therefore it is very important to have them available throughout the school year. Unfortunately, the study revealed that the supply of science learning resources was always a problem. For example:

"... we do not have everything ... for learning science ... some textbooks we have ... but very hard to understand ... science learning is always difficult because we do not have sufficient resources, at times, I don't feel like sitting in a science classroom, listening to our teacher talking about a lot of things ... cannot understand at all...". (S2)

"... we do not have all of the science resources ... we do not have all the books for science ... that is why we do not do some of the experiments that our teacher tells us ... science is always hard for me when there are not many resources to support our lessons". (S4)

"... we have some ... but we never get to use them ... some of our experiment, we watch on YouTube, so at least we see them, very exciting to see those videos ... videos are good, so we should just watch videos all day ... instead of trying to listen to the teacher". (S3)

The student participants mentioned that they often use alternative resources like balls, plastic containers, recycled materials to simulate scientific concepts due to the unavailability of proper equipment.
"Unfortunately, we do not have everything for science, but we do get creative ideas from our science teacher ... using plastic, containers from home ... we bring them to school". (S2)

"We do not have all of them, because we have to use other things, recycle materials, aluminum cans ... from home". (S4)

"it's good that we use some of these recycled materials, but in our exams, the questions use very technical ideas, terminologies, equipment that we have never seen before. With online and internet, I get to see more interesting things and resources that overseas teachers use ... and those kids love science because they are seeing the real things ... I wish I get to use those ...". (S1)

The teacher participant supported these concerns, emphasizing the scarcity of materials available for teaching science effectively. The research participants reported that the availability of science materials, such as books and laboratory equipment, was insufficient. This is consistent with research on science education in developing countries, which often emphasizes resource constraints as a major barrier to effecting teaching and learning [14,85,6]. Without these materials, the students are unable to gain access to and become engaged in a process of constructing knowledge by doing science. Teaching of science as facts became the dominant approach and students became passive recipients who tended to engage with surface learning approaches. In the surface learning approach, the intention is just to cope with the task and store information for the purpose of reproducing it later, with an emphasis on routine memorisation [86,87]. Such an approach gives the learners little time to think and acquire a deep understanding of the subject or to develop life-long skills. Deep learning and understanding of scientific concepts however are supported by constructivist's views that includes active learning processes involving relating ideas to daily life and looking for patterns and principles.

While the study identified the frequent use of improvised materials for science experiments and lesson demonstrations, the student participants recognized the limitation in terms of deep understanding and gaining self-efficacy [85]. In this study, the absence of sufficient science materials contributed to students' frustration and confusion, especially when trying to comprehend complex topics in the chemistry and physics branches of the science curriculum. It is important to acquire better science resources, to make science more interesting and interactive and bridge the knowledge gap created by the lack of practical learning opportunities.

Creating a democratic environment

This theme discusses the democratic environment and teachers support ideologies. The development of this theme was based on the frequent mention of this ideology in relation to physical, social and psychological conditions that support teaching and learning of science in primary school classroom.
A democratic environment in this study identifies ideas about safe, inclusive learning environments, where the research participants actively practice democratic values (respect, equity, freedom of speech), understand their rights, and take responsibility for their behaviour as both individuals and members of a community. Conditions of the democratic classroom environment include:
- high-trust relationships between teachers and students,
- high degree of student voice and agency,
- respect for children's ideas and contributions,
- use of dialogue and group decision-making,
- development of the whole self, including students' critical consciousness.

According to the T1:
"... too often, the fear of being wrong or being laughed at can prevent primary school students from participating in any class activity. It is our job as teachers to help break down those psychological ... social barriers and provide a space where students can try their best. When we do this, we create a sense of trust among students, ... improve classroom relationships, increase engagement, boost creativity and performance, and help everyone feel included and respected".

"... the students actively participate in all activities ... they feel confident in speaking, sharing, volunteering to take part in different roles, perform learning activities, complete assignments honestly and successfully ..."

"... activities include fun science games ... and challenging tasks that promote their self-esteem ...".

From the teacher participant's point of view, activating trust and positive emotions in the classroom creates an atmosphere that foster cooperative relationships, build resilience and persistence, and increase motivation in doing classroom activities. Demirdag (2015) [87] claimed that children with a positive self-esteem act positively, assume responsibility, tolerate frustration, and are proud of their accomplishments. Fostering healthy self-esteem in children is essential for their well-being. This include showing affection, encouraging responsibility, and embracing imperfection. Building self-esteem sets the stage for a child's future success and resilience [89].

The student participants indicated that their teacher creates a democratic environment for them where she treats them fairly and gives them equal opportunities to participate in class activities ensuring that everyone has a chance to contribute. For example:
"Each student is given a chance to give their own thoughts or suggestions about a particular topic ... keeps me thinking also

about our lesson … good to have the opportunity to share our answers … very encouraging". (S1)

"… I really enjoy the way our science teacher teaches some of our lessons … really encourage me to keep learning … when I make mistakes, she challenges me … guide me through the problem instead of telling the answer or get upset at me … very friendly teacher". (S2)

"good that she understands about me … and she treats me very well … and I respect her so much … that's why I like coming to her classes … she makes my learning very comfortable unlike … [other subject teachers]". (S3)

Despite numerous conditions of positive democratic environment perceived by the above research participants, there were also some concerns raised by S4. These includes feeling intimidated in class and often afraid to ask or answer questions.
"I still feel uncomfortable to ask or answer questions … I can see that other students are talking a lot during our discussions … the teacher is always good, trying to convince me to talk but I just feel shy, in case I say something incorrect then the kids will laugh at me making me look stupid". (S4)

In terms of teacher support, S1, S2 & S4 agreed that their science teacher is approachable and willing to help them when they struggle with science topics. They mentioned that the teacher often uses extra time after school to help with difficult science concepts. For instance:
"… give us tutorials about science or arrange someone who can help … sometimes we get the other science teacher to help us … or whatever our science teachers prepare for us". (S4)

"… she will help us with ways to understand some instructions or our take home activities". (S2)

"those extra sessions are very helpful … improve our understanding of the materials we discuss in class … but I feel this extra time is tiring for us and our teacher … but she is keen to offer these extra classes for us". (S1)

The teacher participant confirmed that additional support through one-on-one discussions provides help particularly in reading or understanding instructions. Other times, she utilizes technology and relevant videos from YouTube to help clarify some of the science ideas that they discuss in class. Sometimes, she seeks help from colleagues who have been teaching science for a number of years. S4 and T1 respectively stated that there's a need for more structured support for struggling students.
"Maybe we can use another support teacher to help those who are struggling with specific science topics … because if our teacher continues to pause for the weak ones … our lessons are always slow, and we feel exhausted if that continues". (S4)

"I feel that we should have an assistant teacher to help those who are experiencing some difficulties … do some extra experiments with them … and ensure we have sufficient supply of science equipment/materials for our class experiments". (T1)

Democracy is one aspect of the classroom environment that was identified in this study showing positive impacts and, as a result, the different aspects of students' learning. Moreover, the prevalence of democracy in the classroom means the fulfilment of various characteristics and conditions. Basu, Barton and Tan (2011) [90] argue that schooling is structured around traditional models of education, where students are consumers of knowledge, their actions and their choices are constrained, and they have limited opportunities to participate in classroom decisions. They further argue that from the perspective of democratic science education, "science literacy must be attentive to the roles that youth generate or accept for themselves within science-related communities" (p. 11). As this study suggests, a democratic classroom engages students in living democratically by promoting values such as inclusion, voice, representation, self-esteem, self-efficacy and active participation [91]. These various physical, social and psychological conditions are embraced within everything the teacher provides to support students learning of science in primary schools.

Strategies to support teaching/learning of science
This theme refers to the strategies that were identified as support to the teaching and learning of science in primary school classrooms. It was revealed that interactive activities, visual aids and one-on-one discussions were considered supportive by all research participants. There was also a commendation of online materials such as simulations, videos, models and diagrams as well as theoretical knowledge. In addition, the availability of high interactivity of resources allows students in an active, pictorial and almost tangible way to familiarize themselves with the scientific content, which is often considered abstract for them. S1 and S2 respectively stated that:
"we play games like playing rebus and other activities … help us think deeper about the topic … we watch some videos and some simulations from the internet … those are very helpful … to play and learn … the internet provides a lot of great things for us to see and learn … some videos are unbelievable … like the volcanic eruption video that we watched … amazing … we need to use more of these in our science class".

"Yes … we try to enact certain scenario so that we can understand more of the situation … some of us learn faster by seeing our notes in action/play … it's the actioning of everything we learn in class … we create visual representations or models of science ideas … sometimes we look at the internet for some ideas then we create what we see using our own materials at home … my parents can help build stuff".

The ideas from the two student participants confirm one of the significant roles of technology in education which focuses on improving student engagement [20] through interactive content, multimedia, and gamification of learning resources [92]. Through these resources, students can explore various teaching methods, identify the ones that suit them best, and leverage these approaches to their advantage. Once students are motivated to learn they look forward to having time on various technological devices to explore further and continue learning new ideas. Students can learn and have fun at the same time, which helps them stay engaged with the material [16]. Haleem *et al.*, (2022) [92] argue that this promotes longer learning attention spans and captivates motivation over long periods. Similarly, Suaalii and Tufuga (2024) [20] state that when students are engaged, they do more than just attend class; they self-regulate their behaviour, challenge themselves, and enjoy challenges in learning [23]. In essence, a student who is engaged in learning generates a feeling of belonging and connectedness to the learning environment and therefore strives to benefit from the learning given [16].

The study also revealed the critical role of *maimoaga* [field trips] in the teaching and learning of science in Samoa primary schools.

"when we go outdoor for some activities or for our field trips … give me new perspective, ideas about science … we see the reality of living things, what they do to survive … we also get to see what other animals do like those in the mangrove are … it encourages some thinking and more questions in my mind when we go out because we see a variety of things". (S1)

"Comparing classroom and outside … we see more, we learn more, and I have more questions in my head when we go on field trips. Even one day on a field trip, I enjoy a lot more than sitting inside the classroom … sometimes we bring the ideas from our field trips, and we put into stories or create models or even get into more discussion with our teacher and others". (S2)

"I have a great time when we go outdoor or on a field trip … we get to travel to a different place … we see new things … and fun to play with things out there … sometimes we try to catch those little butterflies … very colourful science out there compared to what we get to experience inside the classroom". (S3)

"… field trips/maimoaga are important because I prefer learning by observing the living things, ecosystems and the science out there … the teacher tries to explain repeatedly but it is always hard for me … but getting out there and see … I get to make the links very easily, like the mangrove fruit [refer to image (figure 2) drawn by participant] … *pointed tip for easy penetration into the seawater and rocky seafloor when it falls … just by looking at it and feeling the fruit I also feel that the fatness near the pointed tip helps guide the fall of the fruit downwards". (S4)*

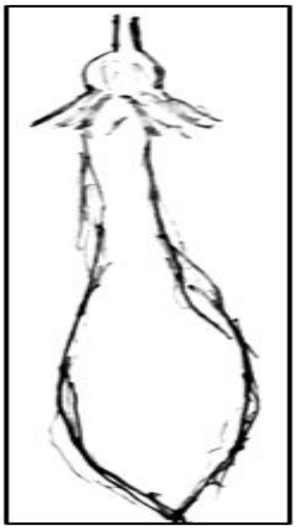

Figure 2: Mangrove fruit drawn by S4

Field trips as revealed in this study reflect important moments in learning; a shared social experience that provides the opportunity for students to encounter and explore novel things in authentic settings [93]. Basically, the implementation of field trips (*maimoaga*) or even outdoor activities can deepen and enhance these students' study of science ideas. With the example demonstrated by S4 (Figure 2), it clearly demonstrates that there are some forms of knowledge constructions based on observations. Further explorations of these phenomena through discussions and research as well as experimentations to test the two ideas: pointed tip and fatness near the end of the fruit will provide more interesting ideas for teachers and students.

Among the many potential outcomes, research has shown that field trips:

- expose students to new experiences and can increase interest and engagement in science regardless of prior interest in a topic [94,95],
- result in affective gains such as more positive feelings toward a topic [96,97],
- are experiences that can be recalled and are useful long after a visit [98,99,94].

However, it is important that field trips are designed to be more effectively support student learning. The literature confirms that field trips work best when they provide support for students to explore in a personally meaningful way [95]. It is obvious from the study that this (field trips) is one of the many methods that help engage students with different learning styles, enhance their understanding, promote deep thinking leading to critically analyzing certain scenarios and concepts of science [98].

Summary

The discussion emphasises several factors relating to physical, social and psychological conditions that impact science education in Samoan primary schools. The three layers of conditions overlap with each other (figure 3) which shows the extensive and strong interrelationship of various factors that ultimately impact students' learning.

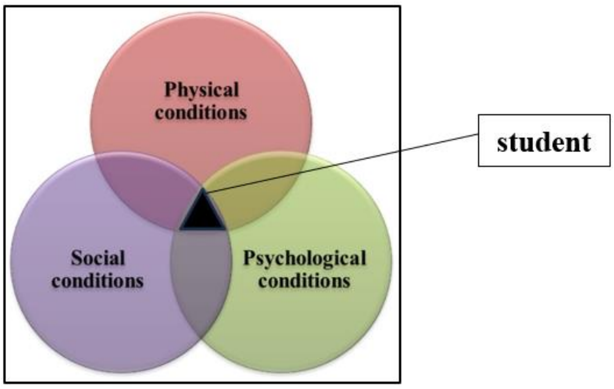

Figure 3: Classroom conditions affect primary school students learning in Samoa

Similar to the work of Bronfenbrenner's ecological systems [100], the analysis identified that a student's learning development is influenced by a series of interconnected classroom conditions, ranging from the physical (e.g. classroom, class size), social (trust, relationships and emotions) to psychological (e.g., critical thinking, problem solving). The small triangle in figure 3, represents a student being placed in the midst of the three conditions within the classroom. This in fact shows that the student's learning will constantly be affected by these conditions once the student enters the formal classroom. It also shows that the student learning accomplishment—positive or negative—is driven by these three conditions.

Conclusion

The findings revealed in this study present strong evidence that the various elements of the three classroom conditions influence the teaching and learning of science in Samoa primary schools. With positive applications of the various elements identified in this study, there is a possibility of improving the quality of science teaching and learning. Therefore, it is critical for educational leaders and science educators to consider these specific elements in spending money and time to improve students' achievement in primary schools, particularly in science subjects. The themes developed from the analysis suggest that science teaching and learning is affected by (i) class size and seating arrangement, (ii) science learning resources (iii) a democratic environment and (iv) various strategies that are used inside the classroom. Basically, these can contribute to enhancing critical thinking skills, constructive learning methods that ultimately lead to improving students' achievement. A positive correlation was found between students' self-esteem, educational capabilities, distinct qualities of learning and their educational accomplishment.

Recommendations, contribution to knowledge and research

An obvious and much-needed area for future research involves addressing the constant increase of class sizes in Samoa primary schools. A lot of physical, social and psychological conditions associated with class size, yet it is often insufficiently explored. While the staffing entitlement for primary school is on a base formula of 1 teacher to every 30 students (Ministry of Education, Sports & Culture, 2019), it is important to deliberate about the suitable classroom size to avoid increase temperatures. Several health factors identified may be triggered if the number of students is high because their activity levels in a classroom generate body heat and eventually raise the temperature over time.

Another area that needs to be addressed is the successful integration of technology into science education in primary levels. It is evident in the literature that technology has empowered educators to create dynamic and interactive lessons that capture students' attention and foster deeper engagement. The study also identified that with access to online learning platforms and educational apps, teachers can supplement their curriculum with multimedia content, interactive quizzes, games, videos and simulations.

This research makes several contributions to the existing body of knowledge on primary school science education in Samoa. First, it provides empirical evidence of the challenges posed by various classroom conditions and that these are strongly interconnected. These findings extend the conclusions of earlier studies conducted in other educational contexts and contribute to the growing literature on the importance of classroom conditions in shaping educational outcomes, particularly in resource-constrained settings like Samoa.

Additionally, the study emphasizes the need for greater resource allocation to science education. The lack of proper materials severely limits students' ability to engage with the curriculum, suggesting that policymakers should prioritize the provision of science equipment, books, and other teaching aids. By improving resource availability, teachers would be better equipped to deliver effective science lessons, and students would have more opportunities for hands-on learning.

Acknowledgment

The authors wish to thank the teacher and students at the primary school in Samoa who agreed to take part in this study. Without your willingness, this research would not exist. You, yourselves, have co-written this research, and have given voice to the people of Samoa and the world about "Classroom conditions: Impacts on the teaching and learning of science in Samoa Primary Schools".

We also wish to thank and acknowledge the lecturers of the Faculty of Education, National University of Samoa for the support throughout the implementation of this research.

Special thanks to the National University of Samoa for supporting this publication.

Conflict of Interest

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

Authors Contributions

The authors confirm contribution to the paper as follows: study conception and design: Faguele Suaalii. Neal Niupulusu; data collection: Neal Niupulusu; analysis and interpretation of results: Faguele Suaalii. Neal Niupulusu; draft manuscript preparation: Faguele Suaalii. Neal Niupulusu. All authors reviewed the results and approved the final version of the manuscript.

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