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Analysing Teachers' Perception of the Try-Understand-Apply-Mastered Discovery Learning Processes in Vanuatu Using the Constructivist Grounded Theory Approach

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Abstract: Internal and external assessment instruments, such as the Vanuatu Standard Test of Achievements (VANSTA) and the Pacific Island Literacy and Numeracy Assessment (PILNA), reveal that mathematics achievements in the Republic of Vanuatu remain below the minimum standard. This study drew on the constructivist grounded theory approach to explore teachers' perspectives of the learning and teaching processes in mathematics education in the Republic of Vanuatu. Specifically, the focus was on the 'I do-we do-you do' approach of teaching, which is common in mathematics education in the country. Teachers' opinions about the current situation of mathematics education and possibilities for improving it were extracted using semi-structured interviews with 22 teachers from two randomly selected urban schools. Based on the constructivist grounded theory analysis, four major interlink themes were found. Overall, the findings show that mathematics achievements in the country can be improved through proven discovery-learning strategies for stimulating students' mathematical thinking in the 21st century, such as the 'try-understand-apply-mastered' (TUAM) discovery learning process.

Keywords: *21st century skills, constructivist grounded theory, I do–we do–you do, try-understand-apply-mastered (TUAM).*

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Introduction

Learning and teaching mathematics in the 21st century should encourage students to be reflective thinkers who take responsibility for their learning under the teacher's guidance. Students should be provided with opportunities to use their minds to construct mathematical ideas themselves to become independent thinkers. Instead of equipping students with narrow occupation-specific knowledge, Jaleniauskienė and Jucevičienė (2018) recommended that in the 21st century, students must be equipped with a wide set of skills. Grevholm (2009) noted that teaching mathematical ideas provides the basic environment which supports the development of students' knowledge structure. That is, since mathematics education is already an avenue for learning, it should help students think and do things themselves. Therefore, teachers are strongly encouraged to take the risks in exploring teaching techniques that may suit their learners' learning styles rather than using the techniques they were influenced by in their elementary years. Studies and practice also show that many teachers still teach mathematics the way they were taught in their school days (Miller & Banes, 2012). Rather, teachers should consider deliver mathematics education which helps meet 21st century education demands. For instance, it should provide students with skills to solve problems related to issues that have not yet been invented and handle problems caused by unexpected situations (Akcanca, 2020). Cai and Howson (2012) promoted this awareness by stating that mathematics education in the 21st century has the responsibility of nurturing students' creativity and critical thinking skills not only for lifelong learning but also for their general benefit and pleasure. Thus, teachers should promote discovery learning approaches that increase students' ability to learn new content by themselves under teacher guidance (Roughead & Scandura, 1968).

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Literature Review

The Current Learning and Teaching Processes in Mathematics Education

The 'I do-we do-you do' model of teaching is the prescribed approach for mathematics education in the Republic of Vanuatu. According to the Ministry of Education and Training - Republic of Vanuatu (2018), this approach is structured on three dimensions: 'I do', 'we do', and 'you do'. The three dimensions occur sequentially. First, the teacher illustrates or undertakes the activity at the beginning of the lesson, referred to as 'I do'. Second, the teacher and students work together through more examples, referred to as 'we do'. Third, the students are provided with the opportunity to solve mathematical problems themselves, referred to as 'you do'. In summary, it begins with the teacher first, then the teacher and student, and finally the student on their own. Initially, the involvement of both teachers and students throughout the learning process is observed to be identical. The time and opportunity students have to explore mathematical ideas is equivalent to the time and opportunity teachers are involved in learning processes.

This approach reflects Vanuatu's traditional ideology of education. It draws on the country's cultural and traditional way of learning, whereby children learn best by observing and copying from peers, parents, and adults or elderly people (Sanga et al., 2004). This approach is considered, to some extent, as a scaffolding process of learning. In the first step, the 'I do' stage, teachers in Vanuatu used examples and demonstrations to guide students' minds in learning new mathematical content. Based on Vygotsky's theory of constructivism, they considered providing examples during a lesson as a way to guide and nudge students to tackle problems by themselves. As Sinha et al. (2021) stated, un-scaffolded problem-solving before receiving instruction can give students opportunities to examine their exploratory hypotheses at the expense of experiencing initial failures. Likewise, Asmuss and Budkina (2009) pointed out that the role of examples in learning and teaching mathematics allows students to better understand the studied concepts and the relations between them. It also allows students to master methods for solving tasks and applying them to practical problems (Asmuss & Budkina, 2009). Encouraging the use of examples in mathematics, Cibulis and Lapiņa (2009) and Kaibe and Rācene (2009) observed that examples are useful to begin a lesson and motivate students to learn. Therefore, teachers should repeatedly provide examples to help in grasping the concepts illustrated by these examples (Kaibe & Racene, 2009). In short, learning mathematics through the 'I do-we do-you do' approach is more dependent on teachers' established ideas at the beginning of their mathematics lessons.

Learning Through Discovery Processes

Mathematics is taught differently in different countries. In Japan as well as other developed countries, mathematics is taught through the try-understand-apply-mastered (TUAM) discovery learning process (Takahashi, 2006). According to Takahashi (2006), the first step 'Try' is presenting the problem, and encouraging students to first explore and discover the solutions to the problem. In the second step 'Understand', students are guided through discussions to compare different solutions to the problem. Next, in the third step 'Apply', students are given other similar problems and asked to apply the method they have confirmed during the discussion. In the fourth step 'Master', as they apply the skills they acquire from the first and second steps, they are also mastering the knowledge and skills. In summary, TUAM begins by presenting a problem that can be solved through varying methods and then have a whole-classroom discussion on the appropriate options (Johansson, 2012). The TUAM approach is based on the principle of not telling or providing answers; rather, as a teacher, one is allowed only to point to and discuss the distinguishing features of possible solutions to the problem (Baker et al., 2012).

According to Mayer (2004), this concept of the discovery learning process is well recognised as a constructivist approach in which learners are active sense-makers who seek to build coherent and organised knowledge. Bakker (2018) argued that here, the term discovery should not be restricted to the act of finding something unknown to humankind; rather, it should include all forms of obtaining knowledge for oneself through the use of one's mind. Importantly, the TUAM approach provides a good opportunity for students to construct new knowledge using their own minds. It is a process of training one's mind to think reflectively and critically, and to improve speed, accuracy, and confidence in mathematical concepts. Trninic (2018) further described this approach as the notion of student-as-explorer. The author explained that through this strategy, knowledge is discovered by the student. The explorer is an active organiser of experiences, constructing a stable understanding by repeatedly constructing them anew. Ojose (2008) further pointed out that children can develop mathematical reasoning skills when they investigate ideas through the discovery learning process.

Furthermore, the TUAM teaching approach allows students to work freely in a learning environment (Mayer, 2004). They are not restricted to the constructing learning processes. Through investigation, they can develop mathematical reasoning skills. The opportunities they have here enhance their mathematical understanding when they extract relevant information from a problem statement (Ojose, 2008). Unlike the 'I do-we do-you do' approach, the TUAM strategy tolerates Vygotsky's scaffolding theory in its rightful manner. It exposes scaffolding as a temporary instructional support that develops cognitive reasoning. It has also gained increasing acceptance as a strategy for developing higher-order thinking skills as well (Byun et al., 2014). Figure 1 presents a synopsis of the 'I do-we do-you do' versus TUAM approaches.

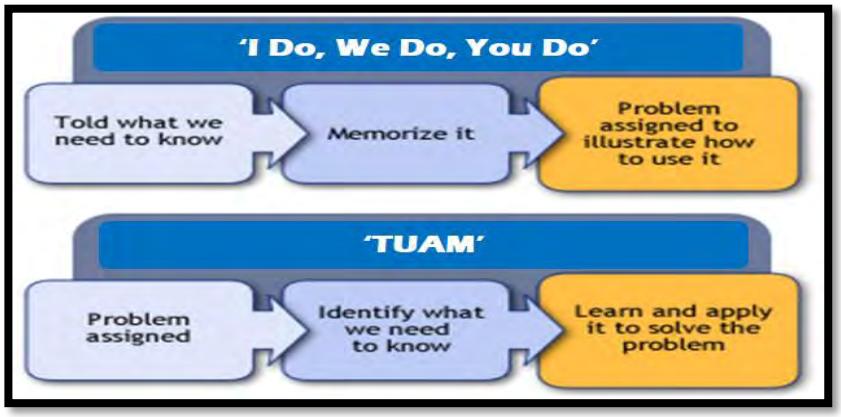

Figure 1. The 'I do-we do-you do' versus TUAM Approaches

Methodology

This study examined teachers' perspectives on the TUAM discovery learning processes compared to the current teaching strategy in elementary mathematics education in the Republic of Vanuatu. The focus was on the current situation of mathematics education in the country and the trends in mathematics for the future. The research questions were as follows:

1. What is the current situation of learning and teaching approaches to mathematics in elementary schools in the Republic of Vanuatu?

2. How can we improve the current situation of learning and teaching approaches to mathematics in elementary schools in the Republic of Vanuatu?

A qualitative research design was adopted. Data were collected via semi-structured interviews with 22 elementary school mathematics teachers from two randomly selected urban schools. The interviews were recorded, decoded, transcribed, and analysed using Charmaz's (2014) constructivist grounded theory approach to identify common themes related to the processes of learning and teaching mathematics in the Republic of Vanuatu.

This theoretical approach was appropriate as it allows the researchers to construct analytic codes and categories from data using the constant comparison method; specifically, comparisons are made during each stage of analysis, thereby leading to the development of theories or conclusions from the data. The general steps in a constructivist grounded theory approach such as this include identifying the: central phenomenon, causal conditions, intervening conditions, and strategies and consequences that impact a situation (Strauss & Corbin, 1998). Thus, this approach can help in investigating and discovering the current situation of learning and teaching mathematics in elementary schools in the Republic of Vanuatu, and how this situation can be improved.

Many researchers have demonstrated the constructivist grounded theory approach to be one of the most efficient analytical approaches for qualitative investigations. For instance, while analysing teachers' representation of digital technology, Ailincai and Gabillon (2018) highlighted that constructivist grounded theory allows them to discover some internal and external factors that play key roles in shaping teachers' skills in technology. This can help in setting the directions for upgrading teachers' skills related to using technology. Another study on the process of general education reform from a faculty perspective was conducted using constructivist grounded theory to identify phenomenon for developing a theory for institutional change that explains the process and implementation of a new general education program (Hachtmann, 2012). The author demonstrated that constructivist grounded theory effectively helped the researcher discover the trends needed for the implementation of the new general education program.

Regarding the participants, semi-structured interviews with 22 teachers (female: 13; male: 9) were conducted from two randomly selected urban schools. Interviews were conducted with individual teachers based on their availability during the data collection period. Participants had recognized teaching qualifications and various years of experience.

In total, 16 semi-structured interview items were administered and categorised into five categories: 1) basic information about the teachers who participated in the study; 2) challenges encountered by teachers while teaching mathematics; 3) the importance of mathematics in the education system; 4) the current situation of teaching mathematics in Vanuatu, particularly current learning and teaching strategies used for delivering mathematical content in elementary classrooms; and 5) teachers' opinions on how mathematics education in Vanuatu can be improved.

All interviews were video-recorded, decoded, transcribed, and analysed with the consent of the individuals. The aim of the analysis was to look for common themes associated with learning and teaching approaches in mathematics education. The relevant themes extracted from the initial codes were identified and presented precisely with insights

from teachers' opinions on various aspects of mathematics education in the country. These relevant themes were supported by the original text of the teachers' translated script extracted from the interviews. Although the script was translated from the national language of the country, Bislama, to English, the meanings of the expression during the discussion did not change. Word-to-word translation was essential to ensure the reliability of the findings. The analysis process also helped safeguard the meanings of the expressed opinions when extracting the initial codes, defining the categories, and formulating the themes that capture the original meaning of the opinions.

Results

Using the constructivist grounded theory approach, the data for the study were analysed from the interview script to the coding of the script, and then to the categorisation of codes. The code categories were then classified under the four interlink themes: (a) challenges in mathematics education, (b) the condition of the current mathematics approach, (c) the opportunities, and (d) advancing mathematics for the future. These themes are discussed below.

Challenges in Mathematics Education

This theme highlighted the scope of the difficulties in the current schema of mathematics education in Vanuatu. Two interlink categories were present under this theme: (a) Limited knowledge of mathematical pedagogies, and (b) Limited understanding of mathematical content.

Limited Knowledge of Mathematical Pedagogies

The limited knowledge of mathematical pedagogies referred the gaps between mathematical concepts and the process of learners' acquisition of the concepts. Participants noted that teaching techniques in mathematics are a major concern for many elementary school mathematics teachers. When they were asked about the challenges they experienced, most expressed that they had a limited understanding of how to teach mathematics more effectively. One participant highlighted that many teachers were still teaching mathematics the way they were taught in their own elementary school days (Teacher A in Table 1). Another participant admitted that she and many other teachers faced difficulties in some mathematical topics, and needed more training on how to teach specific topics (Teacher B in Table 1). Notably, in the original script below, the teacher used the expression 'ol narafala tija tu' (other teachers) to express their opinion that many teachers are struggling to deliver specific mathematical topics effectively. The teacher also used 'provaedem mo trening' (to provide more training) to emphasise the importance of essential skills that teachers are lacking. Because many teachers lack teaching pedagogies in mathematics, this participant believed that providing more training on mathematical pedagogies can be a better solution. Such expressions imply that the current mathematical pedagogy in a country may require changes.

> …I gat sam topik long matematik we mi save se me no stap tijim olsem we oli expektem mi blong tijim. Mi biliv ol narafala tija tu oli gat semak isiu espeseli long bikbikfala klas. So lo mi, mi tink se i beta blog provaedem mo trening long ol technique blong tijim matematik. (…there are some topics in mathematics that I know I am not teaching as expected. I believe other teachers also have this same issue, especially with upper grades. So for me, I think it would be better to provide more trainings on teaching techniques of mathematics…)

Another participant highlighted that for students to be good at mathematics, teachers must first be good at mathematics. They must have proper knowledge of the different teaching techniques in mathematics (Teacher C in Table 1). Together, these responses indicate that many mathematics teachers in the country do not have proper pedagogical knowledge on effectively teaching mathematics.

Table 1. Limited Knowledge of Mathematical Pedagogies – Participants' Responses

Teacher	Response
A	…to be honest, mathematics is not the best subject that I like to teach. But I have to teach it somehow since I am a primary school teacher. Because in primary schools, a teacher is responsible to teach all subjects including mathematics. And for mathematics, I am teaching most topics the same way I was taught in primary school…
B	…there are some topics in mathematics that I know I am not teaching as expected. I believe '*ol narafala tija tu'* (other teachers) also have this same issue, especially with upper grades. So, for me, I think it would be better to *'provaedem mo trening'* (provide more training) on teaching techniques of mathematics…
C	…the main challenge for me in mathematics is to do with teaching techniques. When I was teaching grade one it was a little bit easier, but not that I am teaching grade six. In grade six, sometimes I find it hard to teach some topics. Sometimes I will invite the class five teacher next door to teach the topics that I find difficult to teach…

Limited Understanding of Mathematical Content

Some teachers also note that they have a limited understanding of mathematical content, even as they are making efforts to teach them. When asked about their difficulties in mathematics education, one participant pointed out that mathematical content knowledge is a key issue affecting mathematics achievement in the country (Teacher A in Table 2). Another participant observed that some mathematical topics were too difficult to teach (Teacher B in Table 2). In the original language of Teacher B in Table 2, (see also the original text below), the expression 'i gat plante topik' (there are lots of topics) in this teacher's opinion highlighted the difficulty teachers are encountering with specific mathematical topics in the curriculum. Further, this teacher uses 'oli had tumas' (too difficult) to emphasise that many topics in the mathematics curriculum are too difficult to teach. Together, these expressions depict that a limited understanding of mathematical content is an issue affecting many teachers in the implementation of mathematics education in the country.

> …fesli, mi mas talemaot se matematik i no favret subjek blong mi tijim. Mi likem blong tijim Inglis mo ten matematik. Hemia hemi from nomo se i gat plante topik long matematik olsem mesamen, oli had tumas blong mi tijim… (…firstly, I must admit that mathematics is not my favourite subject to teach. I like to teach English better than mathematics. This is only because there are lots of topics in mathematics, like measurement, that are too difficult for me to teach…)

One participant (Teacher C in Table 2) highlighted that if teachers understand what to teach before delivering it, they will be able to teach it more effectively. Both teachers' limited understanding and ways to address this problem can be vital areas of future research.

Table 2. Limited Understanding of Mathematical Content – Participants' Responses

Teacher	Response
A	…I like to teach mathematics though I was not good at mathematics during my school days. And I think the most important thing to know to teach mathematics effectively is to understand the content of each topic before teaching it. I think this is one of the issues affecting our achievement in mathematics at the moment…
B	…firstly, I must admit that mathematics is not my favourite subject to teach. I like to teach English better than mathematics. This is only because '*i gat plante topik*' (there are lots of topics) in mathematics, like measurement, that are *'oli had tumas'* (too difficult) for me to teach…
C	…sometimes, students find it hard to understand my explanations. Most of the time when I gave students the task to do after my explanations, only a few students and these are the smart ones who will be able to do the task as expected. I think sometimes this one comes back to me as a teacher. Before teaching a topic, I must try my best to understand the content related to that topic. Because really, some topics in our mathematics curriculum are too difficult to understand like measurement…

Condition of the Current Mathematics Approach

This theme described the current situation of mathematics education in Vanuatu, particularly the teaching approaches used as a medium to deliver mathematical content. Four interlink categories of initial codes were extracted: (a) the strengths of the traditional approach, (b) most influential cause of learning, (c) limitations of current approaches, and (d) consequences of the traditional approach.

The Strength of the Traditional Approach

The strength of the traditional approach highlighted the positive impact of the current teaching approach on students' academic performance. Although the current teaching approach has some limitations, it allows students to acquire new knowledge in some situations. When asked about the advantages of the 'I do-we do-you do' approach of teaching, one participant (Teacher A in Table 3) explained that the current teaching approach is very helpful in mathematics lessons as it allows teachers to show students what they are expected to do and how to do it. The participant used the expression 'hemi isi blong soem pikinini wanem blong mekem' (it is easy to show children what to do), which implies that the participant is confident of the outcome of the teaching approach. The participant also used the expression, 'oli save mekem i semak' (do exactly the same), which implies that this teaching approach encourages students to easily know what they are expected to do. The participant's original opinion is as follows;

> ….mi tink se tijing aproj ia i helpful long matematik lesen. Espeseli time tija i wantem pikinini blog ajivim objektiv blog lesen. Hemi isi blong soem pikinini wanem blong mekem, from bae oli save mekem i semak olsem we tija i expektem… (…I think this teaching approach is very helpful in mathematics lessons. Especially when the teacher wants students to achieve the objective of the lessons. It is easy to show children what to do for them to do exactly as expected…)

Another participant (Teacher B in Table 3) further explained that this teaching approach allows students to acquire new knowledge faster through observing the teacher. For instance, when mathematical concepts are illustrated through examples, students may be able to understand them better (Teacher C in Table 3). These responses portray the positive impact of the current teaching approach on students' learning.

Table 3. The Strength of the Traditional Approach – Participants' Responses

Teacher	Response
A	…I think this teaching approach is very helpful in mathematics lessons. Especially when the teacher wants students to achieve the objective of the lessons. *'Hemi isi blong soem pikinini wanem blong mekem'* (it is easy to show children what to do) for them to do exactly as expected…
B	…for students to acquire new knowledge faster, it is better to allow them to imitate the construction of the knowledge. What I mean is that when we explain to students what to do through examples, they will understand it better and be able to do it within the expected time…
C	…in my case, when I showed students what to do through examples, they will do it exactly as I am expecting. So for me, I think one of the advantages of this teaching strategy is to use examples to guide students to learn new concepts…

The Most Influential Cause of Learning

This interlink category describes the inspirational means of learning in mathematics lessons in any Vanuatu classroom. When participants were asked about the advantages of the 'I do-we do-you do' strategy, most conveyed that the most influential medium that drives learning through this approach is the use of examples. Participants conveyed that it is through examples and demonstrations that students are motivated to learn (Teacher A in Table 4). One participant also explained that without examples, students would not be able to complete their tasks or even do any work (Teacher B for further details in Table 4). This participant used the expression, 'studen i depen long tija' (students depend on the teacher), highlighted that the knowledge students are utilising comes directly from the teacher. This participant also used the expression, 'bae oli no save komplitim' (they will not be able to accomplish). These expressions disclose that students' learning is totally driven by the teachers' established ideas. This means that without the teachers' established ideas, students will not be able to achieve new mathematical knowledge in Vanuatuan mathematics learning environments. The original opinion of this participant is as followed;

> …. wan samting mi notisim team mi usum aproj ia hemi hao studen i depen long tija from lening blong hem wan. Long klas blong mi, team mi wapemaot explenesen blong mi long blakbod afta we mi explenem wan tinktink, mo behaen mi givim wok long ol pikinini blong mekem, fulap long olgeta bae oli no save komplitim wok blong olgeta… (…one thing I notice when using this approach is how students depend on the teacher for their learning. In my class, when I erase my explanations on the blackboard after explaining, and afterward I gave students their task to do, most of them will not be able to accomplish the task…)

Teacher C in Table 4 further explained that with this approach, learning is driven by the teacher's ideas. Most participants described this approach as a spoon-feeding strategy, whereby all new knowledge is delivered to students by the teacher instead of allowing students to construct their learning (for instance, see Teacher D in Table 4).

The responses emerging from this category indicated that mathematics learning in Vanuatu classrooms is mostly influenced by the teacher's ideas. Learning is a teacher-centred approach whereby no opportunity is given to students to explore new knowledge by themselves; instead, they only follow the teachers' established ideas to acquire new knowledge.

Table 4. The Most Influential Cause of Learning – Participants' Responses

Teacher	Response
A	…one good thing about this approach is that when we explain mathematical ideas using examples, students will be able to learn. For me, if I decided not to use examples or even if I distributed activities without explanations, after a few minutes into the task students will be coming to me individually for assistance…
B	…one thing I notice when using this approach is how *'studen i depen long tija'* (students depend on the teacher) for their learning. In my class, when I erase my explanations on the blackboard after explaining, and afterward I gave students their task to do, most of them *'bae oli no save komplitim'* (will not be able to accomplish) the task…
C	…I think this approach is teacher-centred based. I say this because learning through this approach is like students acquiring new knowledge based on the teachers' ideas. If the teacher shows students what to do and how to do it, students will do it, but if the teacher shows students what to do but not how to do it, students will fail to do their part…
D	…this approach of teaching is good, but I think it is a teacher-centred based whereby students are spoon feed all the time. Instead of allowing students to learn by themselves, the teacher seems to do everything to get students to understand something…

Limitations of the Current Approach

Nevertheless, the current approach of learning and teaching mathematics has some limitations. Some participants raised concerns regarding how children acquire mathematical concepts using this approach. Teacher A (see Table 5) explained that this teaching approach is teacher-centred. There is no opportunity for students to discover mathematical ideas by themselves. Another participant highlighted that because students are not allowed to explore mathematical ideas, they have limited opportunities to broaden and deepen their mathematical reasoning skills (Teacher B in Table 5). Another participant noted that this teaching strategy shuts down the opportunity for students to learn through their mistakes. Considering mistakes as part of learning, this strategy is limited by not allowing students the right opportunity to learn from their mistakes (Teacher C in Table 5). Finally, this teaching approach may not reflect the trend of mathematics education in the 21st century (Teacher D in Table 5). When students are not allowed to explore possible solutions to a mathematical problem, they do not train their minds to think critically or improve their speed, accuracy, and confidence in mathematical concepts. Speaking of mathematical solutions, Teacher E in Table 5 explained that this approach of teaching does not allow students to explore possible solutions to a mathematical problem since they are just following the teacher's established ideas. Notice that the participant uses the expression 'metod blong tijing ia i lakem' (method of teaching is lacking). This expression implies that this teaching approach may be effective but is still lacking something very significant. The expressions 'ol posibol solusen' (possible solutions) and 'folem idia blong tija nomo' (following the teachers' ideas only) signify that this approach does not allow the student to explore possible solutions; instead, they are just following the teachers' ideas. The word 'nomo' (only) in this expression means that something is done repeatedly in just one way. According to the participant, this expression implies that this approach of teaching encourages students to acquire knowledge based on a specific idea while ignoring other possibilities for a mathematical solution. The original script for this participant is presented below. Overall, these findings suggest that the limitation of this approach of teaching is minimising the opportunity for students to become independent learners in the 21st century.

> …. wan samting we metod blong tijing ia i lakem hemi opotunity blong alawem student blo explorem posibol solusen blong wan matematikel problem from oli stap folem idia blong tija nomo. Olsem we yumi save, long matematik bae i olwes gat plante wey blong finem wan korek ansa… (…one thing this method of teaching is lacking is the opportunity to allow students to explore possible solutions to a mathematical problem because they are just following the teachers ideas only. As we know, in mathematics there will always be many solutions to one correct answer…)

Table 5. Limitation of the Current Approach – Participants' Responses

Teacher	Response
A	…I strongly believe that this teaching strategy is not a student-centred-based approach. I say this because speaking from experience, I think students are not given enough opportunity to learn by themselves. For me, it becomes a routine to explain something and then later allow students to follow my explanations to do the activity…
B	…only if we allow students to explore mathematical ideas by themselves, they will be able to broaden and deepen their mathematical understanding. But if we close this opportunity then we are as well closing the opportunity for students to learn more…
C	…in my personal view, I think sometimes we should allow students to try to solve problems on their own. We must also accept the fact that when students do things for the first time they will make mistakes, but we must also understand that mistake is part of the learning process. So, whenever students made mistake, after all, they will learn from that mistake…
D	…maybe this approach is not reflecting education in this 21st century. I think it is not allowing students to think critically and improve their speed, accuracy, and confidence in mathematics. Because only if we allow the opportunity to use their minds to think around mathematical ideas then they will be able to improve their mathematical thinking…
E	…one thing this *'metod blong tijing ia i lakem' (*method of teaching is lacking) is the opportunity to allow students to explore *'ol posibol solusen'* (possible solutions) to a mathematical problem because they are just *'folem idia blong tija nomo'* (following the teachers ideas only). As we know, in mathematics there will always be many solutions to one correct answer…

The Consequence of the Traditional Approach

This category focuses mainly on the outcomes of traditional teaching strategies. Most participants revealed some critical conditions which should be considered regarding the outcomes. One participant (Teacher A in Table 6) highlighted that this approach of teaching encourages students to be more dependent learners rather than becoming independent learners. This participant used the expressions 'enkarejem studen blo depen oltaem' (encourage student to be dependent always), 'had blo pikinini i rijim' (difficult for a child to reach), and 'indipenden lena' (to become an independent learner). The participant's focus here is to emphasise that this approach of teaching will always encourage

students to be dependent learners. Consequently, they may not be able to reach a level of learning where they will be able to think and do things for themselves. The original opinion for this participant is as follows;

> …long pesonel tinktink blong me abaotem tijing aproj ia, hemi wan aproj we i stap enkarejem student blo depen long tija ol taem. Mo from student bae hemi stap depen long tija blong lan, bae hemi had blo pikinini i rijim level blong kam wan indipenden lena… (…my personal view about this teaching approach is that it will always encourage students to be dependent always. And because students will be depending on the teacher for their learning it will be difficult for a child to reach a level of becoming an independent learner…)

Speaking about dependent and independent learners, another participant (Teacher B in Table 6) noted that through the traditional approach, students will be motivated to learn through external forces such as examples and demonstrations all the time. It will be difficult for them to become independent thinkers. Another participant also pointed out that this method of teaching encourages students to have a poor attitude towards mathematics (Teacher C in Table 6). For instance, when students depend on the teacher most of the time, some of them may hate mathematics and blame the teachers for not teaching them properly. These results highlight the possibility that even though there is a positive outcome of this approach, it is also necessary to be mindful that there are some limitations.

Table 6. Consequence of Traditional Approach – Participants' Responses

Teacher	Response
A	…my personal view about this teaching approach is that it will always *'enkarejem studen blong depen oltaem'* (encourage students to be dependent always). And because students will be depending on the teacher for their learning it will be *'had blong pikinini i rijim'* (difficult for a child to reach) a level of becoming *'indipenden lena'* (an independent learner) …
B	…with this approach students are motivated to learn when there are examples to guide them. Without examples, they can't do their work. And because of that, it does not help them to think for themselves, instead, they will always depend on the teacher for their learning…
C	…to be honest, I hate mathematics even though I am teaching it. When I reflect on my school days, I can remember one of my teachers who impacted me to hate mathematics until today just because of the way he was teaching it…

The Opportunities

This theme notes the potential for higher achievement in mathematics education in Vanuatu. Two interlink categories emerge in this theme: (a) learning opportunities and (b) teaching opportunities.

The Learning Opportunities

Learning opportunities here refer to the potential that students have in learning mathematics. Participants believed that students were capable of improving their performance in mathematics. They have the potential to acquire and advance their thinking processes through mathematical education. When asked about their students' achievements in mathematics, most participants revealed that students who perform well in mathematics are students who like mathematics, and vice versa (Teacher A in Table 7). Another participant highlighted that students have curious minds and that providing the best opportunity encourages their development (Teacher B in Table 7). Highlighting learning potentials in students, this participant used the phrases 'i gat potensel long ol pikinini blong lanem matematik' (there are potentials in students to learn mathematics) and 'oli veri kuiries' (they are very curious). These two specific phrases indicate that the participant had the conviction that students have learning potential and curious minds to excel in mathematics. If this learning potential exists in students, then giving them better opportunities to develop this potential will encourage them to improve their mathematics achievements. See original statement for this participant below.

> ….mi beliv ol pikinini oli gat potensel blong lanem matematek. Fo exampol, sam studens oli veri kiuries blong explorem matematekel idies long own interes blong olgeta. Taem yumi tinkabaotem hemia, yumi sud talem olsem se, oh, pikinini ya hemi interes blong lanem hemia, yumi givem hem mo opotuniti blong explorem.. (…I believe there are potentials in students to learn mathematics. For example, some students are very curious to explore mathematical ideas in their interest. When we think about this, I think we should say, oh, this child is interested to learn about this, let's give him more opportunities to explore it…)

Students' involvement was also highlighted as important factor for being better at mathematics. This is when students are provided with opportunities to participate in mathematical lessons. In situations where students are participating in learning collaboratively, participants believe that they will eventually improve their performance because while interacting, they are also learning from each other (Teacher C in Table 7). Together, these responses show that students can improve their performance in mathematics based on their potential. Thus, providing better opportunities to utilise this mathematical potential can be a much better option in learning and teaching approaches.

Table 7. Learning Opportunities – Participants' Responses

Teacher	Responses
A	…the students in my class are performing at different levels. Some perform better than others. I also notice that those who are performing better are those who like mathematics, but others who are not performing well are those who hate mathematics…
B	…I believe *'i gat potensel long ol pikinini blong lanem matemateik'* (there are potentials in students to learn mathematics). For example, some students *'oli veri kuiries'* (are very curious) to explore mathematical ideas in their interest. When we think about this, I think we should say, oh, this child is interested to learn about this, let's give him more opportunities to explore it…
C	…most of my students this year are not too good with mathematics like my students from previous years. But one thing I can say about this group is that they enjoy working together as a group. When I assign them activities to work on as a group, they love it. To me, this is a sign that students can learn mathematics, but the problem is we are not giving them the opportunity they need…

Teaching Opportunities

Another strength in improving mathematics achievements in Vanuatu is the love teachers have for mathematics, particularly their excitement and interest about the subject. Although not all participants stated that they like to teach mathematics, when they were asked about their interest in mathematics, their responses highlighted that mathematics achievements can be improved if these teachers are proactive in assisting other teachers to gain the same interest that they have in mathematics. One participant (Teacher A in Table 8) noted that some teachers hated mathematics in their school days; however, when they became teachers, their perspectives changed as they were involved in training that allowed them to observe other teachers' experiences. Another respondent (Teacher B in Table 8) highlighted that mathematics is his favourite subject because he believes that mathematics taught him to be creative.

The majority of participants stated that mathematics is their favourite subject for several reasons. One participant (Teacher C in Table 8) used the phrase 'taem mi stap skul yet' (in my school days) means that this participant's interest in mathematics began when he was still a student. The phrase 'skils blong daily laef' (skills in daily life), referring to the participant's interest, was influenced by the skills he gained through mathematics. Through mathematics, he was able to cope with various activities of daily living. (See also the original opinion for this participant below). Therefore, generally, teachers had a passion for teaching mathematics because of their long-term interest in the subject. These responses show that mathematics achievements in Vanuatu can be improved by drawing on teachers' passion for teaching the subject.

> …. matematik hemi favret subjek blong mi taem mi stap skul yet kasem tede. Mi laekem matematik from plante rison olsem ol skils blong daily laef. Mi likem matematik from se hemi alawem me blong development ol skils we i neseseri blong daily suvival blong mi…. (…mathematics was my favourite subject in my school days until today. I like mathematics for many reasons such as skills in daily life. I like mathematics because it allows me to develop life skills that are necessary for my daily survival…).

Table 8. Teaching Opportunities – Participants' Responses

Teacher	Response
A	…I was not interested in mathematics not until I joint the SHEMATA (an association coordinated by JICA in Vanuatu targeting mathematics education in elementary schools in Vanuatu). Once I joint this program, I observe how Japanese people demonstrate and share their experiences on how to solve mathematical problems using different techniques, and different methods, then I started to enjoy mathematics. I even joint the Japanese people to run training for other teachers who struggled with mathematics…
B	…I did not know why other teachers like or hate mathematics, but for me, one thing I like about mathematics is the skills that I have today. I believe that when I teach mathematics to students, I am also learning with the students…
C	…mathematics was my favourite subject *'taem mi stap skul yet'* (in my school days) until today. I like mathematics for many reasons such as *'skils blong daily laef' (*skills in daily life). I like mathematics because it allows me to develop life skills that are necessary for my daily survival…

Advancing Mathematics for the Future

Advancing mathematics described teachers' perceptions of possible solutions for improving mathematics in Vanuatu divided into two code categories: (a) employing a research base strategy and (b) modifying the traditional approach.

Employing a Research-Based Strategy

This category shows the emphasis on shifting from a teacher- to student-centred learning approach that draws on student exploration. Participants revealed that practically, teachers in Vanuatu are most likely to be implementing the teacher-centred approach to teaching in their respective classrooms. When asked about the way forward for improving mathematics in Vanuatu, most participants conveyed that teachers should be encouraged to practice teaching methods that allow students to construct their learning (for instance, Teacher A in Table 9). Another participant suggested that teachers should use teaching strategies that allow students to learn collaboratively instead of spoon-feeding them all the time (Teacher B in Table 9). One participant described student-centred learning as placing students in a situation where there is no way to escape and allowing them to use their minds to make their way out (Teacher C in Table 9). This participant used the illustration of a lizard placed in a box with water in it allowing it to escape the surrounding danger. The participant used the phrase 'lised ia bae hem wan i traem evri posibol wei blong kamaot long dis' (the lizard itself will try every possibility available in the situation to get out of the dish) to explain the success of the lizard. Furthermore, they stated it was 'neija blong lised' (the nature of the lizard). That is, by its own nature, the lizard will try its best to get out of the box without anybody giving instructions on how to get out of the dish. This may allude to doing things by oneself. In the mathematics education context, this means challenging students to acquire mathematical concepts themselves and that the nature of doing things themselves plays an important role in how successful they are in their challenge. Students will broaden and deepen their mathematical reasoning skills only if they are placed in a danger zone or situation where there is danger ahead, and then allowing them to escape the danger to save his own life. Their experience of escaping the danger zone will allow them to learn, and at the same time, they will never forget the experience. This participant original opinion is presented below.

> …. sopos yu putu ol pikinini long wan box, afta yu no givim instraksen abaotem wanem blong mekem blong save kamaot long box ia, ol pikinini olgeta self bae oli save se oli mas mekem wan samting blong kam aot long box. So idia, teknikie, mo skils we oli usum blong asistim olgeta blong kam aot long box hemi wanem we i helpem olgeta blong lan. Mo tu, bae oli olwes remembarem expiriense we oli go tru olgeta wan blong kamaot long box. Bae oli no save fogetem from hemi experiense blong olketa self. Even sopos yu sakem wan lised i go long wan dis we i gat wota long hem, lised ia bae hem wan i traem evri posibol wei blong kamaot long dis. Neija blong lised bae i talem long hem wan blong kamaot long dis. So olsem lised ia, hemia i stap talem long yumi se, ol pikinini oli gat potensel blo save mekem samting olgeta wan, be tijing metod we yumi stap yusum naoya, i no alawem olgeta blo yusum ol potensel we oli gat…(…if you put students in a box without giving them any instruction on what to do to get out from there, students themselves will realise that they must do something for them to get out of the box. So the ideas, the techniques, the skills, and all that they apply to assist them in getting out of the box are what help them to learn. And also the experience of getting out of that box by themselves will always be remembered. Never will it be forgotten. Even if you throw a lizard into a dish with water in it, the lizard itself will try every possibility available in the situation to get out of the dish. The nature of the lizard will tell them to get out from there. So already this is telling us that students already have the potentials to do things on their own, but the current method is not the one that allows them to use and develop these potentials…)

Another participant further explained that student-centred learning is a learning situation that allows students the opportunity to research or investigate mathematical solutions themselves, whereas teachers are present as a guide but not as a lecturer (Teacher D in Table 9). Describing the concept of discovery learning, one participant (Teacher E in Table 9) noted that learning should be based on the principle of not telling answers, but rather telling students what to do and not how to do it. This participant also highlighted that allowing students to explore mathematical ideas themselves is a golden learning opportunity to eliminate misconceptions that may occur when exploring possible solutions to a particular problem. Overall, these findings indicate that a discovery learning strategy can be employed to enhance mathematical achievements in Vanuatu. Even though participants were not informed about the TUAM strategy during this study, the characteristics highlighted through their responses suggest that a discovery learning strategy such as the TUAM strategy can be promising for mathematics education in the Republic of Vanuatu.

Table 9. Employing a Research-Based Strategy – Participants' Responses

Teacher	Response
A	…speaking from experience, I think it would be better for teachers to apply teaching strategies that allow students enough opportunities to construct their learning. We should change our mindset from a teacher-centred approach to a student-centred approach…
B	…when we allow students to work in groups they are motivated to learn. And I think it is because they have the opportunity to help each other when they face difficulties. Because sometimes students find it difficult to ask for assistance from the teacher when they do not understand something…

Table 9. Continued

Teacher	Response
C	…if you put students in a box without giving them any instruction on what to do to get out from there, students themselves will realise that they must do something for them to get out of the box. So the ideas, the techniques, the skills, and all that they apply to assist them in getting out of the box are what help them to learn. And also the experience of getting out of that box by themselves will always be remembered. Never will it be forgotten. Even if you throw a lizard into a dish with water in it, '*lised ia bae hem wan i traem evri posibol wei blong kamaot long dis*' (the lizard itself will try every possibility available in the situation to get out of the dish). '*Neija blong lised*' (the nature of the lizard) will tell them to get out from there. So already this is telling us that students already have the potentials to do things on their own, but the current method is not the one that allows them to use and develop these potentials…
D	…in mathematics lessons, we should allow students to research and discover by themselves what solutions are best for them. Well, we might say, but we are paid to teach them. I think our responsibility here is just to guide them through the learning process but not to lecture them to learn something…
E	…when I attended SHEMATA (Shefa Mathematics Teachers Association) coordinated by JICA volunteers I know discovery learning is a teaching method used by the Japanese. And I can say that it is a very good method to teach mathematics. Teachers are only telling students what to do but not how to do it. So, it is like giving instructions but not answers…
F	…only when we allow students to solve problems themselves, they will be able to learn from their mistakes, and thus, their mistakes as their best teacher will also allow them to identify the misconceptions that might occur in a mathematical situation…

Modifying the Traditional Approach

This category described participants' opinions of possible solutions to improve the 'I do-we do-you do' teaching approach. When questioned about this, most participants conveyed that it would be better to redefine the definition of the 'I do' dimension. The 'I do' step refers to the teacher's part at the beginning of the lesson before students work under the teacher's guidance. Participants felt that this was like closing the opportunities for students to think critically and develop their mathematical potential. Thus, participants suggested that instead, students should be given the initiative in the 'I do' step instead of teachers, and that the 'we do' and 'you do' steps remain as they are (Teacher A in Table 10). Emphasising this suggestion, another teacher explained that when students are challenged with opportunities to attempt a solution to a problem, they are indirectly encouraged to develop the courage needed to solve mathematical problems (Teacher B in Table 10). As highlighted by this participant, the moments that an individual will treasure in life are moments of new experiences. Specifically, in this participant's original text, the phrase 'opotuniti blong mekem atem' (opportunity to attempt) signifies that if students are given the first opportunity, they are given the best way of learning. Thus, attempting does not seem to be a new concept for students; rather, executing the attempt matters. The time or opportunity provided for the attempt is the most necessary aspect to consider. Thus, allowing the first opportunity of learning for students to attempt mathematical solutions instead of teachers' involvement at the beginning of the lesson should be considered. Below is the original statement for this participant.

> …. taem yummi alawem studen opotuniti blong mekem atem blong solvem wan matematikol problem, hemi olsem we yumi givim hem wan golden opotuniti blong go tru wan experiense we bae oli neva fogetem from hemi own experiense blong olgeta self. Iven sopos oli mekem mistek, bae oli lan tru long mistek blong olgeta… (…when we allow students opportunity to attempt a mathematical solution, it is like giving the best and golden opportunity of experiencing something they will never forget since it is their own experience. Even if they make mistakes, they will learn from their mistake…)

Another suggestion for the improvement of the 'I do-we do-you do' approach is greater student involvement in the 'we do' stage. Specifically, the 'I do' stage should be eliminated to allow time for more involvement in the 'we do' stage (Teacher C in Table 10). Another participant elaborated on this, stating that when we do not show students how to solve a mathematical problem, we encourage them to use their minds to reflect and think to become independent learners (Teacher D in Table 10). By eliminating the 'I do' stage, where teachers show students how to solve a mathematical problem, students are encouraged to understand that they are responsible for their learning and then involving them together at the 'We do' stage to begin the lesson. Moreover, these findings also revealed that the 'I do-we do-you do' strategy has greater teacher involvement than expected compared to student involvement, which means that this strategy does not seem to be student-centred learning. Nevertheless, there are possibilities to modify this strategy to encourage greater student involvement, and actually become a student-centred approach to learning and teaching.

Table 10. Modifying the Traditional Approach – Participants' Responses

Teacher	Response
A	…instead of the teacher explaining at the beginning of the learning process, this first opportunity – the 'I do' should be given to students. So maybe instead of defining the 'I do' as the teacher explains, we can change it to students attempting the solutions. So it will be like 'I do' – student, 'we do' – student and teacher, and 'you do' – student again…
B	…when we allow students '*opotuniti blong mekem atem*' (opportunity to attempt) a mathematical solution, it is like giving the best and golden opportunity of experiencing something they will never forget since it is their own experience. Even if they make mistakes, they will learn from their mistake…
C	…this method seems to be involving teachers more than students. So, I would prefer we remove the 'I do' stage and allow more time for the 'we do' involvement. This will be like having more involvement of teacher and student first before allowing students to work themselves. In this way, I think students will remember ideas better than telling them what to do and how to do it all the time…
D	…if we remove the 'I do' stage at the beginning to allow more time for the 'we do' involvement and then the 'you do', it will encourage students to understand that their learning is their responsibility. This is to say that if they try to do something they will learn from the experience. If they make mistakes, they will learn from their mistake…

Discussion

The findings through this constructivist grounded theory enquiry revealed that a research-based approach to teaching, such as TUAM discovery learning, can improve achievements in mathematics and equip students with 21st century skills. Four major themes emerge as phenomena central to the mathematics learning and teaching processes in Vanuatu in the 21st century. Figure 2 presents a summary of these key phenomenon. The specific issues currently affecting mathematical achievements in Vanuatu are also opportunities to improve mathematics achievements at the basic level of education. The findings are discussed below.

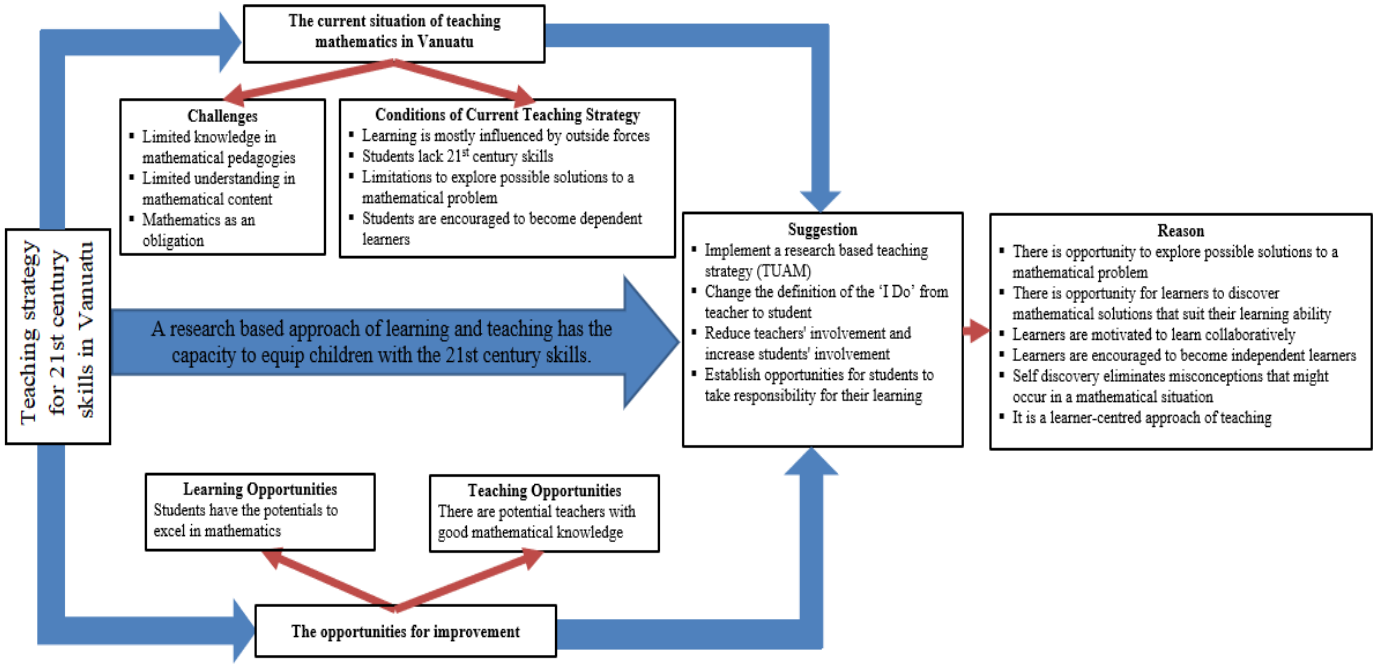

Figure 2. Overview of the Phenomenon Central to this Study's Findings

The Current Situation of Learning and Teaching Approaches to Mathematics in Elementary Schools

According to the Ministry of Education and Training - Republic of Vanuatu (2018), mathematics education in the country is implemented through the traditional 'I do-we do-you do' model of teaching. Many studies, such as Sanga et al. (2004), Jambunathan et al. (2021), Khwanchai et al. (2017), and Asmuss and Budkina (2009), have highlighted this as a teaching approach that motivates students at the beginning of the lesson through imitations or examples to actively participate throughout the learning processes. These studies noted that students learn better when they observe what the teacher does. This study's findings also highlight that students seem to be motivated to learn when they observe what the teacher does beforehand. For instance, two significant categories portray the positive impact of the 'I do-we do-you do' strategy on students: this strategy is very helpful in mathematics lessons as it allows teachers to first show students what they expect from them for them to do it exactly as demonstrated (Table 3); and without examples,

students may not be able to complete any assigned tasks (Table 4). Thus, teachers believe that students learn better through examples, as highlighted by Sanga et al. (2004). These results also reinforce the findings of Darrow and Adamek (2018), Khwanchai et al. (2017), and Alfieri et al. (2011) that as an instructional strategy, the 'I do-we do-you do' strategy guides students in what they should expect as an evidence of successful learning before practising the skills themselves.

Meanwhile, the findings also revealed that although teachers transfer mathematical knowledge to students through this strategy to some extent, this approach also imposes some limitations on learners' achievements. According to Cai and Howson (2012), one of the most important qualities that teachers can help their students develop in the 21st century is the ability to think independently and critically, and learn how to learn. Mayer (2004), Conclin (2007), Miatun and Muntazhimah (2018), Alfieri et al. (2011), and Ojose (2008) observed that for a learner to become a reflective and independent learner, they must be challenged with the opportunity to explore possible ideas themselves to develop the relevant skills. Jambunathan et al. (2021) and Conclin (2007) further pointed out that effective learning can happen only when learners play a major role in constructing their learning.

Indeed, the results revealed that the 'I do-we do-you do' strategy is limited to some extent as does not provide enough opportunities to students to reflect, think, and learn independently. The two interlinked categories–'limitation of the current approach' and 'consequences of the traditional approach'–signify that learning through explanations, where teachers show students how they want them to solve a problem, involuntarily prevents students from exploring other possible solutions to a mathematical problem. Guided by the teachers' established ideas, students do not have the opportunity to explore mathematical solutions themselves, and use their minds to reflect and think about other possible solutions. When students are not challenged to use their minds to construct mathematical ideas, their chances of becoming reflective and independent learners are reduced. Participants' narratives in Table 6 also highlight that since students depend on the teacher to acquire a piece of knowledge, the learning environment then becomes teacher-centred instead of student-centred. Teachers' involvement also prevents two significant components that are necessary for a child's learning. When teachers are more involved, their participation prevents students from taking risks in their learning and prevents them from learning from their mistakes. Further, Tan et al. (2009) noted that taking risks in learning as well as learning through trial and error is an opportunity for students to broaden and deepen their level of understanding. However, the traditional teaching approach does not provide this opportunity effectively.

The Possibilities for Improving the Current Situation

In the 21st century, the foremost imperative qualities that teachers can offer their students are the ability to reflect and think autonomously, learn, be imaginative, and think critically and improve their performance (Cai & Howson, 2012; Jaleniauskienė & Jucevičienė, 2018). Takahashi (2006) stated that for an individual to become an independent learner, as highlighted by these researchers, they must have the opportunity to develop the knowledge and skills necessary for an independent learner. This can be demonstrated by the level of understanding of a mathematical concept that one has. This study's findings show that mathematics education in elementary schools in Vanuatu can be improved by implementing a research-based teaching approach like the TUAM discovery learning strategy.

For instance, the interlink category 'employing a research-based strategy' denotes that when students are challenged with the opportunity to work independently and collaboratively themselves, they can receive the assistance that suits their learning ability from their classmates under the teacher's guidance. Responses from teachers noted that if students are challenged with the opportunity to explore mathematical ideas themselves, they will be able to broaden and deepen the mathematical potential that they have, as highlighted through the interlink category 'the learning opportunity'. As noted in Table 9, teachers believe that effective learning of mathematics occurs when students are placed in a challenging or dangerous zone, and are allowed to explore possible solutions to successfully escape the danger zone using their thinking, demonstrated by the interlink categories 'the learning opportunities', and 'employing a research-based strategy'. They believe that real learning occurs when students are immersed in a situation and are encouraged to explore mathematical ideas encompassing the situation. The experience they undergo to get out of the challenging zone becomes the best teacher that helps them acquire the best solutions to overcome the challenge. Undoubtedly, they will encounter difficulties. Nevertheless, participating teachers conveyed through the themes 'the opportunities' and 'advancing mathematics for the future' that thinking happens only when there is doubt. Where there is doubt, students need time to persevere to deepen their curiosity. The struggle they undergo will allow them to deepen their curiosity and encourage them to develop the ability to take risks in learning. Indirectly, this process of Trying-Understanding-Applying-Mastering allows teachers to model the courage they want their students to have. When teachers allow students to interact with mathematical ideas through such an approach, they are encouraging students to take ownership of their learning and develop their mathematical potentials, as highlighted through the interlink category 'the learning opportunities'.

Participants also conveyed that such an approach to teaching encourages students to develop 21st century skills. The narratives in Tables 9 and 10 highlight that when students are provided with learning opportunities at the appropriate practice level, they will be able to develop 21st century skills, such as critical thinking, problem-solving, and reasoning skills. As Conclin (2007) and Tan et al. (2009) highlighted, discovery learning strategies are teaching strategies that can

increase students' motivation to learn, promote higher-level thinking skills, and provide reasons for learning information. Therefore, if students are guided through such discovery learning processes, they may be able to become reflective and independent learners and demonstrate 21st century skills through their performances.

Interestingly, some participants suggested modifications in the traditional 'I do-we do-you do' teaching strategy. Although both teaching approaches highlighted in this study impacted students' mathematical performance, students' level of thinking when they attempt to solve mathematical problems on their own may differ. As highlighted in Table 10, teachers noted that the definition of the first dimension of the typical 'I do-we do-you do' strategy should be changed from teacher examples at the beginning of the lessons to students' attempts at the beginning of the lesson. Giving students the first opportunity with guided instruction rather than providing examples, demonstrations, or explanations will give them a chance to explore possible solutions to mathematical problems that may suit their way of thinking. This can help in increasing students' involvement while simultaneously reducing the amount of time teachers are involved in the learning processes. As highlighted by Miatun and Muntazhimah (2018), the amount of time allocated to students throughout the learning process reduces the teacher's direct instruction, whereby their role is more determined as a learning coach and learning facilitator while allowing students to construct their knowledge. These emerging ideas highlight the conviction that teachers have towards a research-based approach of teaching, such as the TUAM discovery learning strategy which encourages students to explore mathematical ideas themselves under the teacher's guidance.

Finally, the findings noted that mathematics achievements in Vanuatu can be improved by appropriately enhancing and refining students' mathematical potential. Although children behave differently in many ways, each has the learning potential that makes them unique (Bergeson et al., 2000). The interlink category, 'the learning opportunities', revealed that teachers were conscious that students in Vanuatu possess the potential to acquire mathematical knowledge. However, they can perform better only if these potentials are guided and refined appropriately. Specifically, as highlighted in Table 7, participants noted that students can improve their performance in mathematics if the learning opportunities challenge them to utilise their mathematical potential. That is, students can develop their mathematical potential when they are encouraged through appropriate opportunities to use their minds to discover mathematical solutions in a teacher-guided learning environment. Indeed, the TUAM strategy can provide students with appropriate opportunities to deepen and broaden their mathematical potential.

Conclusion

Drawing on constructivist grounded theory analysis, this study revealed that the level of mathematics achievements in basic education in the Republic of Vanuatu can be improved by leveraging certain possibilities. Necessary efforts should be undertaken for essential activities for bridging the gap between the delivery and acquisition of mathematical content via mathematical pedagogies that allow students to acquire 21st century skills in mathematics. However, these transformations may take time to transpire, as the process of implementing new approaches requires time, planning, strategies, and teachers' motivation to accept changes. Hence, this study calls for a structural and sustainable decision be made on improving the method of teaching mathematics at the level of basic education in Vanuatu. Proven teaching approaches that help stimulate students' mathematical thinking and improve their performance, such as the TUAM discovery learning strategy, should be considered.

Recommendations

First, while this study does not reject the 'I do-we do-you do' strategy, an opportunity should be given to implement the TUAM discovery learning strategy described by Takahashi (2006). Teachers are encouraged to implement the TUAM strategy in their mathematical lessons slowly over time until it accommodates the learning and teaching routines of teachers and students. As noted, this approach can help students to acquire 21st century skills. Hence, the TUAM teaching approach should be encouraged in the mathematics education system in the Republic of Vanuatu. Second, teachers should also be mindful of the instructions they deliver during the first step of this strategy. Specifically, the instructions should guide students on what to do only but not on how to do it. Knowing that this discovery approach of learning and teaching is a student-centred learning strategy, all elementary school teachers should be encouraged to adopt and adapt it as a 21st century mathematical teaching strategy.

Finally, some teachers suggested integrating the TUAM strategy into the 'I do-we do-you do' strategy. Therefore, future research should further examine how these two strategies can be merged and the impact that the new design may have on students' mathematical achievements.

Limitation

The sample population was limited to only two selected urban schools. Different schools in other regions may have different environments, such as rural and urban schools. Hence, the scope of the sample population of the study was anticipated to have some impact on the results of the study.

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Authorship Contribution Statement

Sawah: Conceptualisation, design, analysis, writing. Kusaka: Editing/reviewing, supervision, final approval.

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