The Use of Robotics Embedded in Playful Learning Scenarios in Secondary Schools

Teachers' and Students' Perspectives

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EXPLORE

- The process underpinning playful learning scenarios integrating robotics.
- The learning experience both from the students' and the teachers' perspective.
- The impact of robotics integration on pedagogical practices.

Play, Games, Robots and Learning

When students play games withing the ZPD, a sense of motivation is fostered as they are challenged within their skill level

(Malone, 1980)

ZPD + Game Development = Introduction of Game-Based Learning in Education

(de Freitas 2006, Squire 2003, Tang et al., 2009)

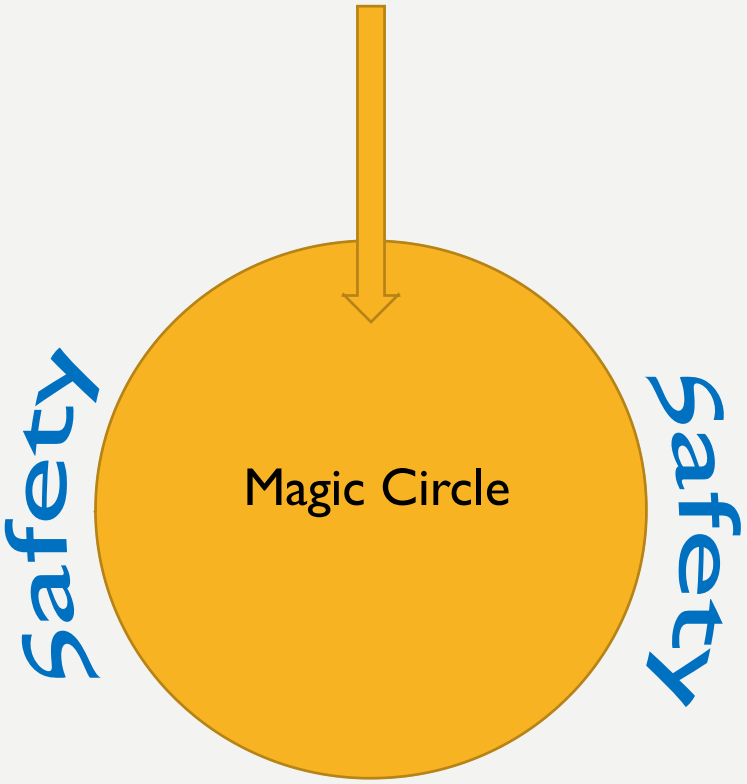
Game Based Learning aids:

- Retention
- Self-constructed learning
- Developing of cognitive and social transferable skills including critical thinking and teamwork

(Boyle et al., 2016; Cojocariu and Boghian, 2014; Hung et al. 2014; Terri 2014, Gee 2007).

Gamification

Playful Approaches



(Huizinga, 1955)

Playful Learning characteristics:

- intrinsically motivated learning
- learning accessed through a spirit of play and experimentation
- embracing failure during play

(Whitton, 2018)

Student-centred Pedagogical Approaches

Stimulate knowledge construction, where emphasis is on **students' active participation in learning** (Baetan et al., 2016; Ertmer et al., 2012; Cannon and Newble 2000).

If it is technology-aided, it can help students **develop 21st century skills**, such as thinking, communication, collaboration, and problem-solving (McCain, 2005; Ertmer et al., 2012).

requires a shift in the teacher's role where the teacher becomes **an active collaborator** by:

guiding discovery;
modelling active learning;
stimulates students to question (Ertmer et al., 2001; Ertmer et al., 2012; Pratt 2008).

LOCAL CONTEXT

All secondary students were exposed to C3 'Computing Competency Certificate', to help them develop core digital fundamentals

(Catania, 2019)

Robotics introduced in an optional secondary subject, Computer Studies, in 2010

(Directorate for Learning and Assessment Programs, 2020)

Although schools invested in new robots, presently they are not well integrated across the secondary school curriculum

This Study

This study sought to investigate robotics use in playful learning scenarios in non-ICT related secondary subjects in Malta

- Two secondary Church school teachers
- With our support they created a pedagogical framework aligned with the curriculum based on the three aspects of playful learning, namely tools, techniques and tactics and integrated them into their planning (Whitton, 2018)

Ozobots were used.

Small enough to move on students' desks, programmed either through drawn colour codes or through block coding

LESSON 1

ACTIVITYPLAN - Teamwork

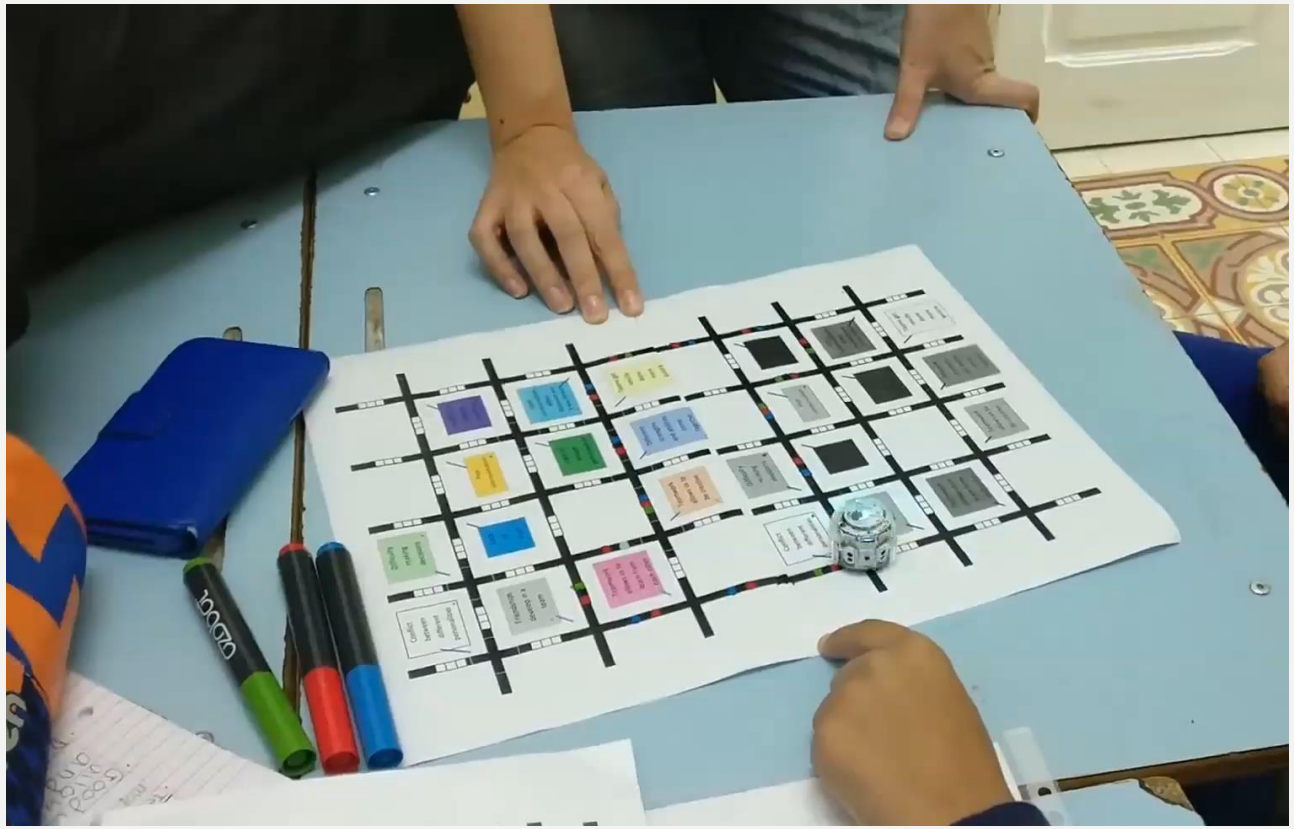
This activity will allow you to think critically and solve the problem to find the correct path to visit either the advantages of teamwork or the problems that could occur in a team only, avoiding the other intersections.

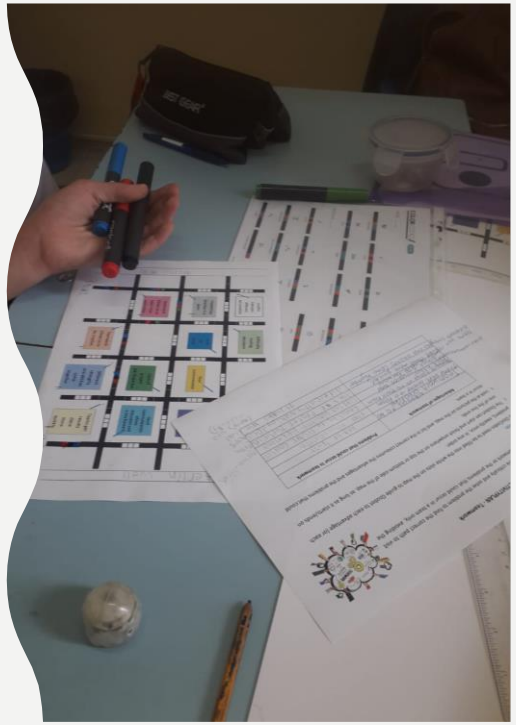
Instructions:

1. The OzoCodes need to be filled into the white slots on the map to guide Ozobot to each advantage (or each problem), exactly once, in any order.
2. The Ozobot can start and finish anywhere on the top or bottom-side of the map, as long as it starts/ends on one of the line ends.
3. Look at the pictures on the map, and list in the correct coloumns the advantages and the problems that could occur in a team.

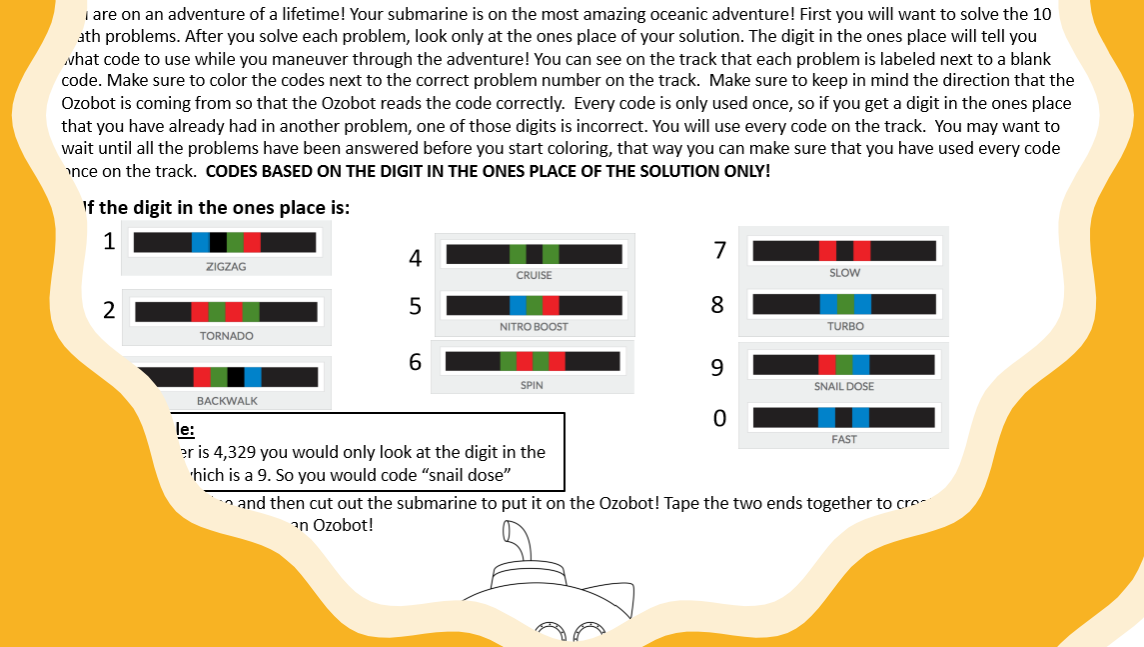
Advantages of teamwork	Problems that could occur in teamwork

Students applied team building concepts learnt in the Prince's Trust Achieve Programme





LESSON 2



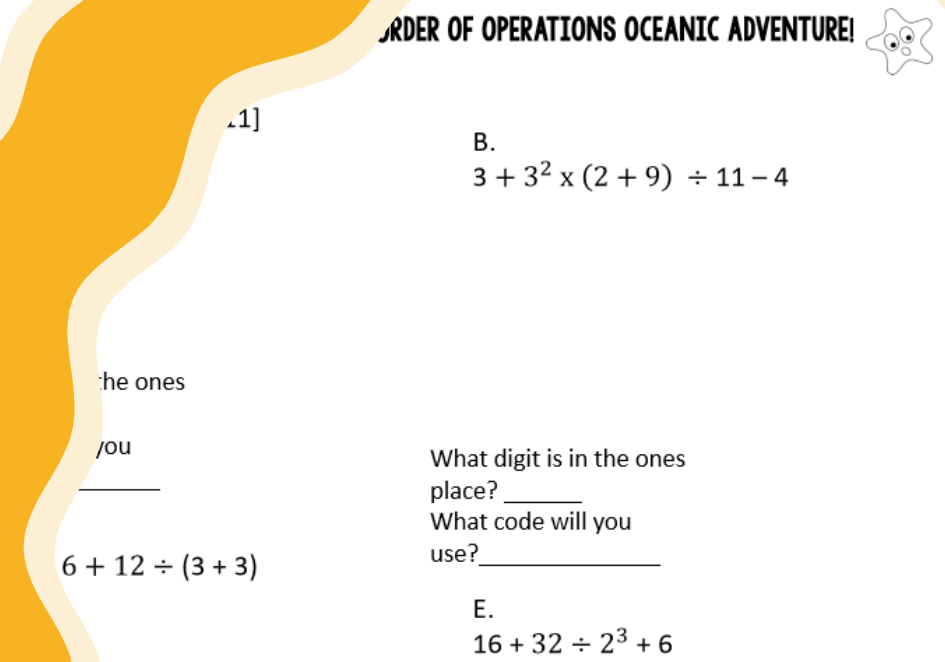
are on an adventure of a lifetime! Your submarine is on the most amazing oceanic adventure! First you will want to solve the 10 ath problems. After you solve each problem, look only at the ones place of your solution. The digit in the ones place will tell you what code to use while you maneuver through the adventure! You can see on the track that each problem is labeled next to a blank code. Make sure to color the codes next to the correct problem number on the track. Make sure to keep in mind the direction that the Ozobot is coming from so that the Ozobot reads the code correctly. Every code is only used once, so if you get a digit in the ones place that you have already had in another problem, one of those digits is incorrect. You will use every code on the track. You may want to wait until all the problems have been answered before you start coloring, that way you can make sure that you have used every code nce on the track. **CODES BASED ON THE DIGIT IN THE ONES PLACE OF THE SOLUTION ONLY!**

f the digit in the ones place is:

1 ZIGZAG
2 TORNADO
BACKWALK
4 CRUISE
5 NITRO BOOST
6 SPIN
7 SLOW
8 TURBO
9 SNAIL DOSE
0 FAST

le:
er is 4,329 you would only look at the digit in the hich is a 9. So you would code "snail dose"

and then cut out the submarine to put it on the Ozobot! Tape the two ends together to cre n Ozobot!



RDER OF OPERATIONS OCEANIC ADVENTURE!

1]

B.
$3 + 3^2 \times (2 + 9) \div 11 - 4$

he ones

ou

$6 + 12 \div (3 + 3)$

What digit is in the ones place? _____
What code will you use?_____

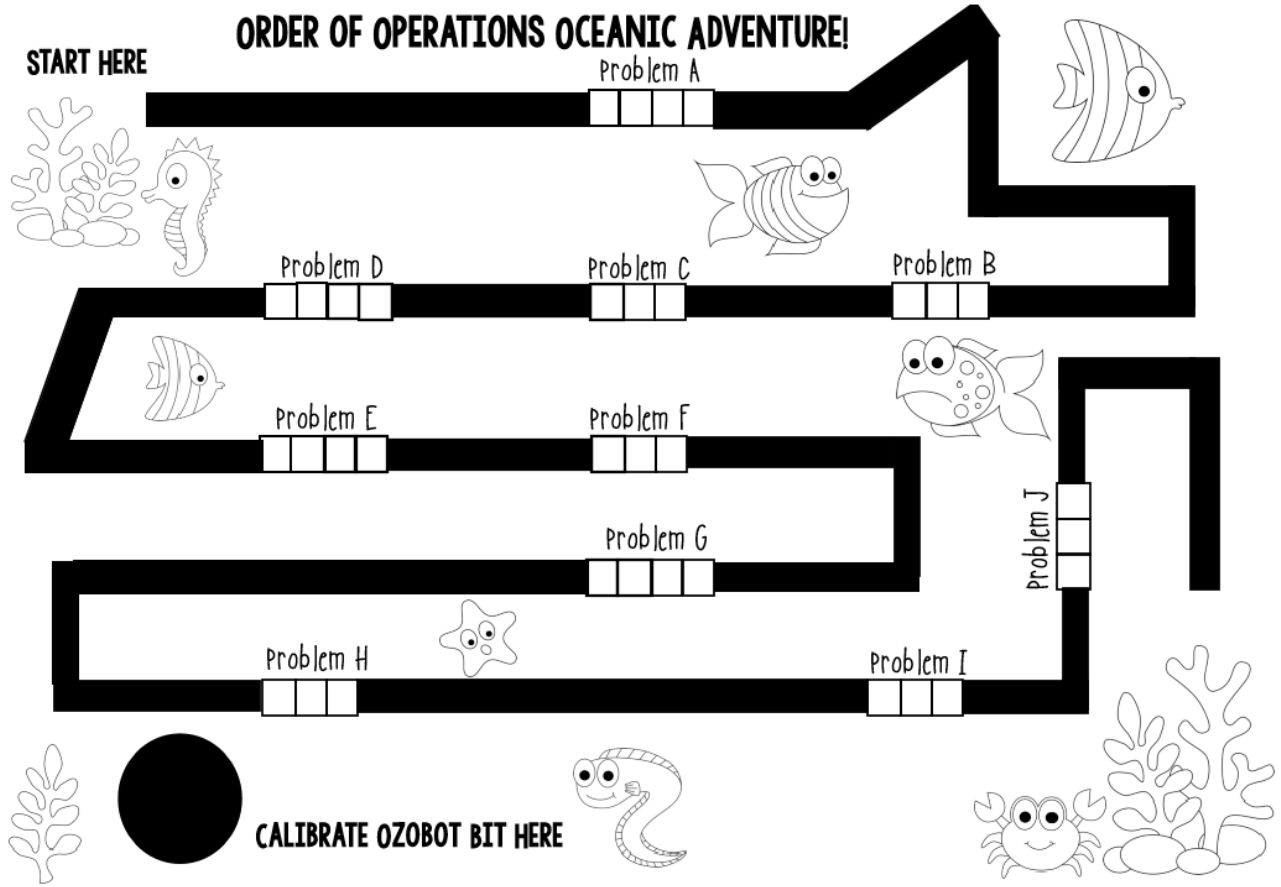
E.
$16 + 32 \div 2^3 + 6$

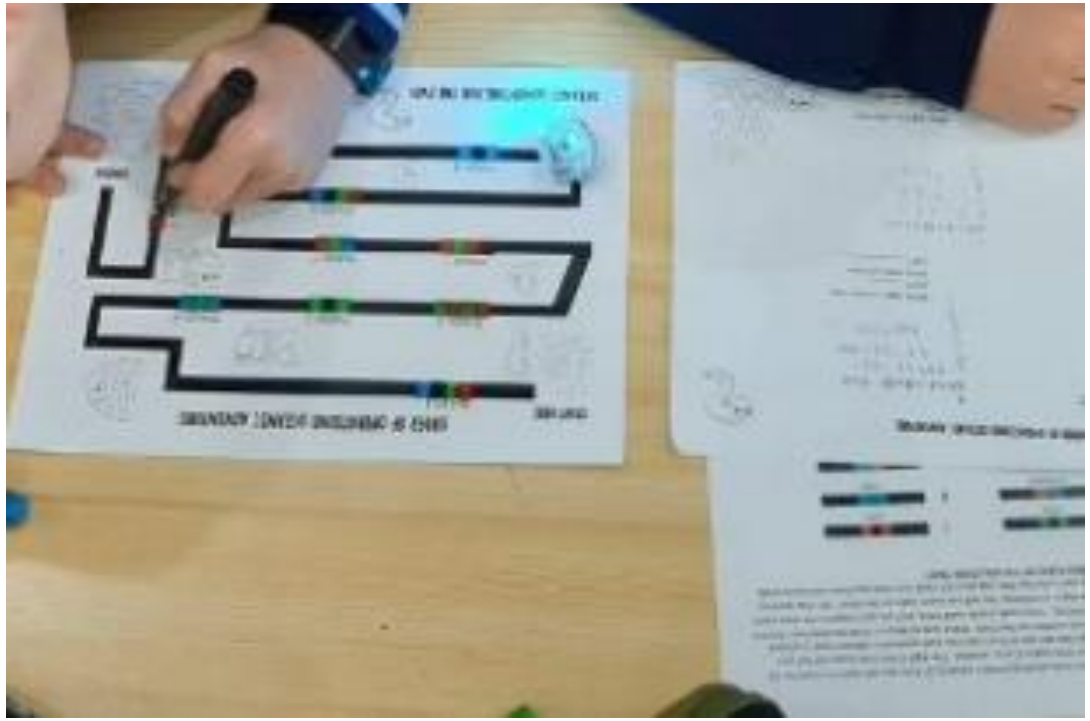
What digit is in the ones place? _____
What code will you use?_____

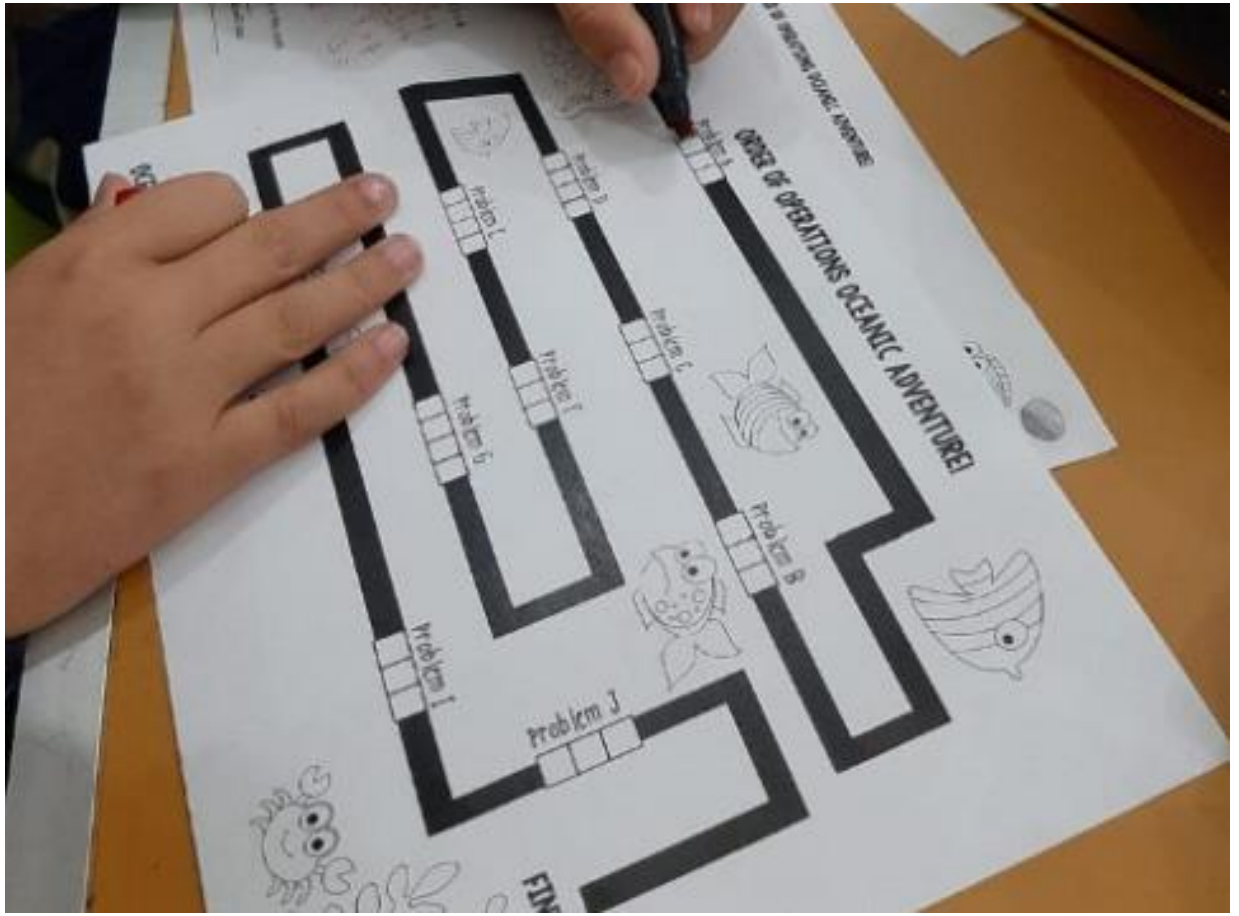
Students applied mathematical concepts to problems, where the numerical answer was linked to a particular colour code

LESSON 2

Ozobot's Pathway







Research Design

A **qualitative methodology** was adopted to enable an in-depth exploration of the implementation and planning process

Data were generated through:

(i) Participant observation in four 50-minute lessons with 60 students aged 11 to 14 years from mixed-ability classes;

(i) Semi-structured audio recorded interviews with two teachers and seven students selected by maximum variability sampling to cater for different ages and abilities, which were transcribed verbatim.

Interview transcripts and observation fieldnotes were analysed by **inductive thematic analysis**, guided by Braun and Clarke's (2006) approach.

Research Design cont…

Prior to thematic analysis, to compare the wealth of qualitative raw data collected from the interviews, **word clouds** were generated from the transcripts (selected for its formatting options)

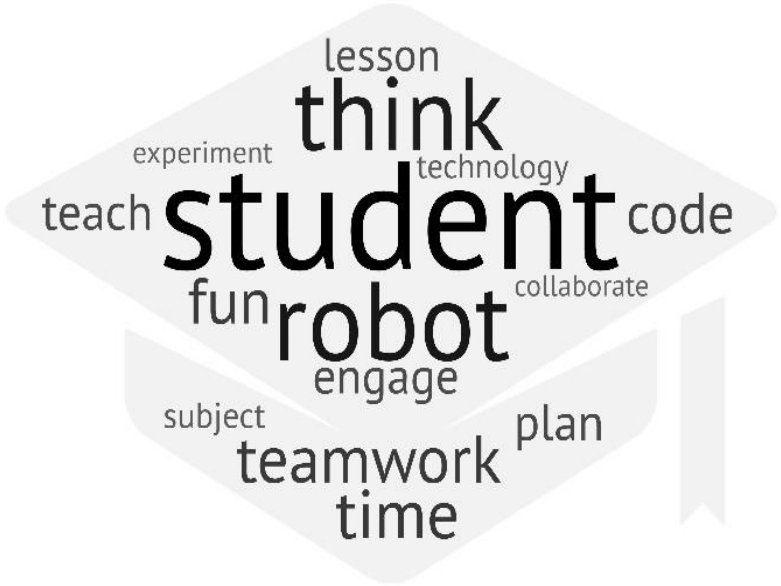
Teachers' and students' responses were dealt with separately.

Common words were eliminated and inflected words were reduced to their word stem by the software

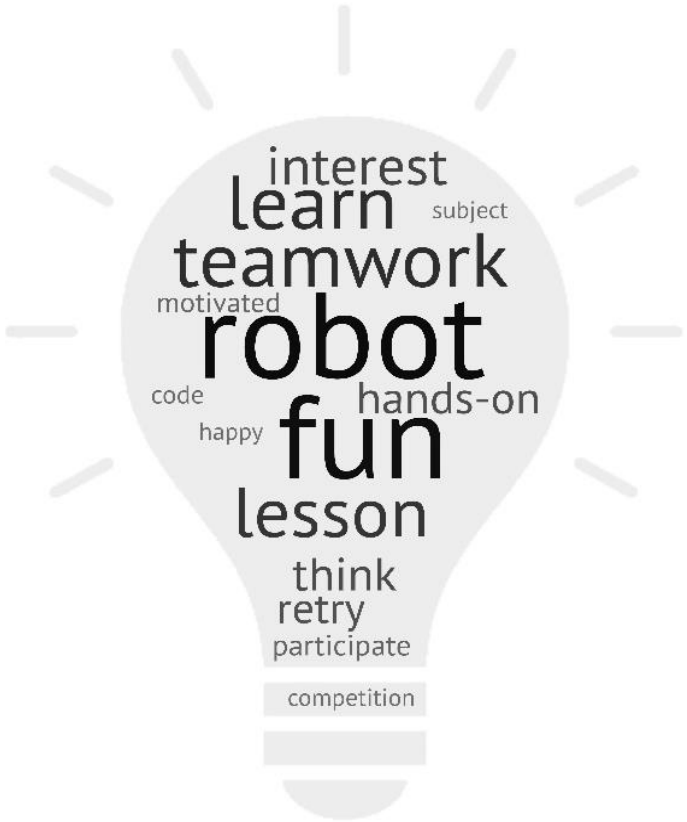
To ensure consistency across word clouds, the **same font and style** were used, whereby the font size represented word frequency

Keywords were generated from the data and a thematic map incorporating themes and sub-themes was drawn up

Results, Analysis and Discussion



Teachers' Word Cloud



Students' Word Cloud

The fifteen most frequent terms that emerged from word clouds indicated the focus of the students' and teachers' responses (Atenstaedt, 2017)

Main Emerging Themes:

Mindset

Learning Curve

Teaching and Learning Approaches

Mindset

'*I was a little sceptical whether I would manage*' (T1)

'*You open your horizons, and you try to avoid staying within your usual methods of teaching*' (T2)

Teachers' Perspective

"the professional teacher needs to realise the potential of new technologies"

(Philips & Condy, 2020, p.214)

both teachers embraced a growth mindset and designed positive learning environments

'when something interests them, they are more ready to listen to you as a teacher…you also build a better rapport…you get to know them better… we try our best to help them, we are not making them learn things by heart' (T1)

Mindset

Students' Perspective

The positive shift in the teachers' mindset was reflected in the students' responses:

'[we] hope [we] get the opportunity to do this again' (S2)
'it felt great' (S5)
'[I] felt very happy…excited' (S7)
'there was energy' (S1)

It was also reflected in the students' behaviour resulting in deeper learning and persistence (Campbell et al., 2019)

'you are having fun learning the topic, you want to learn the topic, you're there, you're also learning other things' (S1)

In this study, teachers adopted an open and positive mindset which impacted their students' mindset, resulting in a more positive approach towards the lesson and better teacher-student relationships. This ripple effect aligns with Dweck's (2006) idea that mindsets do affect human behaviour.

Learning Curve

Teachers' Perspective

Teacher-student partnerships were enabled by digital access as both students and teacher share and grow in these more meaningful teaching and learning experiences (Rosenstock, 2014; Camilleri, 2017).

'you prepare them for independent learning [and]…they would be capable to learn from their own experience…they were learning, and I was learning from them' (T1).

Educational professionals must "educate children to be prepared for life-long learning and sustainability wise thinking" (Hercz et al., 2020, p.46)

'did not memorise it but they learnt the skill' (T1)

mathematics '*did not remain something fearful…it became more tangible, approachable as a subject*' (T1)

collaboration is a skill… they [students] learnt it from when they are young' as 'when…in the world of work you need to know how to collaborate with others…to work as a team' (T1).

Learning Curve

Students' Perspective

'if we fail, we have to see what we did wrong. It was fun seeing what we did wrong…[so] we could do it right' (S6)

'if I did a mistake in the sum, and the robot took a wrong path, most definitely I would rework the sum again' (S1).

Dweck (2006) and Whitton (2018) look at failure as a constructive learning experience where failure is part of a positive learning growth

Students confirmed that they engaged in peer-to-peer communication and collaborated to reach a common goal

'we were working together during the lesson…as a team…skills that we normally don't really use in normal Maths lessons' (S3)

Relating to Bers's (2008; 2010; 2012) work and ideas, both stakeholders underwent a learning curve embracing intellectual and cognitive skills as they underwent the experience of learning by doing things.

Teaching and Learning Approaches

Teachers' Perspective

'*In these types of sessions, it is the children that are at the centre, and the teacher is the one who facilitates the things, the one that helps them arrive to the learning outcome*' (T1).

'*I knew it was going to be a success, knowing the students…it was going to…draw their attention to know more about it*' (T2)

Both educators expressed that building on the students' learning styles and interests is crucial to leaners' involvement in a student-centred approach.

Teaching and Learning Approaches

Students' Perspective

All students affirmed that the lesson met their learning styles

'*a good example of trying different things*' (S2)

'*hands on, something exciting...I think that I definitely prefer this method*' (S1)

'*a fun learning experience…finally [we are] making the decisions here*' (S6)

Students reflected that as they progress to secondary schooling, such opportunities are replaced with more authoritative teacher-talk approaches

'*where you cannot say anything, all you do is just listen to a lesson, sit in a place [and] get bored*' (S1)

The learners' voice was clear that this is not what they want

'*it [lesson] doesn't need to be the normal way, time is changing, you need to change the way. It has been rather the same method for quite some time now*' (S1)

'*the ways of teaching through book…is out of date…[here] we did more instead of learning through the textbook, we learnt more through activities*' (S6)

Data showed that, pedagogies should revolve around the learner and employ playful learning environments that increase engagement and development of 21st century skills.

Conclusion

Teachers' Perspective

More Training is Required

'*[I] had to personally go through the process of how they [robots] work*' (T2)

Mentoring is Needed

'*it is one thing to see and it is another thing when you are actually going to deliver the lesson*' (T2)

Limited Lesson Time

'*these type of activities should be more on the education agenda, because…they are not being integrated enough in the curriculum*' (T2)

Students' Perspective

Intrinsic Motivation

'*if I did a mistake in the sum, and the robot took a wrong path, most definitely I would rework the sum again. As we said competition, I want to get it right*' (S1).

Positive Attitudes and Fun

'*it is more fun to solve the problems…I participated more than I usually do' (S2)*

Both educators adopted a **growth mindset** shifting towards a student-centred approach resulting in a **similar shift** in the student's mindset (Campbell et al., 2019)

Teachers realised that it is **hard to motivate** 21st century students, who are deeply embedded in technology use (Prensky, 2010)

Students are **not passive learners** but want to be part of the learning process with teaching that is **relevant** to them allowing them to develop 21st century **transferable skills** that go beyond the learning outcome

Robotics use was not the ultimate aim, but **a means to an end**, having learning **with** (rather than from) technology

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