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Prize Winner

Citizen Science

Secondary

GoSmashMaths! - An Educational App Using Neuroscience and Neurodesign to Help Reduce Maths Anxiety in Students

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Department for Education

SASTA South Australian Science Teachers Association

Oliphant Science Awards Submission

Category: Citizen Science

Project Title: GoSmashMaths! - An Educational App Using Neuroscience and Neurodesign to Help Reduce Maths Anxiety in Students

WILLEM KOEHNE
Pulteney Grammar School

Acknowledgments

This project would not have been possible without the support of Dr. Fiona Kerr (Neuroscientist), who provided guidance on neurodesign and engagement psychology; Rebecca Starling (Educator), for strategic input on inclusive classroom learning; and Scott Xi (UX Developer), who helped apply accessibility principles in the app's interface. Thank you also to the 60 students, 10 teachers, and 70 survey participants who helped shape GoSmashMaths! through in-class testing and feedback.

Background and Research Question

Mathematics anxiety affects over 100 million children globally and begins as early as age six. In Australia, declining maths confidence has led to a drop in OECD rankings from 11th to 29th. Based on insights from neuroscience and neurodesign, this project explores the research question:

To what extent can neurodesign be used to create educational resources that engage all children, especially those who find maths challenging or are neurodiverse?

This question was investigated through the development of GoSmashMaths! - a gamified learning app that builds on the 2024 Oliphant Science Awards prize-winning physical games (Figures 1-3) to address maths anxiety using neurodesign principles.

Rationale

Educational neuroscience highlights how emotional states like anxiety affect cognition, attention, and memory. When students feel overwhelmed or embarrassed, their ability to process information declines. GoSmashMaths! was specifically designed to interrupt that pattern. By using familiar game mechanics, fun, and highly visual pathways, the app reduces cognitive pressure while improving confidence. Neurodiverse students in particular benefit from the clean layouts, structured routines, and predictability the app provides, helping reduce sensory overload and build mastery over time.

This project also connects to broader global discussions around inclusive design, digital literacy, and the urgent need for educational equity in STEM fields. With declining performance and increased anxiety around numeracy, many learners - especially those who are neurodiverse - require tools that are more adaptive, emotionally supportive, and evidence-based. By investigating how visual and emotional design principles impact student confidence, GoSmashMaths! contributes to an emerging field where education, psychology, and technology intersect.

I chose to create GoSmashMaths! based on the increasing amount of research linking maths anxiety to cognitive overload and lack of confidence in their own ability. Using principles from neuroscience (including visual processing and cognitive load theory), GoSmashMaths! applies design strategies to improve learning confidence and emotional regulation.

By incorporating research-backed neurodesign features - such as simplified layouts, high-contrast visuals, and interactive reinforcement - GoSmashMaths! provides students with a safe, supportive environment in which to practice key maths skills.

Process

Project Steps and Collaboration

Planning and Research

- Initial concept based on investigating maths anxiety, neuroscience, and neurodesign.
- Award-winning card and board games (Figures 1-3) formed the prototype foundation.

Design and Development

- Wireframes and gameplay flow mapped in Figma.
- Interface design aligned with neuroaesthetic and accessibility principles.

Programming and Prototyping

- Developed using React Native and Firebase.
- Features include drag-and-drop tasks, progress tracking, adaptive gameplay, and real-time feedback (Figures 9-12).

Testing and Feedback

The project followed a clear development arc: GoSmashMaths! began as a series of physical card and board games created for the 2024 Oliphant Science Awards, where they received three Highly Commended Awards. Building on this success, testing expanded into classroom trials. Once the core concepts were validated in analogue formats, development progressed into a digital app in 2025, with testing conducted across three schools and shaped by both qualitative feedback and Google survey data.

- In-class testing with 60 students and 10 teachers (Figure 4).
- Google survey completed by 70 participants.

Data Collection and Analysis

- Type of Data: Mixed-method - Google Form survey and in-person feedback.
- Participants: Students (Years 3-6) and teachers.
- Collection Methods: Google Forms, in-class observation, written reflections.

Key Results:

- 92% found the games engaging.
- 67% reported increased maths confidence.
- 85% felt motivated by animated rewards (Figure 8).
- Teachers reported reduced anxiety in "reluctant learners.

Data Summary

Results in both the in-class testing as well as the three surveys (Years 3-4, Years 5-6 and teachers) indicated similar patterns: students improved under low-pressure, goal-focused game play.

Neurodiverse students in particular responded well to simplified layouts, dynamic animations, and structured progress feedback loops. Teachers indicated these tools not only facilitated academic concentration but enhanced students' mood and collaboration between groups. This suggests that design plays an important role in defining educational behaviour than content delivery alone.

GoSmashMaths! Card + Board Games

Subtraction Card and Board Game

(Achieved an Oliphant Science 2024 Award)

Figure 1. GoSmashMaths Minus Madness! Card Board Game is a subtraction-focused game featuring calming colours, bold numbers, and clear pathways to guide players through subtraction challenges. Designed with neurodiverse learners in mind, it reduces anxiety and promotes confidence in solving subtraction problems.

GoSmashMaths! Card + Board Games

Addition Card and Board Game

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Figure 2. GoMashMaths! All Adds Up! Card Board Game (focuses exclusively on addition, using colourful boards and intuitive gameplay to make learning addition fun and accessible. The game's design fosters engagement and confidence by encouraging incremental progress through neurodesign principles.

GoSmashMaths! Card + Board Games

Addition + Subtraction Card and Board Game

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Figure 3. GoSmashMaths! Plus or Minus? Card and Board Game combines addition and subtraction in an engaging, fun card and board game designed to teach foundational maths skills. Its vibrant, colour-coded pathways and neurodesign-inspired visuals reduce cognitive load and enhance usability, particularly for neurodiverse learners.

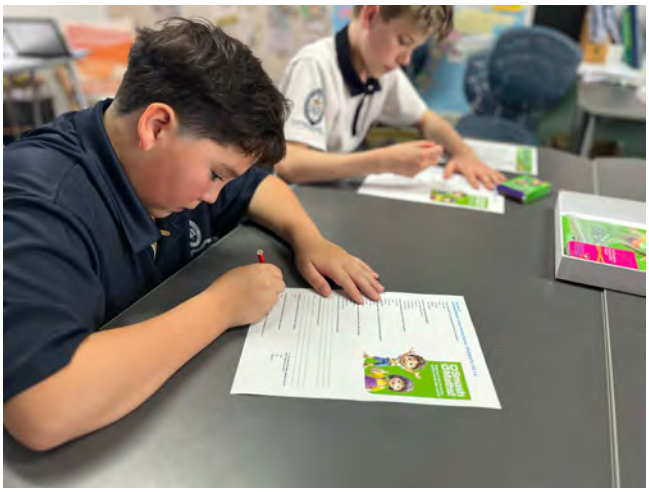


Figure 4. GoMashMaths! All Adds Up!, Minus Madness and Plus or Plus or Minus Card and Board Games - User Testing in Action!

These photos capture students testing the games and completing feedback surveys, which informed my app's operational mechanics and highlighted the effectiveness of neurodesign principles in engaging students during gameplay.

GoSmashMaths! App Prototype Design

Landing Page Design and UX Development

The GoSmashMaths! landing page welcomes users with vibrant colors, the GoSmashMaths! logo, and friendly avatars setting a fun, relaxed scene with a relatable tone. The design focuses on simple navigation, accessibility and inclusivity, encouraging students to be eager to dive into their GoSmashMaths! learning journey with confidence and excitement.

Simplified navigation and avatar selection on the Pre-Game Selection Screen in the GoSmashMaths! app prototype. This design allows the user to play in their own time, reducing cognitive load - allowing users to intuitively choose their game and avatar.

Figure 5.
Logo: Centered at the very top of the screen, the GoSmashMaths! logo is prominently displayed - bright and colorful to grab attention.
Avatars Carousel: a horizontal carousel where users can swipe through and select different friendly character -which hero different math games.

GoSmashMaths! App Prototype Design

Pre-Game Selection Page Design for UX Development

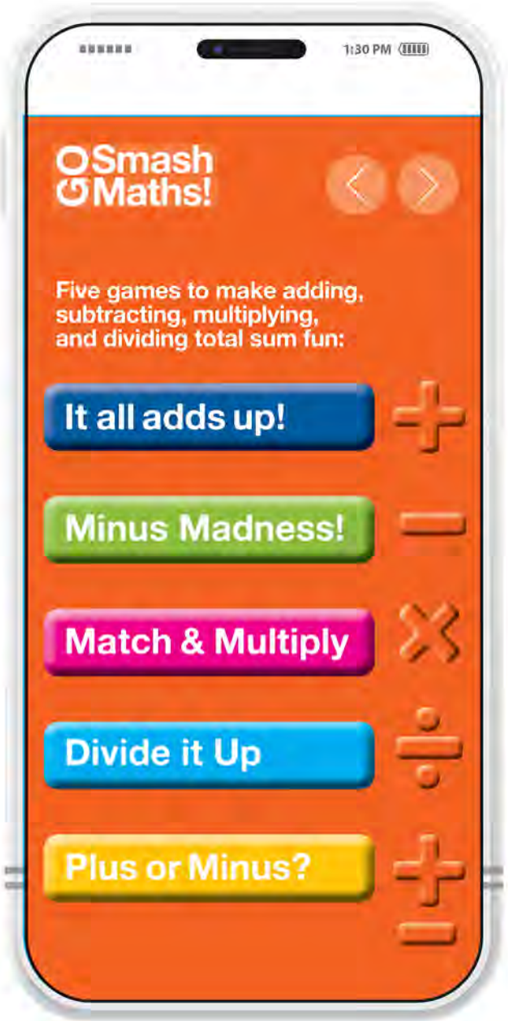
The selection page provides users with an intuitive way to choose the GoSmashMaths! game they would like to play and an avatar. Each game is represented with a vibrant screen featuring its name, description, and associated game avatars. This user-friendly design simplifies navigation and reduces cognitive load, ensuring learners can jump into their preferred game right away.

Simplified navigation and avatar selection on the Pre-Game Selection Screen in the GoSmashMaths! app prototype. This design allows the user to play in their own time, reducing cognitive load - allowing users to intuitively choose their game and avatar.

Figure 6.
Game Name: Displayed prominently at the very top of the screen, the GoSmashMaths! title is bright and colourful, designed to grab attention and set an engaging tone.
Pre-Game Selection Screen: this screen allows users to choose their math game and avatar, setting the stage for a fun and interactive learning experience
Avatars Carousel: a horizontal carousel where users can swipe through and select different friendly character -which hero different math games

GoSmashMaths! App Prototype Design

Selection Page Design for UX Development



Game Selection

The game selection page provides users with an easy-to-navigate interface, featuring high-contrast buttons and clear icons for accessibility. Each button represents a different GoSmashMaths! game (eg. Minus Madness, Plus or Minus, It all adds up!) with a brief description of the game, making it simple for GoSmashMaths! users to select the game they would like to play.

Game selection buttons, each representing a different GoSmashMaths! game, designed with high-contrast colours and friendly icons for accessibility and engagement.

Figure 7.
Game Selection Buttons: Below the avatars, there are five large, rectangular buttons, each representing one of the games (Minus Madness, It All Adds Up, Plus or Minus?, Divide it Up, Match and Multiply). Each button includes:
An icon representing the game (e.g., a subtraction symbol for Minus Madness).
A brief description below the icon explaining the game's focus.

GoSmashMaths! App Prototype Design

Feedback Loops

The GoSmashMaths! app's feedback system includes motivational pop-ups and animations to encourage and guide students to keep going - and that they're smashing maths! Avatar-driven messages like 'Great job!' and 'You're a numbers ninja!' increase maths confidence, while hints such as 'A clue! A tiny addition will open the door!' provides relaxed, 'thought bubble' hints and guidance. Dynamic animations such as paper planes or rockets make the maths experience engaging and reinforce positive learning experience (without realising it!).

Figure 8. In-Game Feedback & Encouragement Wireframe Description

Layout:

- Avatar Pop-Up: When a player makes a correct move, a speech bubble appears next to the avatar with encouraging text (e.g., "Great job! Keep it up!").
- Achievement Animation: Small animations (like confetti or stars) appear on the screen when a player successfully solves a problem or reaches a milestone.
- Error Management: If a player makes a mistake, a subtle prompt appears at the top or centre of the screen with an encouraging message and a hint (e.g., "Try subtracting again!").

GoSmashMaths! App Prototype Development

Landing, Selection & Settings Pages

This section showcases the game's landing page, selection page, and settings page. When the app loads, a random landing page is displayed first. After the player clicks the centre of the screen, they enter the game selection area (defaulted to Plus or Minus). Players can swipe left or right (or tap buttons) to choose a game.

The settings menu can be accessed from any page except the landing page, and its background colour matches the previous scene colour. Within the settings menu, players can toggle the background music and sound effects, check score rankings, and quickly launch their desired game.

Landing, Selection & Settings Pages

You'll meet the bright, smiling, animated GoSmashMaths! avatars when launching the app - on bold landing screens - everytime you visit. Game selection is intuitive - users swipe to explore the other games titles. Settings allow users adjust sound, view scores, and easily navigate back to the game selection page, making it an uncomplicated and fun user experience.

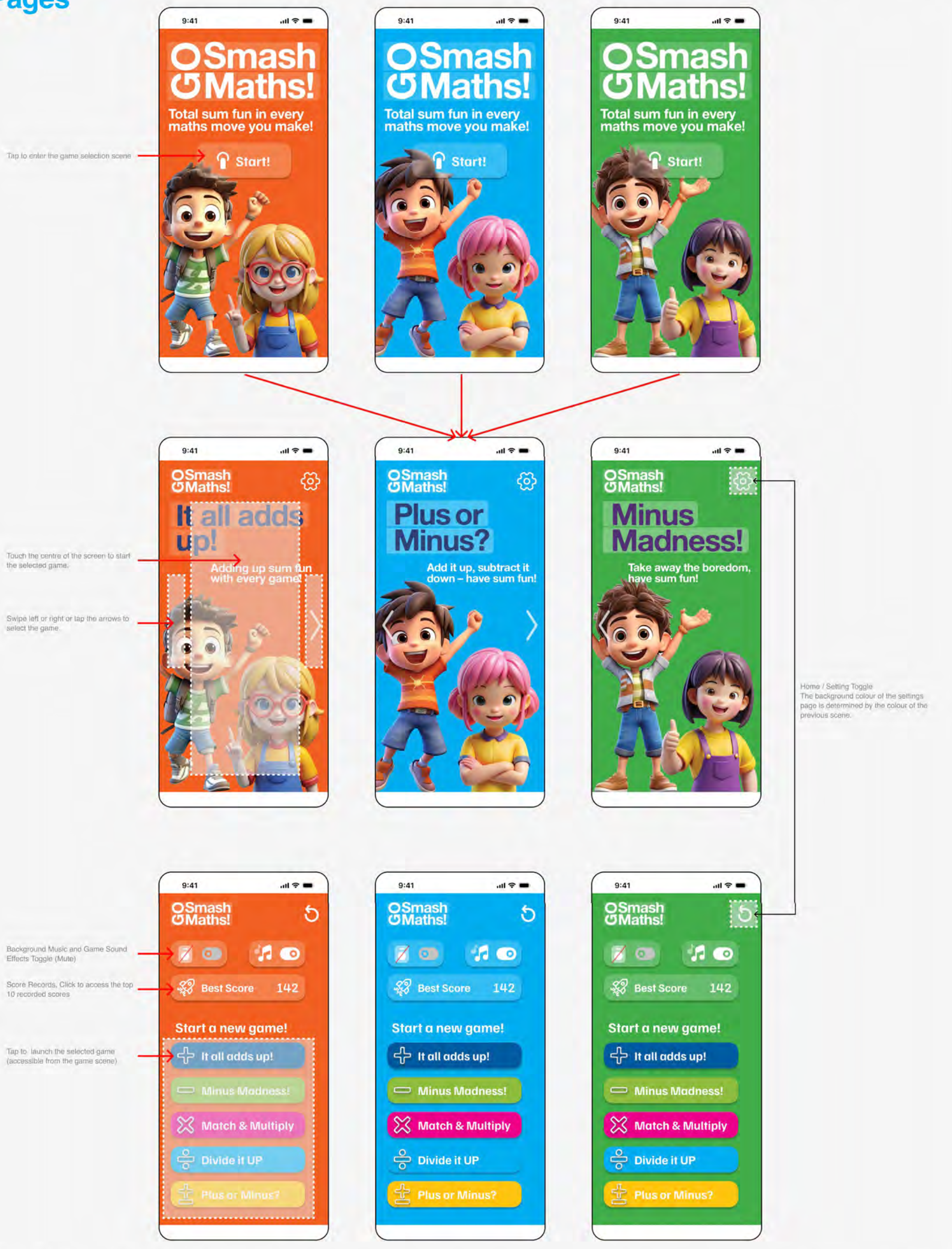


Figure 9. Transitioning to an App Prototype
As part of my project's evolution, my GoSmashMaths! physical card and board games were transitioned into an app prototype, aligning with neurodesign principles to ensure a seamless and engaging user experience for students. The screenshots show the GoSmashMaths! app's visual interface - the development included user feedback from teachers and students though my realtime, in-class gameplay sessions, educators, IT expersts and a neuroscientist.

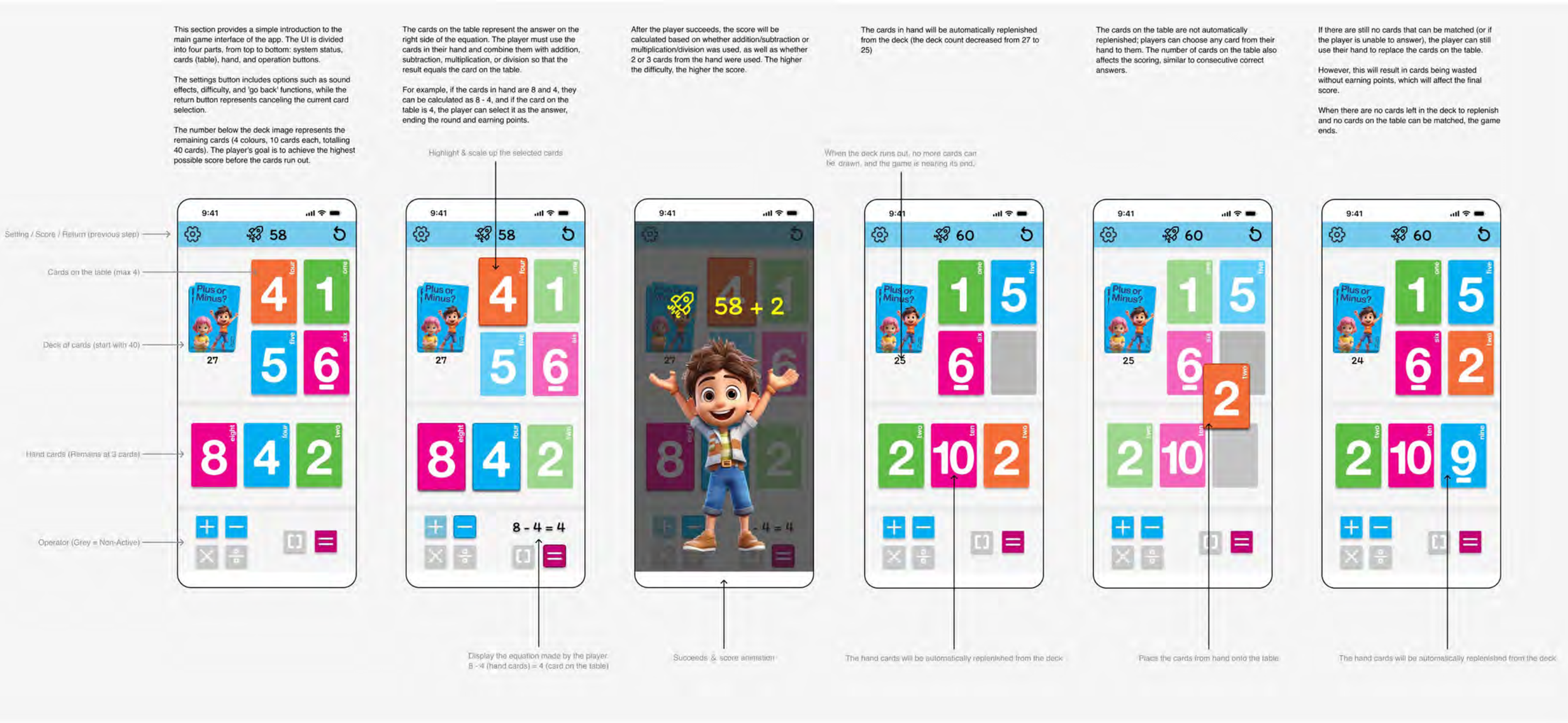
GoSmashMaths! App Prototype Development

Introduction to the main game interface

Figure 10. Introduction to the Main Game Interfac

GoSmashMaths! app prototype's main game interface introduces players to an interactive and visually engaging maths experience. Features include a clean, simple, but vibrant card display for problem-solving, a progress tracker, and dynamic avatar animations for feedback.

Cards are played by matching operations to targets, reinforcing learning through instant feedback and score updates. The layout is clear and accessible, with intuitive controls and clear visual indicators for actions like matching, selecting, or reshuffling cards.



GoSmashMaths! App Prototype Development

Main Game Interface

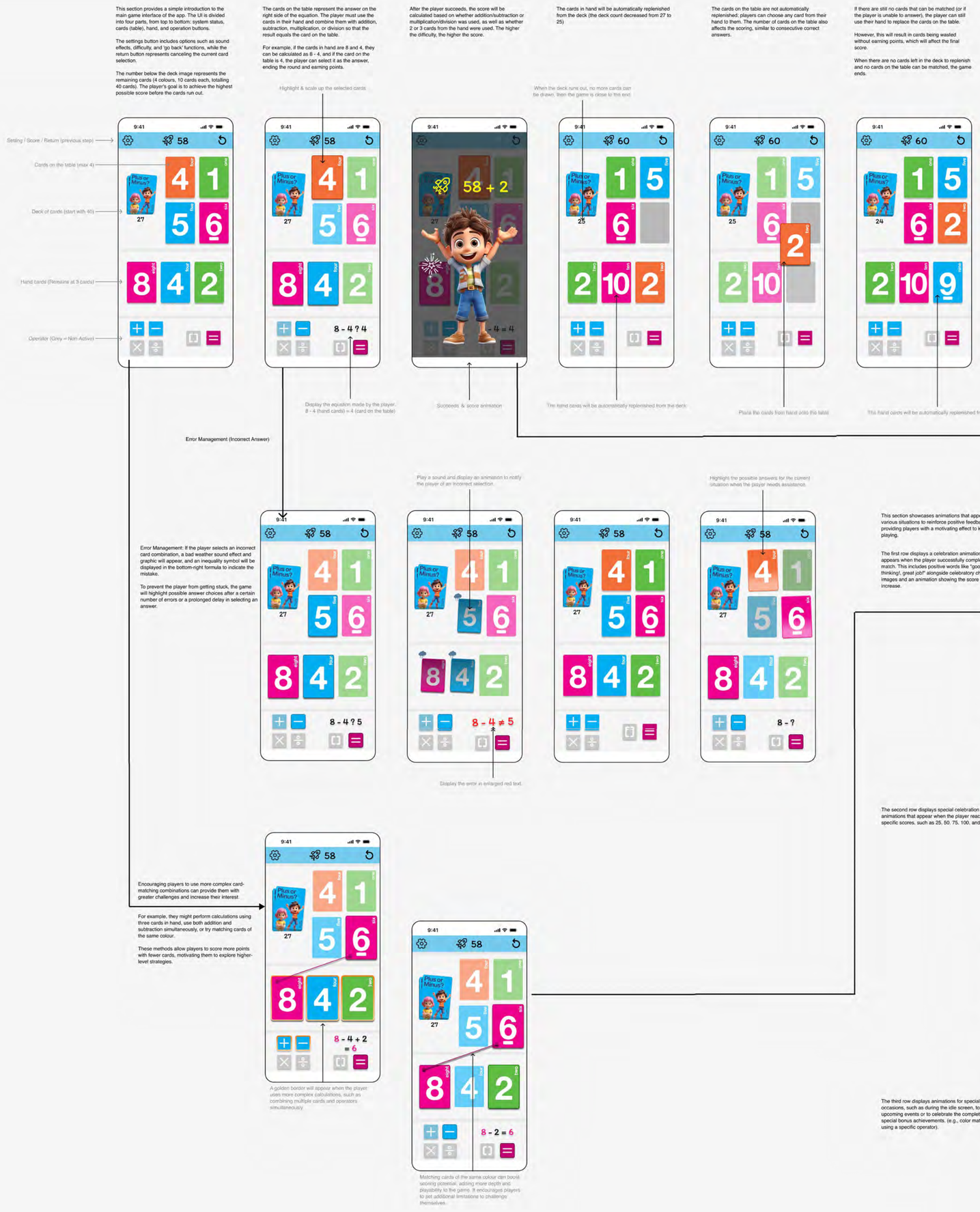


Figure 11. Main Game Interface and Feedback System

GoSmashMaths! main game interface provides a dynamic and interactive space for solving maths challenges. Players engage with clean, uncomplicated, simple cards and bright, positive avatars, guided by clear instructions and responsive animations. The feedback system incorporates 'feel good' messages such as 'Good thinking!' and 'You're a numbers ninja!' to reinforce positive involvement in the game/s. Dynamic content and animations such as rockets or balloons celebrate successes, while subtle hints and 'thought bubble' encouragement messages gently guide students to try again, creating a supportive and rewarding space for all learning levels.

GoSmashMaths! App Prototype Development

Feedback Loops

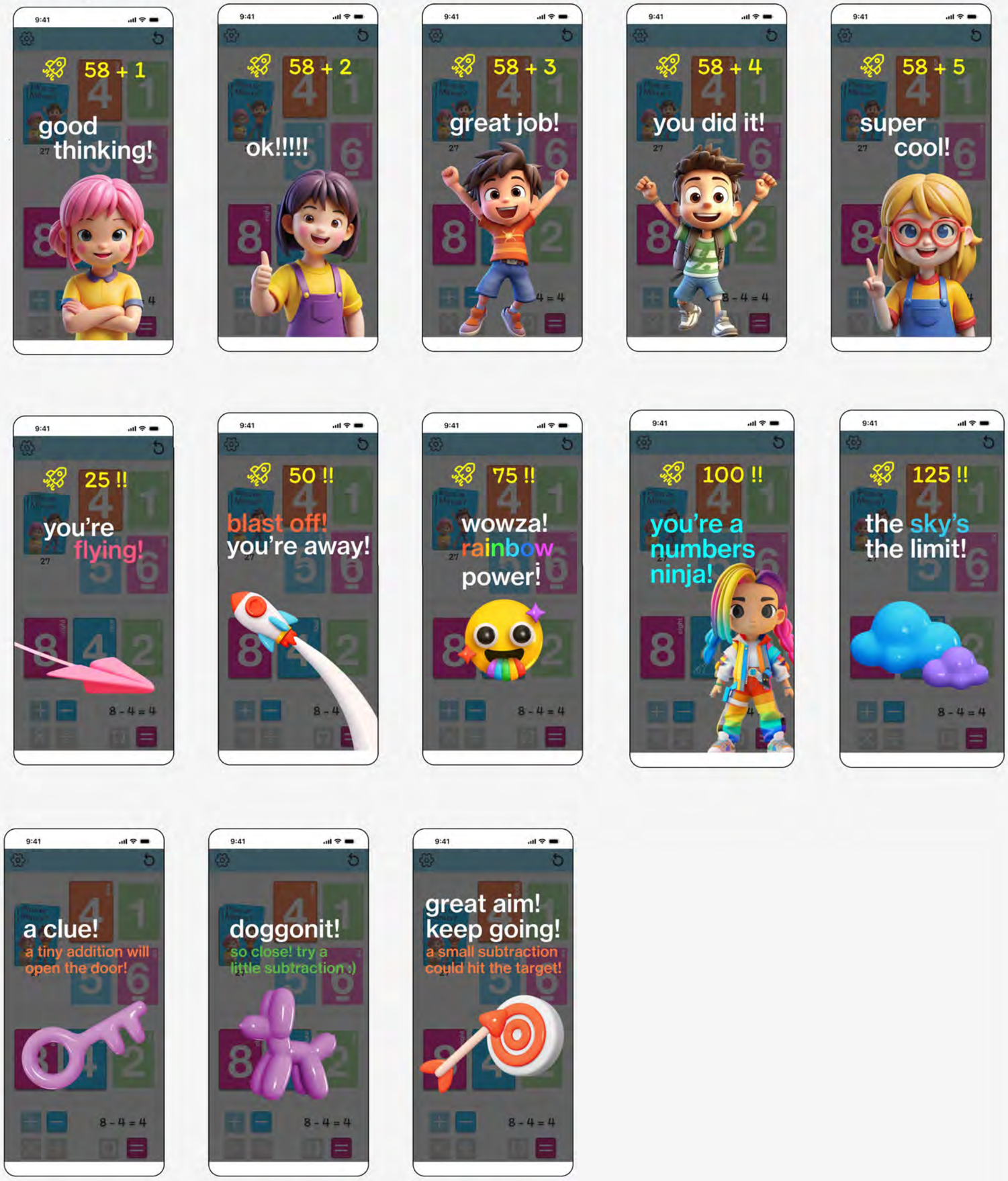


Figure 12. Feedback Loops in Gameplay
GoSmashMaths!'s feedback system uses encouraging natural, conversational messages, animations, and interactive visuals to guide players through their maths challenges. Phrases like'thought bubble' quotes/ messages, like 'You're flying!' and 'Wowsa! Rainbow power!' are big words of encouragement for students and acknowlege their achievements, while hints like 'A tiny addition will open the door!' provide subtle guidance. GoSmashMaths!'s avatars, animations, and bright, modern visuals keep users motivated, connected and engaged. It's a positive, supportive learning space - made for Generation Zs and Generation Alpha and anyone wanting to relax with maths.

Data Summary (cont'd)

Metric	Percentage/Feedback
Engagement (Years 3–4)	92% found the games fun and engaging.
Engagement (Years 5–6)	100% found the games fun and engaging.
Accessibility (Rules easy to follow)	87% (Years 3–4), 75% (Years 5–6).
Maths Anxiety Reduction	67% of students felt more confident in maths.
Interest in App Transition	89% of students supported the transition to a GoSmashMaths! app.

Students responded positively to motivational feedback. Quotes included:

"Everything was so fun, I want to play it again!"

"Hearing 'You're smashing it!' made me want to keep going even when I got stuck."

Teachers noticed high engagement even during end-of-week lessons and improvement in students typically disengaged from maths.

Findings and Conclusions

User feedback demonstrated that neurodesign principles were successful in reducing cognitive load and improving motivation. The adaptive learning pathways supported diverse learning styles, and error-friendly reinforcement encouraged persistence.

Terms such as cognitive scaffolding, neuroaesthetics, feedback loops, and adaptive learning were embedded in app logic and user interface.

Relevance and Impact of Results

GoSmashMaths! also holds potential for use in regional schools where access to tailored learning resources is limited. Because the app can be used offline, it supports equitable access and flexibility across diverse learning environments. Teachers in testing environments expressed interest in using it during small group rotations, intervention blocks, or as revision support for students with learning gaps.

GoSmashMaths! is not just a game - it's an invitation to rethink how maths can be taught. Traditional systems often reward speed and memorisation, which does not suit all students. This app takes the opposite approach: slowing things down, allowing mistakes, and rewarding persistence. Teachers have remarked that students using GoSmashMaths! games were more focused and less anxious, and the app's flexibility will allow for individual, group, or classroom use. It can be used during independent learning sessions, as a warm-up, or for revision.

As the student designer of GoSmashMaths!, I learned how scientific thinking can extend beyond traditional labs. Working with Dr. Fiona Kerr (Neuroscientist) and Scott Xi (Developer), I saw how user feedback, research, and design all intersect. Gathering and analysing data helped me see how citizen-led research can solve real-world problems - especially when driven by empathy, testing, and iteration.

It was challenging but rewarding to take constructive criticism and turn it into something better.

Translating the logic of a board game into an app taught me to think in systems, not just ideas, and I became more confident communicating with adults, asking for feedback, and standing behind my choices as a designer and researcher.

GoSmashMaths! also helped me learn about the power of citizen-led research. Gathering, analysing, and applying real-world data provided valuable insight into how end users shape the success of a product. It reinforced that scientific projects can come from students, and that educational innovation isn't only a top-down process. The outcome has already prompted discussions with teachers around integrating GoSmashMaths! into differentiated classroom instruction, particularly for students with anxiety or learning differences.

The findings show that neurodesign offers a promising solution to engagement issues in STEM learning. GoSmashMaths! is applicable in both neurodiverse and mainstream classrooms and adaptable for use across various platforms and age groups.

By demonstrating how design and neuroscience can work together, this project provides a model for future educational resources in Australia and globally.

GoSmashMaths! does not just support individual learning - it offers a practical tool for schools seeking to address broader issues of engagement, anxiety, and curriculum equity.

Teachers who tested the prototype reported greater inclusion of neurodiverse learners, reduced behavioural disruptions during maths sessions, and increased willingness among students to collaborate.

This project has already prompted conversations within participating schools about how educational technology grounded in neuroscience can be incorporated into Tier 2 intervention, catch-up programs, and broader school wellbeing strategies.

Future Directions

Before this project, I thought science was mainly about experiments in labs. But now I see it as a mindset - one that can be used in design, education, and empathy-driven problem solving. This project helped me see how creative thinking and evidence-based testing can go hand in hand.

- Because app development is complex and expensive, my goal is to complete and launch GoSmashMaths! in 2026, after I finish Year 12 later this year.
- February 2026 Launch: Final app release with updated functionality.
- GoSmashScience! and GoSmashWords!: Neurodesign applied to STEM and literacy.
- AI-Personalisation: Scaffolding based on user data.
- Broader Testing: Inclusion of regional schools.
- Accessibility Additions: Voice navigation, haptic cues.

The neurodesign framework behind GoSmashMaths! is not limited to maths and numbers. Its success has encouraged the design of GoSmashScience! and GoSmashWords! - future tools aimed at tackling learning challenges in STEM and literacy.

Because the app is modular and adaptable, its scaffolded structure and visual design can be retooled for topics like fractions, algebra, ecosystems, grammar, or even critical thinking.

With voice navigation, haptic feedback, and offline usability, GoSmashMaths! can also serve students in remote, regional, and low-connectivity settings - making it a scalable tool for educational equity.

Visual Figures:

- Figures 1-3: Award-winning board game prototypes (Appendix Pages 1-3)
- Figure 4: In-class user testing (Appendix Page 4)
- Figures 5-7: App landing page and game selection screens
- Figure 8: Motivational animations and feedback loop examples
- Figures 9-12: Sample gameplay flow and maths task interaction

Sources and Appendices

A full set of visual, research, and interview appendices has been submitted as supporting material in a single PDF.

- Appendix A: Visual Figures (Pages 1-13)
- Appendix B: Google Survey Graphs and Written Feedback (Pages 14-30)
- Appendix C: Student and Teacher Testing Responses (Pages 31-64)
- Appendix D: Expert Interviews – Dr Fiona Kerr, Rebecca Starling, etc. (Pages 65-102)
- Appendix E: Reference List (Page 107)

Conclusion

GoSmashMaths! demonstrates that young people can contribute to real scientific and educational progress. Through structured inquiry, cross-disciplinary thinking, and user-centred development, this project illustrates the power of citizen science not just to measure problems, but to creatively solve them. This experience has shown that design thinking - when backed by research and directed by feedback - can help break down barriers that many students face when learning mathematics.

GoSmashMaths! is a student-developed, research-driven app that shows how design psychology and citizen science can improve maths confidence. Its findings are both measurable and applicable and lay the foundation for future apps across STEM and education.

With ongoing development and classroom integration, GoSmashMaths! has the potential to become a powerful tool in rethinking how young people learn - and feel - about maths. And most importantly, helping to reduce maths anxiety in students.

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APPENDIX A

GoSmashMaths! Visuals

Award-winning board game photos

User testing in-class

App UI mockups: landing page, game selection, feedback loop

GoSmashMaths! Card + Board Games

Subtraction Card and Board Game

(Achieved an Oliphant Science 2024 Award)

Figure 1. GoSmashMaths Minus Madness! Card Board Game is a subtraction-focused game featuring calming colours, bold numbers, and clear pathways to guide players through subtraction challenges. Designed with neurodiverse learners in mind, it reduces anxiety and promotes confidence in solving subtraction problems.

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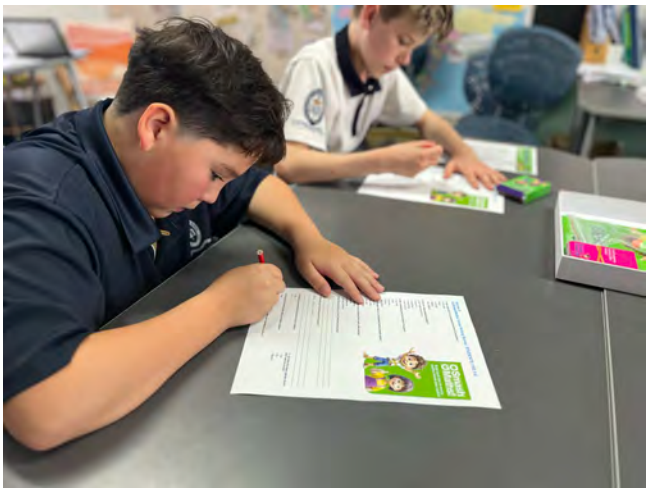

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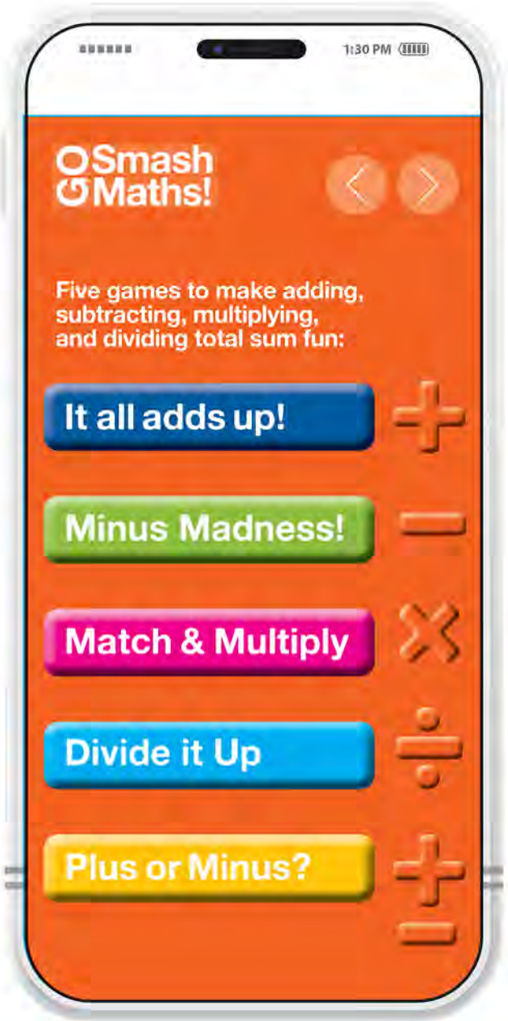

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Layout:

- Avatar Pop-Up: When a player makes a correct move, a speech bubble appears next to the avatar with encouraging text (e.g., "Great job! Keep it up!").
- Achievement Animation: Small animations (like confetti or stars) appear on the screen when a player successfully solves a problem or reaches a milestone.
- Error Management: If a player makes a mistake, a subtle prompt appears at the top or centre of the screen with an encouraging message and a hint (e.g., "Try subtracting again!").

GoSmashMaths! App Prototype Development

Landing, Selection & Settings Pages

This section showcases the game's landing page, selection page, and settings page. When the app loads, a random landing page is displayed first. After the player clicks the centre of the screen, they enter the game selection area (defaulted to Plus or Minus). Players can swipe left or right (or tap buttons) to choose a game.

The settings menu can be accessed from any page except the landing page, and its background colour matches the previous scene colour. Within the settings menu, players can toggle the background music and sound effects, check score rankings, and quickly launch their desired game.

Landing, Selection & Settings Pages

You'll meet the bright, smiling, animated GoSmashMaths! avatars when launching the app - on bold landing screens - everytime you visit. Game selection is intuitive - users swipe to explore the other games titles. Settings allow users adjust sound, view scores, and easily navigate back to the game selection page, making it an uncomplicated and fun user experience.

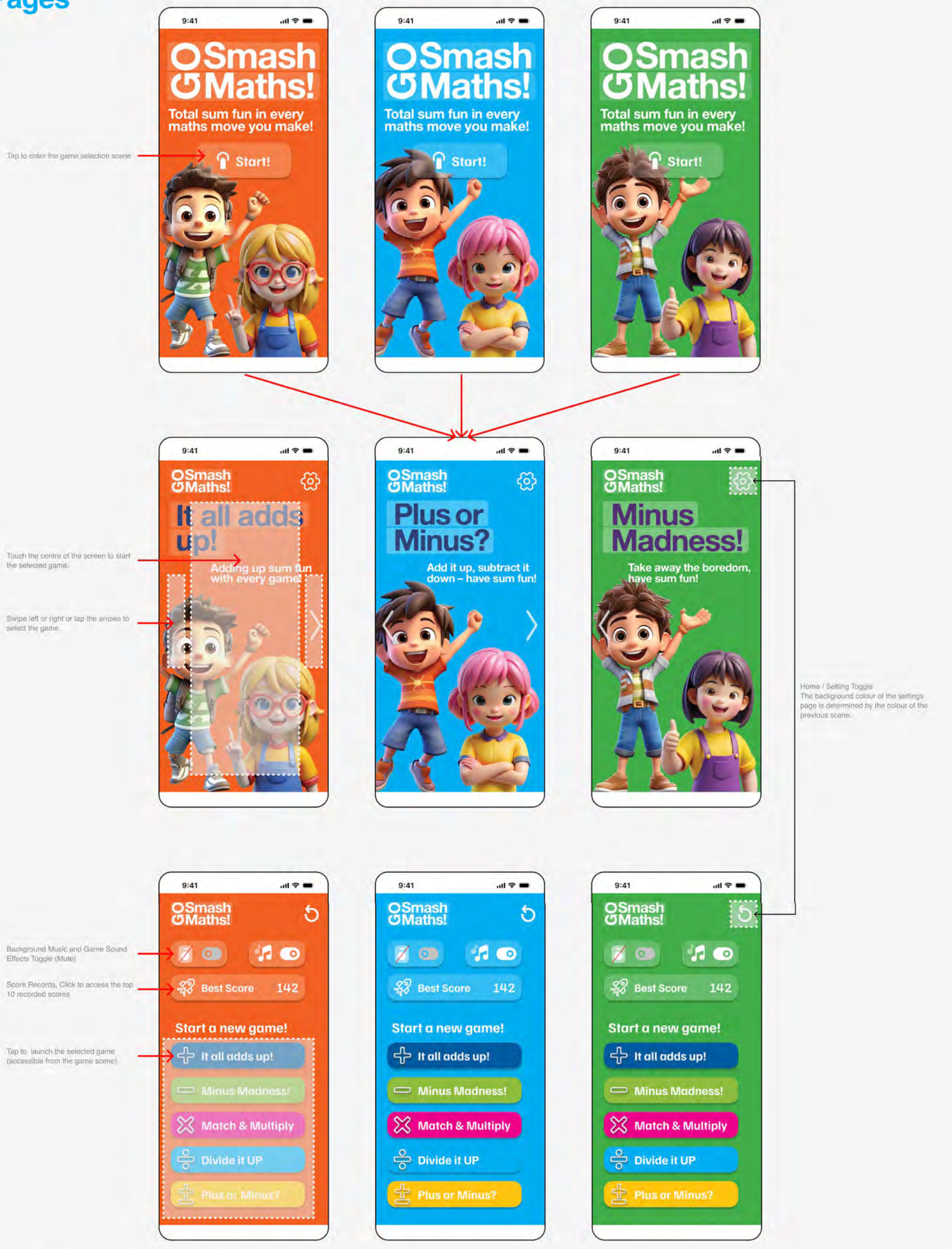


Figure 9. Transitioning to an App Prototype
As part of my project's evolution, my GoSmashMaths! physical card and board games were transitioned into an app prototype, aligning with neurodesign principles to ensure a seamless and engaging user experience for students. The screenshots show the GoSmashMaths! app's visual interface - the development included user feedback from teachers and students though my realtime, in-class gameplay sessions, educators, IT expersts and a neuroscientist.

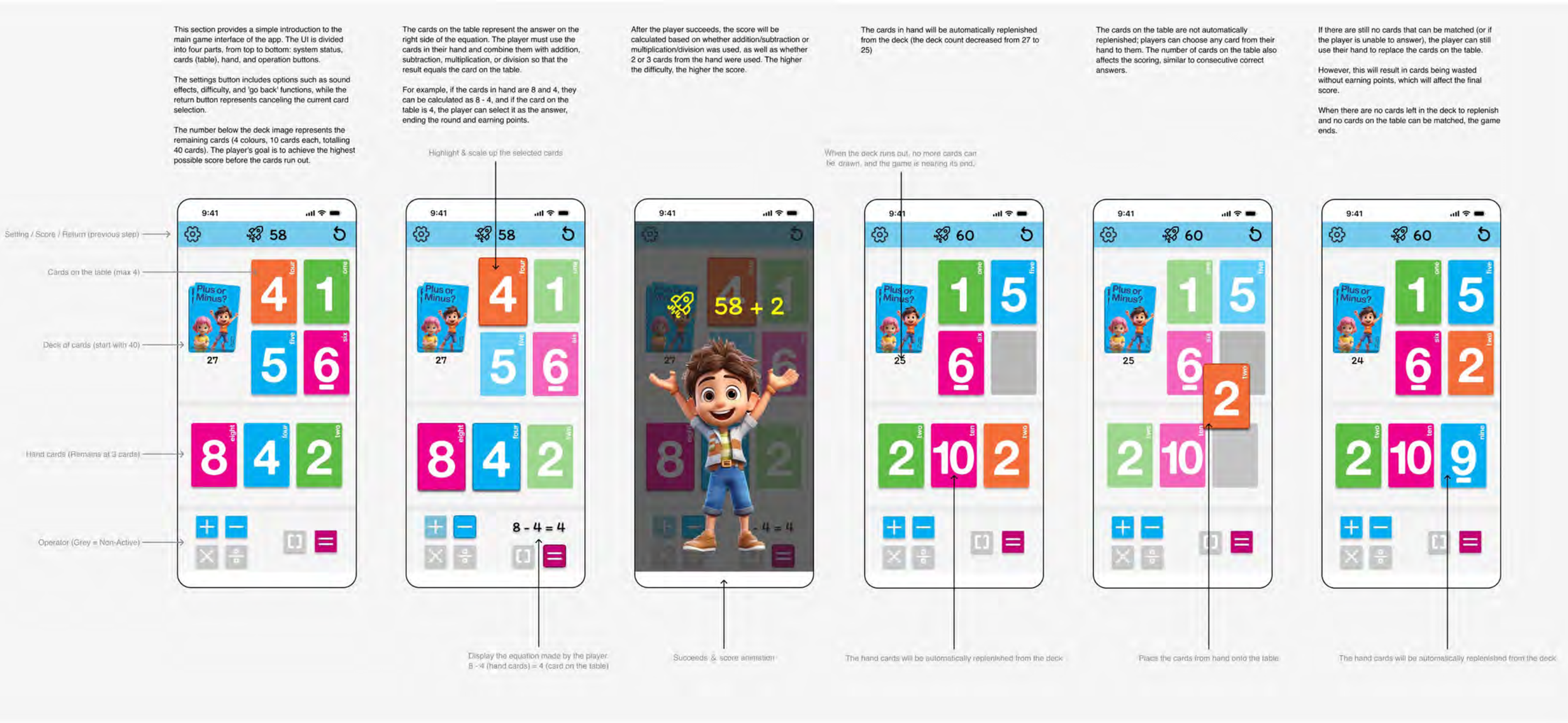
GoSmashMaths! App Prototype Development

Introduction to the main game interface

Figure 10. Introduction to the Main Game Interfac

GoSmashMaths! app prototype's main game interface introduces players to an interactive and visually engaging maths experience. Features include a clean, simple, but vibrant card display for problem-solving, a progress tracker, and dynamic avatar animations for feedback.

Cards are played by matching operations to targets, reinforcing learning through instant feedback and score updates. The layout is clear and accessible, with intuitive controls and clear visual indicators for actions like matching, selecting, or reshuffling cards.



GoSmashMaths! App Prototype Development

Main Game Interface

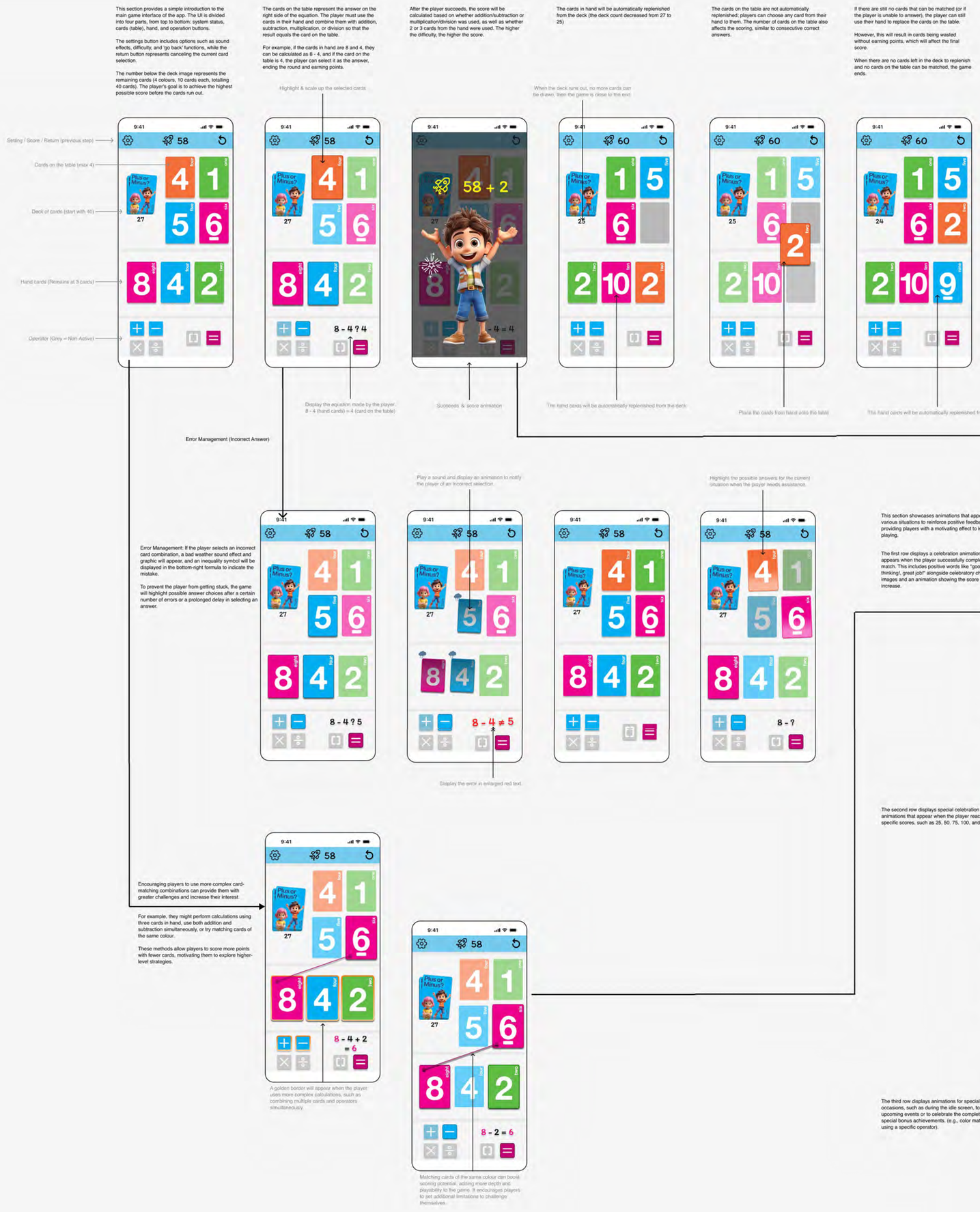


Figure 11. Main Game Interface and Feedback System

GoSmashMaths! main game interface provides a dynamic and interactive space for solving maths challenges. Players engage with clean, uncomplicated, simple cards and bright, positive avatars, guided by clear instructions and responsive animations. The feedback system incorporates 'feel good' messages such as 'Good thinking!' and 'You're a numbers ninja!' to reinforce positive involvement in the game/s. Dynamic content and animations such as rockets or balloons celebrate successes, while subtle hints and 'thought bubble' encouragement messages gently guide students to try again, creating a supportive and rewarding space for all learning levels.

GoSmashMaths! App Prototype Development

Feedback Loops

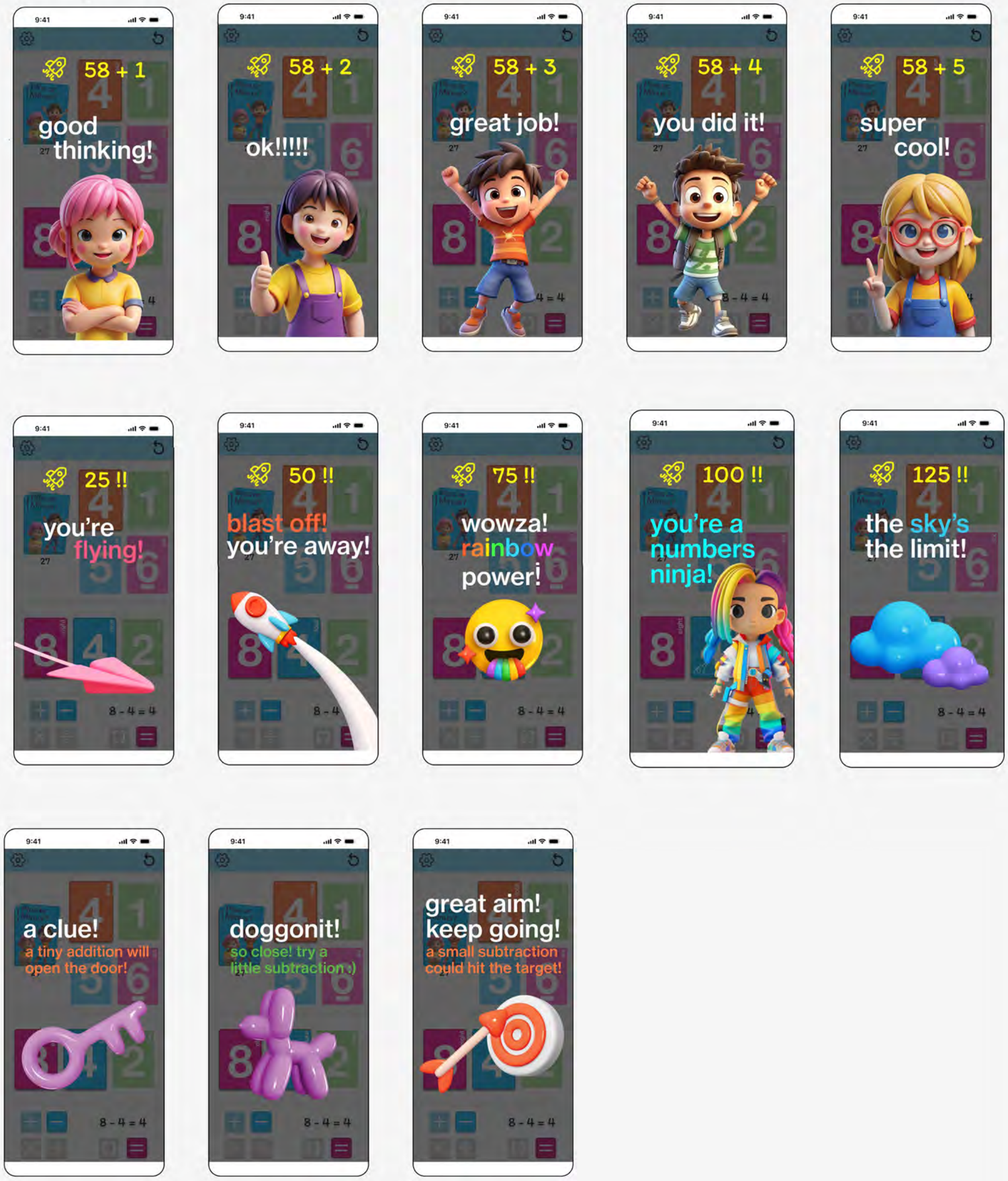


Figure 12. Feedback Loops in Gameplay
GoSmashMaths!'s feedback system uses encouraging natural, conversational messages, animations, and interactive visuals to guide players through their maths challenges. Phrases like'thought bubble' quotes/ messages, like 'You're flying!' and 'Wowsa! Rainbow power!' are big words of encouragement for students and acknowlege their achievements, while hints like 'A tiny addition will open the door!' provide subtle guidance. GoSmashMaths!'s avatars, animations, and bright, modern visuals keep users motivated, connected and engaged. It's a positive, supportive learning space - made for Generation Zs and Generation Alpha and anyone wanting to relax with maths.

APPENDIX B

Google Survey Results
70 Participants

Google Survey Stats

70 responses

Link to Sheets

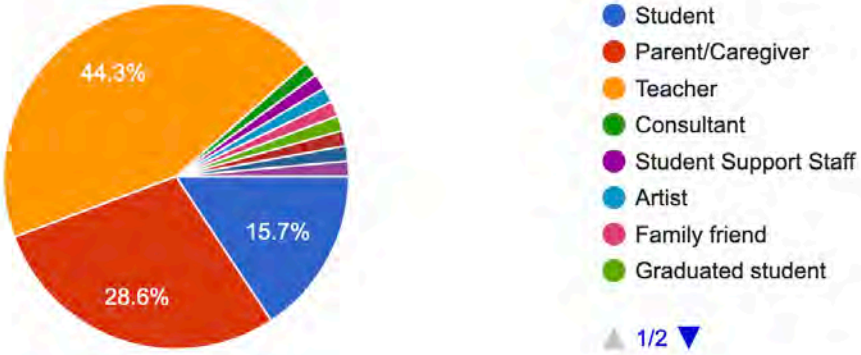
Accepting responses

Summary | Question | Individual

What is your role?

Copy chart

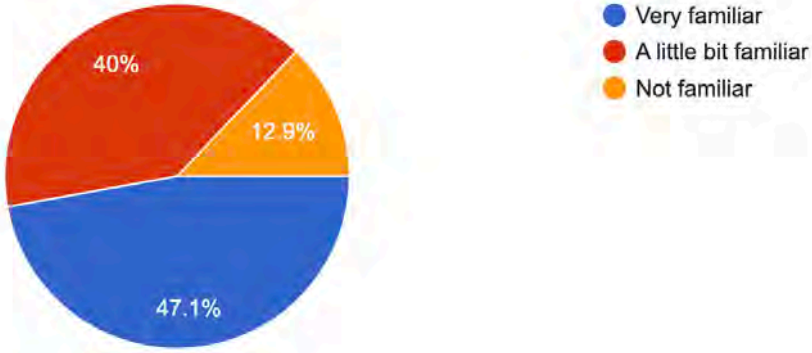
70 responses



How familiar are you with neurodiversity?

Copy chart

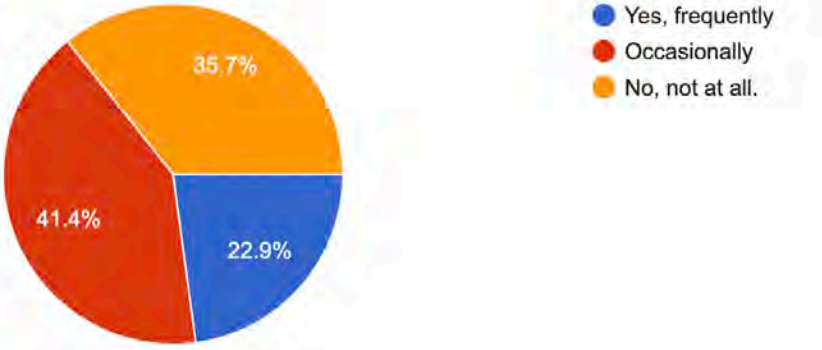
70 responses



Have you used any educational tools designed for neurodiverse, students, or students simply struggling with maths?

Copy chart

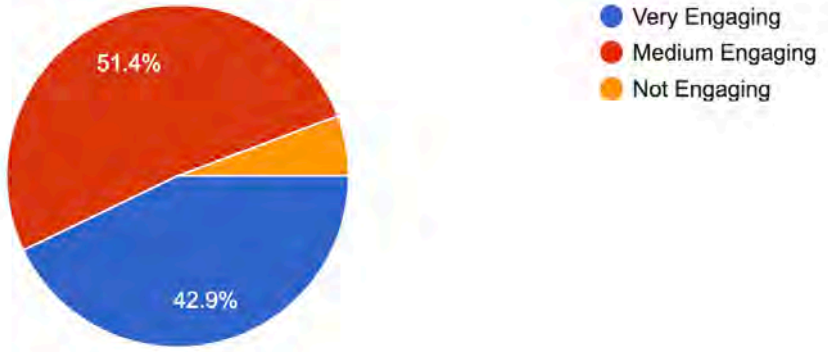
70 responses



How engaging do you find educational board games for teaching maths?

Copy chart

70 responses



How important are physical, tactile elements (eg. game pieces, cards, boards, pens) in maintaining a student's attention during maths activities?

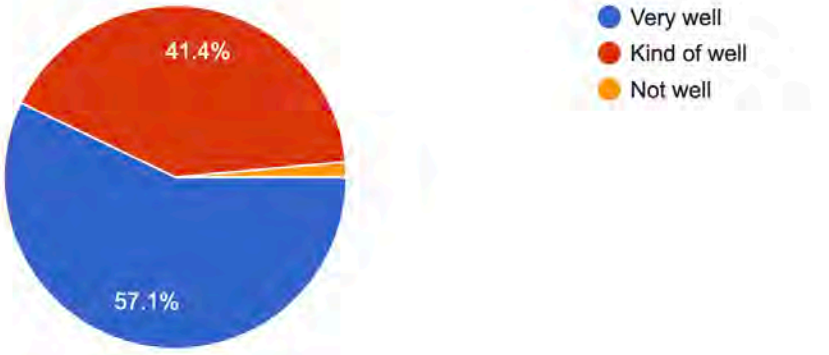
Copy chart

70 responses

In your opinion, how well do collaborative games support social skills and group learning in neurodiverse students, or students struggling with maths?

Copy chart

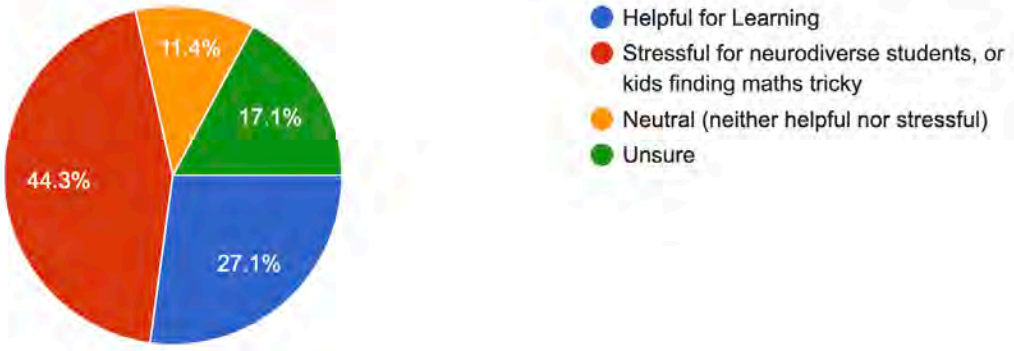
70 responses



Do you think having a competitive element in the board game would be:

Copy chart

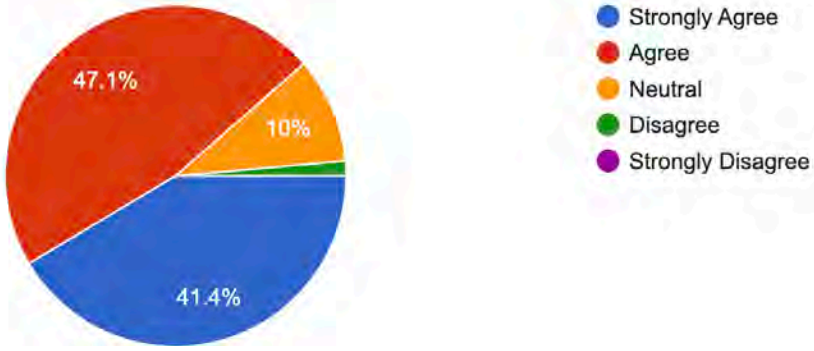
70 responses



Please rate how much you agree with the following statement: "Board games are effective in helping students understand maths concepts through hands-on interaction."

Copy chart

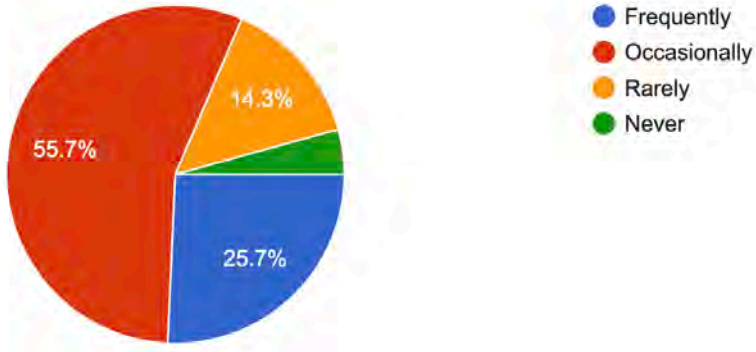
70 responses



How often do you or your students use educational apps?

Copy chart

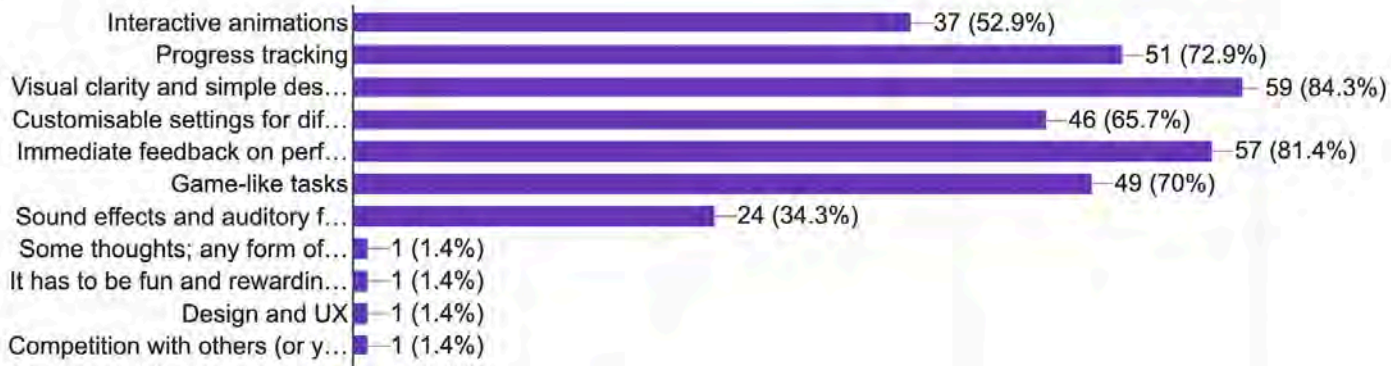
70 responses



What features do you think are most important for an educational maths app? (Select all that apply)

Copy chart

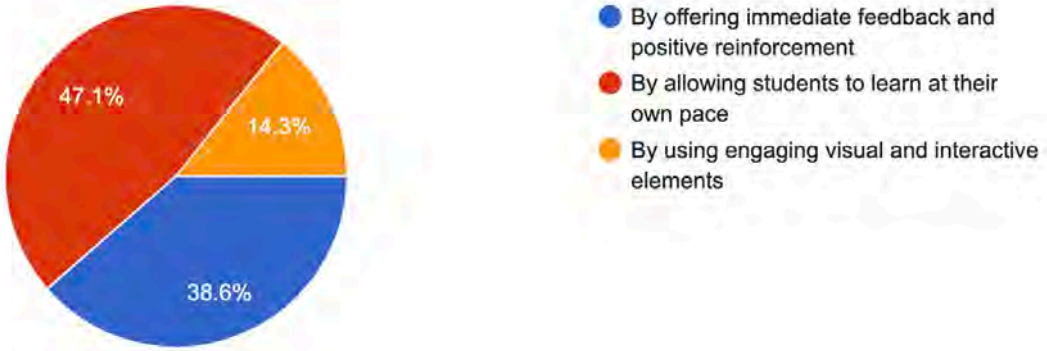
70 responses



In your opinion, how might the app help reduce maths anxiety for students who struggle with maths?

Copy chart

70 responses



How important is it to include features like progress tracking and feedback mechanisms in the app?

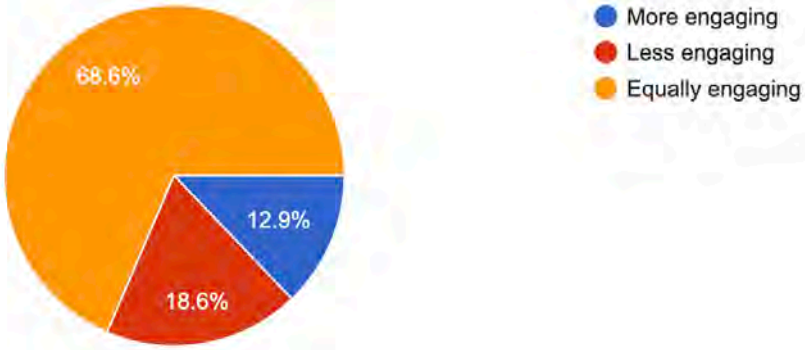
Copy chart

70 responses

Do you think a digital version of the board game would be more or less engaging than the physical board game?

Copy chart

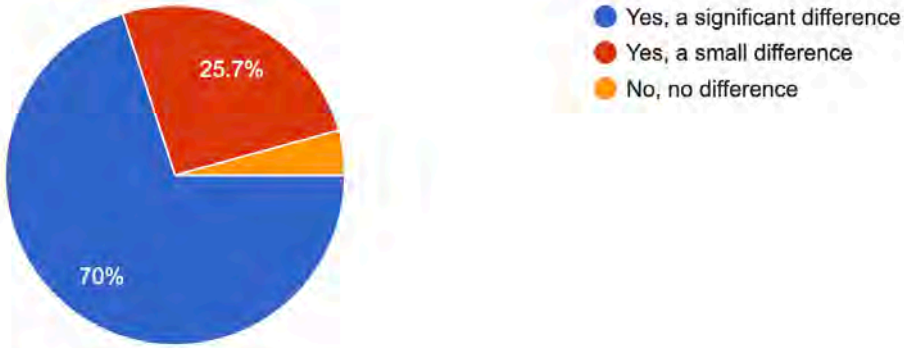
70 responses



Have you noticed a difference in engagement when educational tools use clear visuals and simple design?

Copy chart

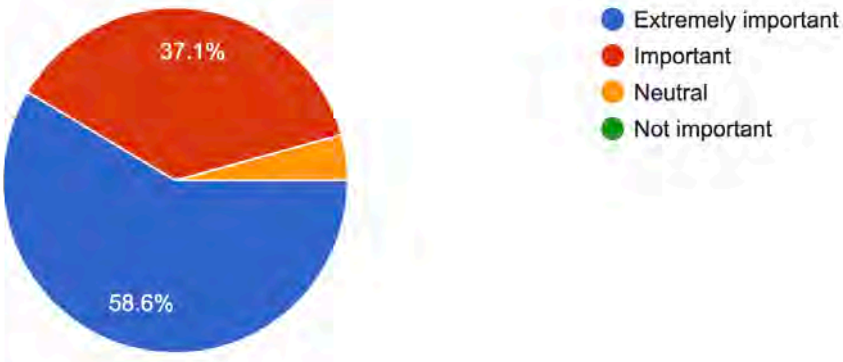
70 responses



How important do you think it is for educational tools to be specifically designed for neurodiverse learners?

Copy chart

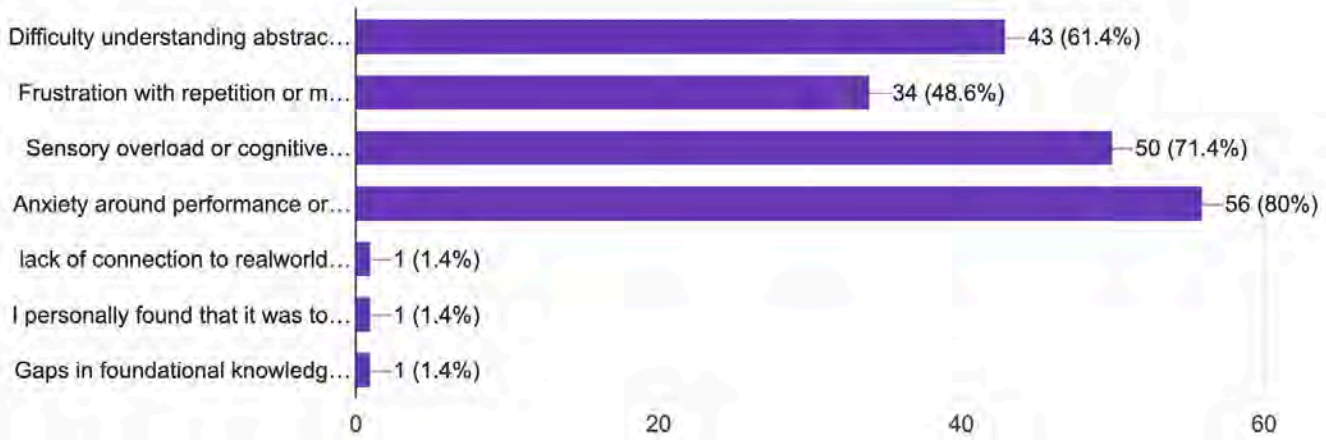
70 responses



In your experience, what challenges do neurodiverse students face when using traditional maths learning tools? (Select all that apply)

Copy chart

70 responses



What do you think is the most important feature that the app should have to support neurodiverse students and those who find maths challenging?

70 responses

Positive reinforcement

Clarity

accessibility of visual design

Focus on positive reinforcement and iterative success, rather than punitive or confronting consequences for inability/delayed progress.

Usability - intuitive interface and the ability to track progression in real time

Engagement

I find being able to aesthetically make things interesting and cute, or being able to doodle on stuff, gets me well more interested then without.

Differentiation application

Positive experience

Simplicity

Clear explanations

Appropriate learning goals and interative with the students and others in class

Different options, for different learning styles.

interactive

Fun, engaging and enjoyable, makes them feel good and improve their confidence in their abilities, support them if they get it wrong so they don't freak out (if possible eg di you know lots of people find that tricky? Well done for giving it a go, it will be a cinch in no time if you keep trying!)

Connecting to classroom curriculum and assessment

Simple instructions and a clear explanation of answers (ie. Link it all together)

Clarity and a bespoke user friendly interface

feedback

Soft gentle noise

Immediate feedback, positive reinforcement, own pace.

What do you think is the most important feature that the app should have to support neurodiverse students and those who find maths challenging?

70 responses

Clarity regarding objectives and differentiation

Be engaging , & fun

immediate access to correct answers and feedback

Simple engaging design

Solving problems relevant to real life

Clear, simple design

Unsure

Clear, precise instructions

Clarity on the perceived outcome As a teenager I had a bad case of concussion and although I had always been top of the class in maths I found I'd difficult to add up or do do simple mathematic tasks. I had to relearn it all again. The hardest thing was teachers recognising my difficulties. If I thought about maths using colours I could handle it.

Simplicity, straightforward instructions.

A single pre planned lesson path rather than multiple possible topics that can be learned simultaneously.

Inform them of their progress

Visually engaging

Explain new concepts in multiple ways

Positive reinforcement and clear instruction

Repetition of the same maths principles delivered in multiple ways to aid learning and reduce boredom and frustration

Customiseable settings for people to be able to learn at their own pace.

Multiple ways to reflect the question/problem to solve

Structured learning pathways

Encouragement to students as they progress through levels.

Repetition and positive reinforcement

What do you think is the most important feature that the app should have to support neurodiverse students and those who find maths challenging?

70 responses

Simple and even cute design like duo lingo, other learning apps that have personalised features and a game-like learning aspect

Rewards

Appropriate difficulty scaling as they use the app

Educational games

Visual controls, sound controls - scale up or scale down based on need

To be able to progress at own pace

The visual elements should address the conceptual understanding of the maths topic.

simple and clear - addressing few concepts at a time.

engaging

multiple ways to learn one concept, concrete ways and self paced with positive reinforcement

My son is neurodiverse, and he doesn't like to be timed. It puts pressure on the child to answer within a set time frame and they cannot think. An app that works at the pace of the student, that has settings that can modify sound, challenges and level in ability is important. It needs to have some elements of challenge, but not too challenging, or they give up. It must have some sort of reward or system to show progress and give feedback.

Easy to use, limited number of steps, engaging animation and engaging game style

Uncomplicated and user-friendly

Be engaging from the start with incentives to keep using

Concept simplification and development

Timely and independent feedback. Otherwise interest will be lost and/or incorrect habits reinforced

Self paced, not overstimulating

Simple design, ability to read instructions/tasks aloud

Simplicity to decrease sensory overload and minimise cognitive load

Self paced

What do you think is the most important feature that the app should have to support neurodiverse students and those who find maths challenging?

70 responses

Easy to read. Make it fun

Progress tracking and rewards (such as an in game currency) to help motivate students.

Immediate feedback

Making it fun and engaging

Immediate feedback

Is there anything else you would like to share about your experience with maths learning tools for neurodiverse students, or those who find maths challenging?

70 responses

No

N/A

I think the ability for the game to hide the explicit maths curriculum in the context of game objectives and wins woud be good. then revealing at game end that they have mastered x,y or z skill - then providing options for further challenge.

Making maths part of the journey but not the entire focus is beneficial. For example: A student wants to create something aligned to their interests like a favourite story personally bound via the development of a new skill in book binding. The student is required to budget for the resourcing of this, calculate the sheets of paper for the bound segments and understand the mathematics behind page numbering for binding (it is not 1 to end like standard documents). The student learns maths and meets learning criteria with the overall goal being an area of specific interest, catalysin intrinsic motivation.

My first year of highschool, I had a conversation with my maths teacher and brought up how much not using visual and physical representations decreased my understanding. He went on to use food - mostly wrapped candy - to teach us maths to both give us a tool and a reward simultaneously. I and most of the students immediately started doing better.

Anxiety can become a significant constraint to learning, and the novelty of a learning tool can mitigate this so that back brain can settle & the pre-frontal cortex can better engage.

Audio & visual

Clear explanations, expectations and boundaries are very important

Think this is a great idea than should be explored more when applicable with a unit or topic

Finding ways to incorporate maths subtly into other subjects or focuses can be more engaging than framing it as a maths task.

Not in particular

As a parent I find u gave to drive the activity, whether it's online or physical items. When concepts are challenging I've found equal success in online and physical (pop sticks, number lines, number sheets etc). I thought online would be appealing but I think there is still a lot of frustration if there is even one mistake.... We're working in this! 🙄

NIL

Be flex - we all learn at our own pace, and "standard" approaches for learning formulas doesn't work for everyone.

There does not appear to be anything similar out there

Is there anything else you would like to share about your experience with maths learning tools for neurodiverse students, or those who find maths challenging?

70 responses

traditional learning and text books are too linear. classes are often too past paced. too much 'testing' as assessment

Thank you for asking the question - very important.

Stress created around perceived competition amongst peers can be detrimental and therefore a game or app where the student is free to be supported and challenged without fear of judgment or competition is very valuable.

Learning and improving maths skills while seemingly playing a game and having fun learning new skills

Australia is falling behind in maths performance and anything that helps make maths education more approachable is important

Miss Flowers at St Andrews excels in this area

Has to be fun to encourage learning

The element of 'competition' and getting a 'score' can be highly problematic for neurodiverse students

Progress tracking is encouraging.

No thanks

this isa complex topic as neurodiversity presents so differently in each individual. One size will not fit all, but having access to a variety of jways to engage students is important.

As above

no:)

0

Delivery methods. Break up with a physical activity or breathing

No I do not.

No

Maths times tables songs were helpful, I still sing them when doing my times tables 15 years later.

They helped me personally with even audio, sound tools for memorisation

Is there anything else you would like to share about your experience with maths learning tools for neurodiverse students, or those who find maths challenging?

70 responses

N/a

NA

Maths can be fun and so using games to emphasize this is good

Simple objectives, audio and visuals are important for neurodiverse students and those who find the maths concept challenging.

keeping games/materials required simple - for building maths fluency, basic concepts, number sense games need to be clear, simple and fun. few materials required and simple to play.

make it fun

I think showing learners that maths is actually all around us in ways that are simple and understandable - that you can see maths is pretty much everything - building on that concept for confidence

I have been a teacher for 20 years, I am a mother of a neurodivergent child and I have spent a lot of time catering for the needs of children with diverse needs.

Often children who find maths challenging require repetition that is more than just repeating of the same activity. They also often experience anxiety around maths so everything that is new needs to be non-threatening

No, I have not known of any such specific maths tools for neurodiversity.

No, predominantly teach languages

Depends on the challenge . Lots of nd people are good at Maths

The lack of evidence based intervention programs is troubling. I particularly find it difficult when students are struggling but are moved to the next year level regardless of progress. I find it means the gap gets wider and the demotivation and resentment towards the subject grows. I don't know what the solution is though as other research shows the negative impacts of holding students back.

-

Sometimes, the opportunity for students to work with each other allows kids to use kid language as opposed to teachers...

No, all I know is that maths is not easy for everyone!

Is there anything else you would like to share about your experience with maths learning tools for neurodiverse students, or those who find maths challenging?

70 responses

Enhanced student interaction with peers is important

Simplicity is important

Competitive interaction is important

Thank you so much for participating in my survey, if you have anything else to share, please let me know:

17 responses

X

Great idea Willem!

card games work well

Love that you are doing this, I too have designed a maths board game for my students :)

It was very interesting

Need to consider sensory preferences. An occupational therapist would be good to consult with. I am an OT but this is not my speciality. Too much noise and flashing lights will be difficult for some kids and they would be better with the board game version. Some kids need lots of sensory stimulation to get interested

No thanks

I know that complex maths can be confusing, but I truly do think that teachers not touching on the abilities and scope of maths severely negatively impacted my learning and motivation towards it. As a highly pattern recognition neurodivergent, learning about how maths interacts and can predict and build so much would have done wonders for little me.

Good luck with your research project!

Interesting survey!

I hop my previous answer goes through. I am happy to talk about it.

I'm so pleased you are researching this Willem! I loved teaching you in Year 2. All the best with your studies.

Good luck!!

Good luck with your project. I can't wait to see what amazing things you produce Willem!

All the best

I'm a student with lived experience of neurodivergence and varying levels of comfort around mathematics throughout my lifetime. My answers to this survery around grounded more in this lived experience, than in my observations of others.

Thank you so much for participating in my survey, if you have anything else to share, please let me know:

16 responses

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X

No thanks

Great idea Willem!

All the best

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I'm so pleased you are researching this Willem! I loved teaching you in Year 2. All the best with your studies.

Good luck!!

APPENDIX C

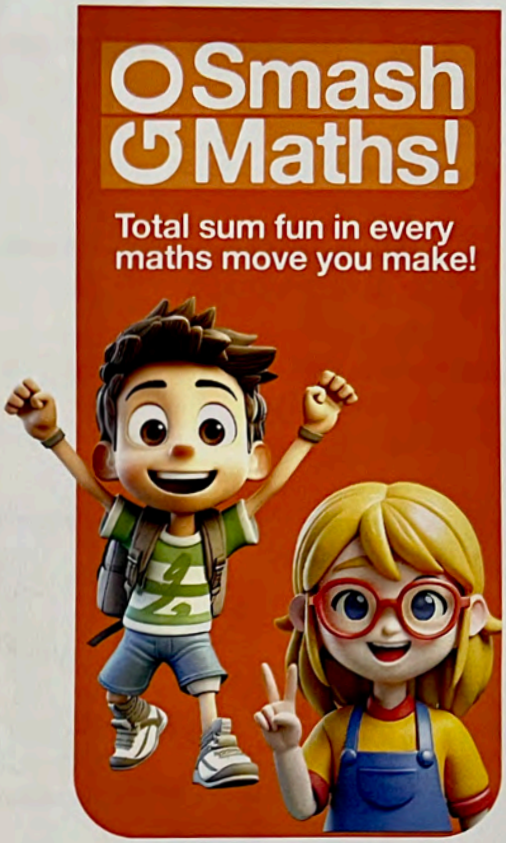
In-class User Testing Feedback
60 Students, 10 Teachers

TEACHER SURVEY SAMPLES

Survey 3: GoSmashMaths! Game Testing Survey: TEACHERS

1. How easy was it to explain the rules of the game to students?

- Very easy
- ✓ Easy
- Neutral
- Difficult
- Very difficult



2. How engaged were the students while playing the game?

- ✓ Very
- Sort of engaged
- Neutral
- Not very engaged
- Not engaged at all

3. Did the game align with maths learning goals in your classroom?

- ✓ Yes, completely
- Sort of
- Neutral
- Not really
- Not at all

4. Do you think the game helped students with maths concepts?

- ✓ Yes, a lot
- Yes, somewhat
- Neutral
- Not really
- No, not at all

5. How well did the game accommodate neurodiverse students or those who struggle with maths?

- ✓ Very well
- A little
- Neutral
- Not very well
- Not at all

6. What improvements would you suggest for the game?

This was very thorough.
It was clear with good examples. Within 5 minutes all groups were playing & very engaged. The graphics and colours were enticing and effective.

7. Did students collaborate well while playing the game?

- Yes, they collaborated well
- ✓ Sort of — some forgot but that was on them.
- Neutral
- No, they didn't collaborate

8. How likely would you be to use this game in your classroom again?

- ✓ Very likely — I would love a copy! How much are they?
- Likely
- Neutral
- Unlikely
- Very unlikely

9. Do you think the board games will work well as an app?

- ✓ Yes
- No
- Not sure

Survey 3: GoSmashMaths! Game Testing Survey: TEACHERS

11. Do think students suffer maths anxiety (70% as global stats suggest)?

- [x] Yes
- [ ] No
- [ ] Maybe

12. How did students respond to challenges or mistakes while playing the game?

- [ ] Really Postively
- [x] Postive
- [ ] Neutral
- [ ] A little negative
- [ ] Very negative

13. Did you observe any signs of reduced maths anxiety during gameplay?

- [x] Yes, significantly
- [ ] A little
- [ ] Neutral
- [ ] Not really
- [ ] No, not at all

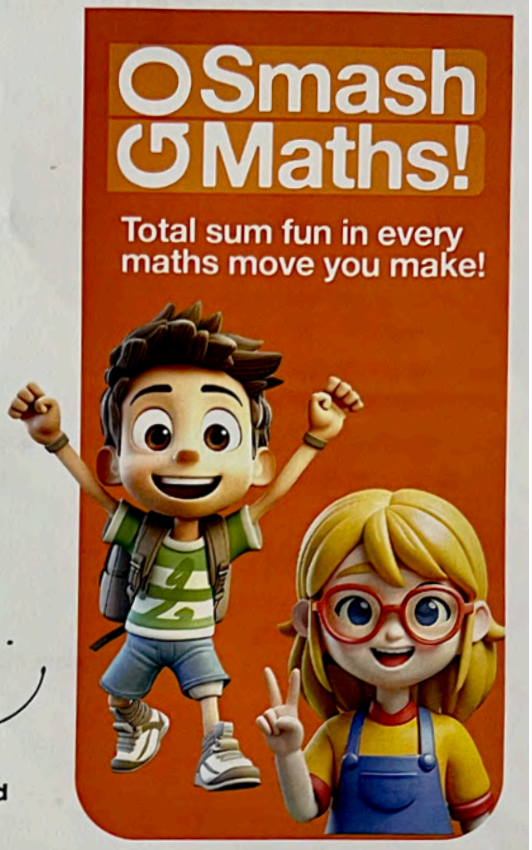
Student who usually avoid math played much longer than their time! :)

14. How comfortable do you think the students felt participating in the game compared to other maths activities?

- [x] Much more comfortable
- [ ] A little more comfortable
- [ ] About the same
- [ ] A little less comfortable
- [ ] Uncomfortable

15. Did the game encourage students to share strategies and discuss maths concepts?

- [ ] Yes, frequently
- [x] Sometimes
- [ ] Neutral
- [ ] Rarely
- [ ] Not at all



Survey 3: GoSmashMaths! Game Testing Survey: TEACHERS

1. How easy was it to explain the rules of the game to students?

- Very easy
- ✓ Easy
- Neutral
- Difficult
- Very difficult

2. How engaged were the students while playing the game?

- Very
- ✓ Sort of engaged
- Neutral
- Not very engaged
- Not engaged at all

3. Did the game align with maths learning goals in your classroom?

- ✓ Yes, completely — very good
- Sort of
- Neutral
- Not really
- Not at all

4. Do you think the game helped students with maths concepts?

- ✓ Yes, a lot
- Yes, somewhat
- Neutral
- Not really
- No, not at all

5. How well did the game accommodate neurodiverse students or those who struggle with maths?

- Very well
- ✓ A little
- Neutral
- Not very well
- Not at all

6. What improvements would you suggest for the game?

* ~~SAVE~~ fantastic links to the year 4 curriculum.
* engaging and easy to understand once explained
* ~~engaging~~ children did it last lesson on a Friday so hard to engage focus but there is some good learning strategies

7. Did students collaborate well while playing the game?

- ✓ Yes, they collaborated well
- ✓ Sort of
- Neutral
- No, they didn't collaborate

8. How likely would you be to use this game in your classroom again?

- ✓ Very likely
- Likely
- Neutral
- Unlikely
- Very unlikely

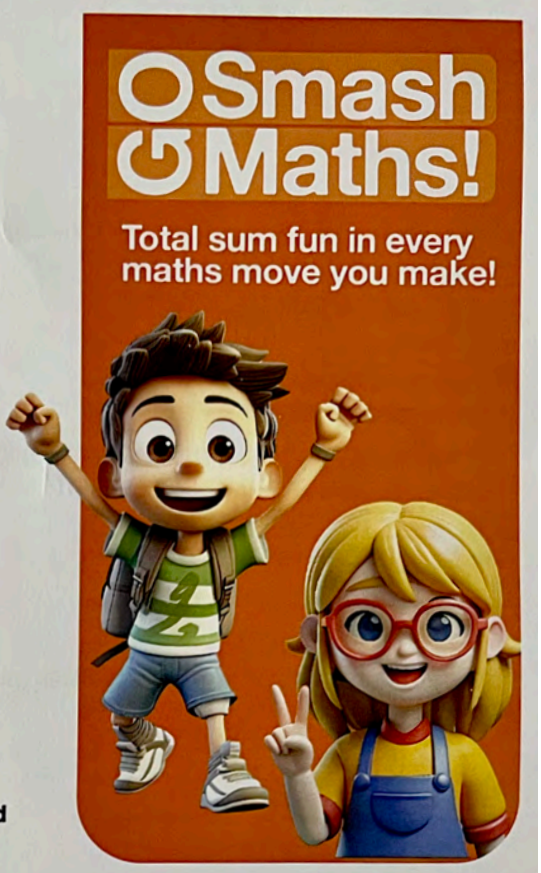
9. Do you think the board games will work well as an app?

- ✓ Yes
- No
- Not sure

Survey 3: GoSmashMaths! Game Testing Survey: TEACHERS

11. Do think students suffer maths anxiety (70% as global stats suggest)?

- [x] Yes definitely
- [ ] No
- [ ] Maybe



12. How did students respond to challenges or mistakes while playing the game?

- [ ] Really Postively
- [x] Postive
- [ ] Neutral
- [ ] A little negative
- [ ] Very negative

13. Did you observe any signs of reduced maths anxiety during gameplay?

- [ ] Yes, significantly
- [x] A little
- [ ] Neutral
- [ ] Not really
- [ ] No, not at all

14. How comfortable do you think the students felt participating in the game compared to other maths activities?

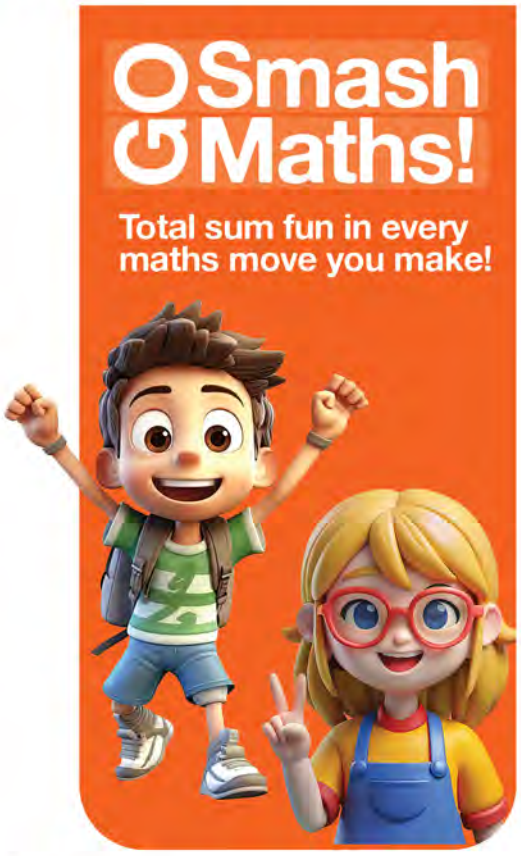
- [ ] Much more comfortable
- [x] A little more comfortable
- [ ] About the same
- [ ] A little less comfortable
- [ ] Uncomfortable

15. Did the game encourage students to share strategies and discuss maths concepts?

- [ ] Yes, frequently
- [x] Sometimes
- [ ] Neutral
- [ ] Rarely
- [ ] Not at all

User Testing Feedback Forms

Survey 3: GoSmashMaths! Game Testing Survey: TEACHERS



1. How easy was it to explain the rules of the game to students?

- Very easy
- Easy
- Neutral
- Difficult
- Very difficult

2. How engaged were the students while playing the game?

- Very
- Sort of engaged
- Neutral
- Not very engaged
- Not engaged at all

3. Did the game align with maths learning goals in your classroom?

- Yes, completely
- Sort of
- Neutral
- Not really
- Not at all

4. Do you think the game helped students with maths concepts?

- Yes, a lot
- Yes, somewhat
- Neutral
- Not really
- No, not at all

5. How well did the game accommodate neurodiverse students or those who struggle with maths?

- Very well
- A little
- Neutral
- Not very well
- Not at all

6. What improvements would you suggest for the game?

7. Did students collaborate well while playing the game?

- Yes, they collaborated well
- Sort of
- Neutral
- No, they didn't collaborate

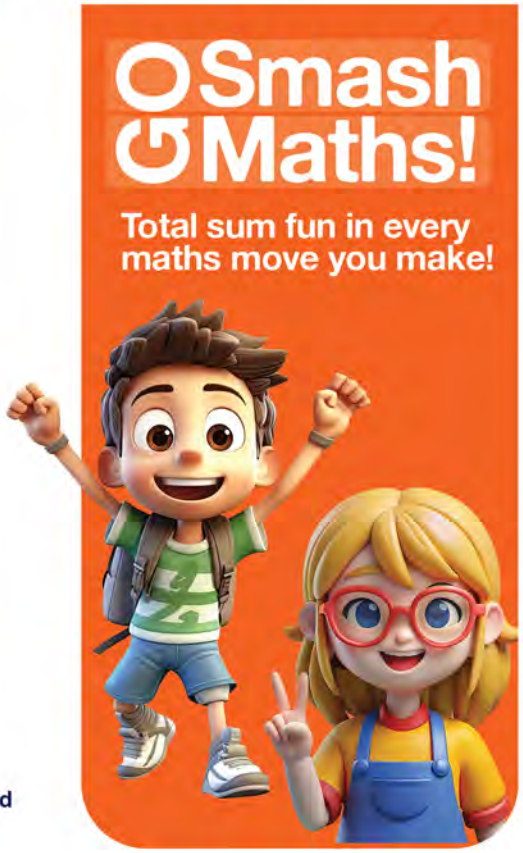
8. How likely would you be to use this game in your classroom again?

- Very likely
- Likely
- Neutral
- Unlikely
- Very unlikely

9. Do you think the board games will work well as an app?

- Yes
- No
- Not sure

Survey 3: GoSmashMaths! Game Testing Survey: TEACHERS



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- Yes
- No
- Maybe

12. How did students respond to challenges or mistakes while playing the game?

- Really Postively
- Postive
- Neutral
- A little negative
- Very negative

13. Did you observe any signs of reduced maths anxiety during gameplay?

- Yes, significantly
- A little
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- Not really
- No, not at all

14. How comfortable do you think the students felt participating in the game compared to other maths activities?

- Much more comfortable
- A little more comfortable
- About the same
- A little less comfortable
- Uncomfortable

15. Did the game encourage students to share strategies and discuss maths concepts?

- Yes, frequently
- Sometimes
- Neutral
- Rarely
- Not at all

APPENDIX C

In-class User Testing Feedback
60 Students, 10 Teachers

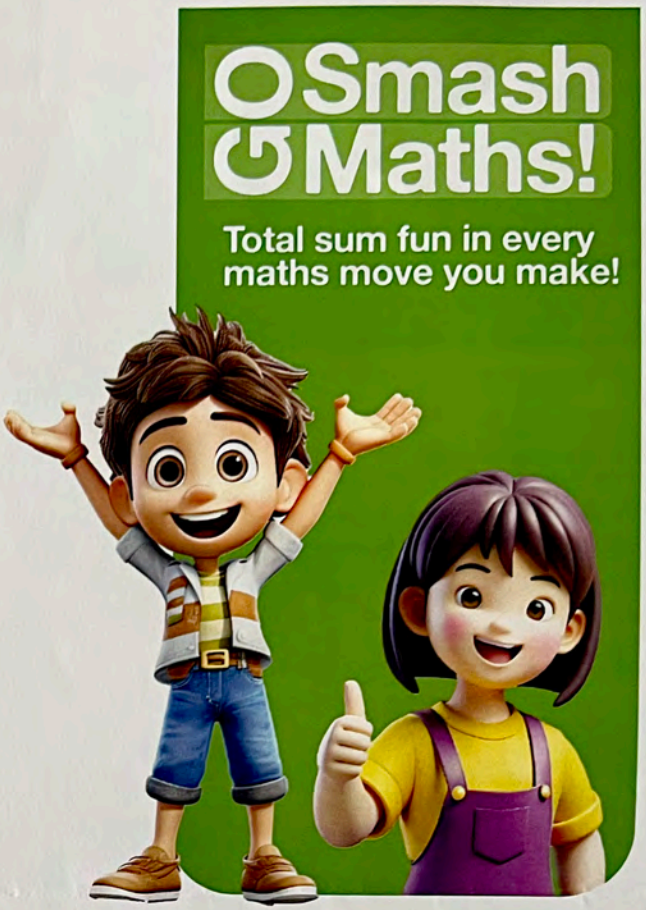
STUDENT SURVEY SAMPLES

YEARS 5-6

Survey 2:
GoSmashMaths! Game Testing Survey: STUDENTS YRS 5-6

1. How easy was it to understand the rules of the game?

- Very easy
- Easy
- ✓ Just right
- Difficult
- Very difficult



2. Did you enjoy playing the game?

- ✓ Yes, it was loads of fun!
- It was fun
- It was okay
- It was boring
- I didn't enjoy it

3. How challenging was the maths in the game?

- Very easy
- Easy
- ✓ Just right
- Difficult
- Very difficult

4. Did the game help you understand maths concepts better?

- Yes, a lot
- ✓ Yes, a little
- Not really
- No, not at all

5. Did you feel more confident with maths after playing?

- Yes, definitely
- ✓ A little bit
- No difference
- I felt less confident

6. Was there anything you didn't like about the game?

no it was perfect.:)

7. What was your favourite part of the game?

Moving my peice to first place.:)

8. Would you recommend this game to your friends?

- ✓ Yes!
- No

9. Do you find maths harder than your other subjects?

- ✓ Yes
- No

10. Do you sometimes find it makes you frustrated or anxious?

- ✓ Yes
- No

11. Do think the board games would work well as an app?

- ✓ Yes
- No
- Maybe

Survey 2:
GoSmashMaths! Game Testing Survey: STUDENTS YRS 5-6

1. How easy was it to understand the rules of the game?

- ✓ Very easy
- Easy
- Just right
- Difficult
- Very difficult

2. Did you enjoy playing the game?

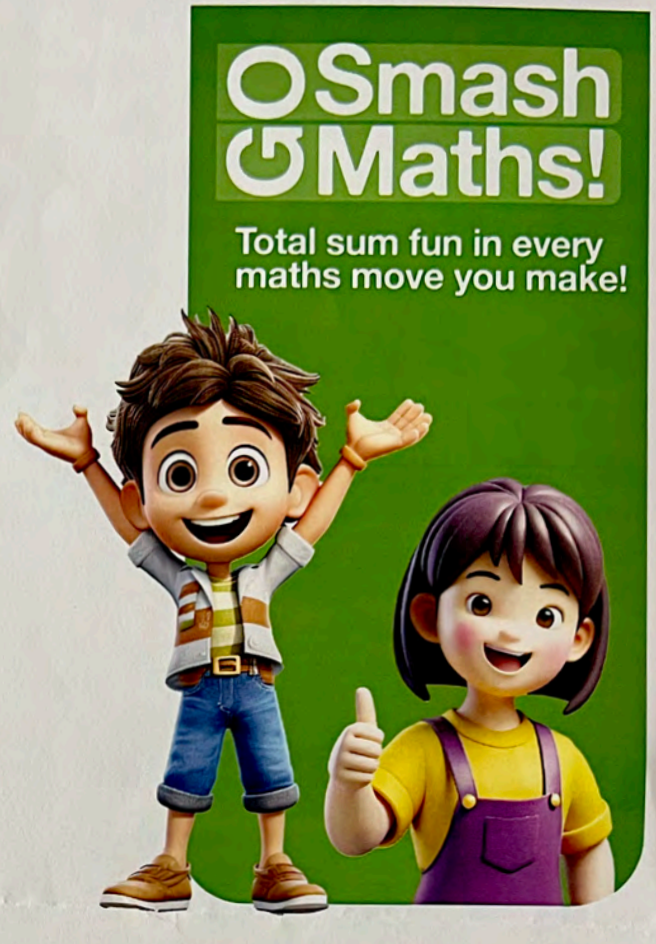
- Yes, it was loads of fun!
- It was fun
- ✓ It was okay
- It was boring
- I didn't enjoy it

3. How challenging was the maths in the game?

- ✓ Very easy
- Easy
- Just right
- Difficult
- Very difficult

4. Did the game help you understand maths concepts better?

- Yes, a lot
- Yes, a little
- ✓ Not really
- No, not at all



5. Did you feel more confident with maths after playing?

- Yes, definitely
- A little bit
- ✓ No difference
- I felt less confident

6. Was there anything you didn't like about the game?

No, I liked it

7. What was your favourite part of the game?

I liked adding numbers

8. Would you recommend this game to your friends?

- ✓ Yes
- No

9. Do you find maths harder than your other subjects?

- Yes
- ✓ No

10. Do you sometimes find it makes you frustrated or anxious?

- ✓ Yes
- No

11. Do think the board games would work well as an app?

- Yes
- No
- ✓ Maybe

Survey 2:
GoSmashMaths! Game Testing Survey: STUDENTS YRS 5-6

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- Easy
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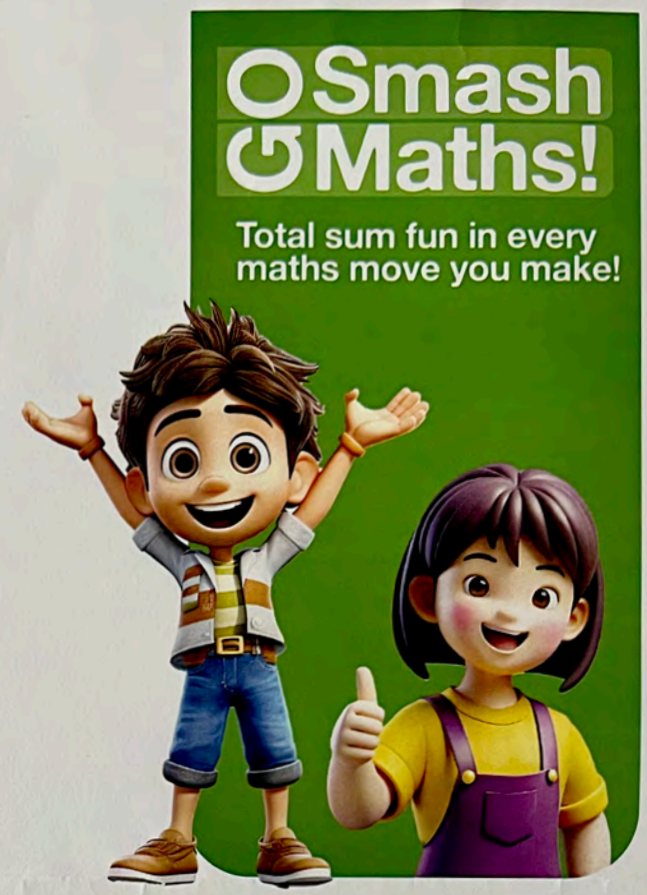
- Very difficult

4. Did the game help you understand maths concepts better?

- Yes, a lot
- Yes, a little
- ✓ Not really
- No, not at all



5. Did you feel more confident with maths after playing?

- Yes, definitely
- A little bit
- ✓ No difference
- I felt less confident

6. Was there anything you didn't like about the game?

No

7. What was your favourite part of the game?

Pairing the cards together was very fun and exiting. It makes you feel good when you have a good pair.

8. Would you recommend this game to your friends?

- ✓ Yes
- No

9. Do you find maths harder than your other subjects?

- Yes
- ✓ No

10. Do you sometimes find it makes you frustrated or anxious?

- Yes
- ✓ No

11. Do think the board games would work well as an app?

- ✓ Yes
- No
- Maybe

Survey 2:
GoSmashMaths! Game Testing Survey: STUDENTS YRS 5-6

1. How easy was it to understand the rules of the game?

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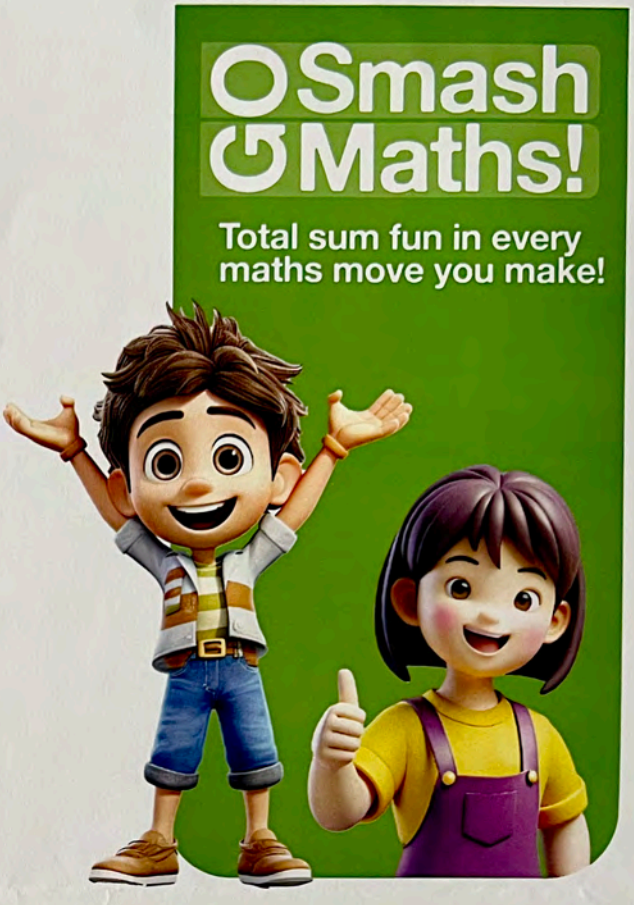

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- It was okay
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- I didn't enjoy it

3. How challenging was the maths in the game?

- ✓ Very easy
- Easy
- Just right
- Difficult
- Very difficult

4. Did the game help you understand maths concepts better?

- Yes, a lot
- ✓ Yes, a little
- Not really
- No, not at all

5. Did you feel more confident with maths after playing?

- Yes, definitely
- A little bit
- ✓ No difference
- I felt less confident

6. Was there anything you didn't like about the game?

No we really liked it

7. What was your favourite part of the game?

moving my piece infront of peoples

8. Would you recommend this game to your friends?

- ✓ Yes
- No

9. Do you find maths harder than your other subjects?

- Yes
- ✓ No

10. Do you sometimes find it makes you frustrated or anxious?

- ✓ Yes
- No

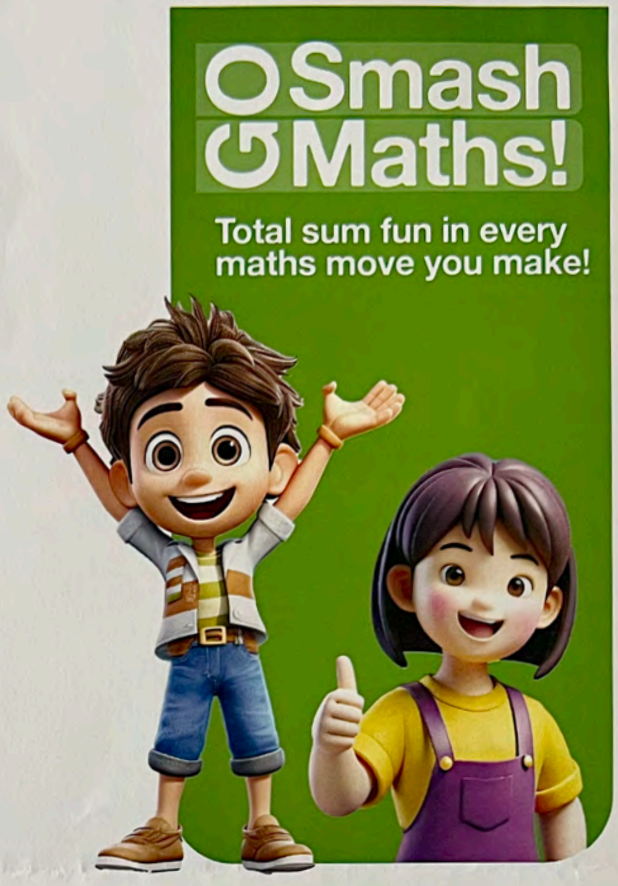
11. Do think the board games would work well as an app?

- ✓ Yes
- No
- Maybe

Survey 2:
GoSmashMaths! Game Testing Survey: STUDENTS YRS 5-6

1. How easy was it to understand the rules of the game?

- Very easy
- ✓ Easy
- Just right
- Difficult
- Very difficult



2. Did you enjoy playing the game?

- ✓ Yes, it was loads of fun!
- It was fun
- It was okay
- It was boring
- I didn't enjoy it

3. How challenging was the maths in the game?

- Very easy
- Easy
- ✓ Just right
- Difficult
- Very difficult

4. Did the game help you understand maths concepts better?

- Yes, a lot
- Yes, a little
- ✓ Not really
- No, not at all

5. Did you feel more confident with maths after playing?

- Yes, definitely
- ✓ A little bit
- No difference
- I felt less confident

6. Was there anything you didn't like about the game?

No I really liked it.

7. What was your favourite part of the game?

I ~~did~~ really liked how you had to try and get a higher number to move more spaces.

8. Would you recommend this game to your friends?

- ✓ Yes
- No

9. Do you find maths harder than your other subjects?

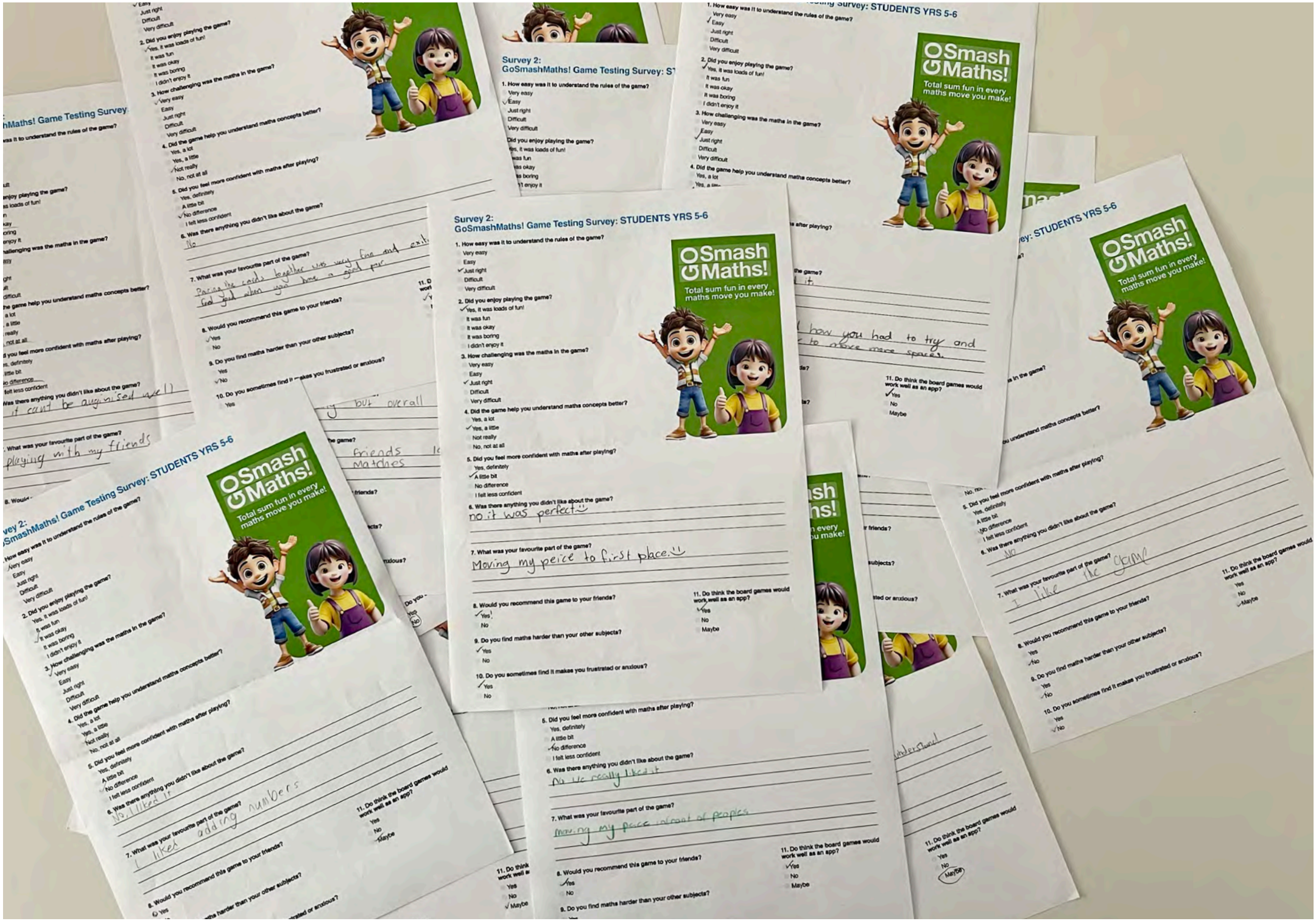
- Yes
- ✓ No

10. Do you sometimes find it makes you frustrated or anxious?

- ✓ Yes
- No

11. Do think the board games would work well as an app?

- ✓ Yes
- No
- Maybe


Survey 2:
GoSmashMaths! Game Testing Survey: STUDENTS YRS 5-6
Smash Maths!
Total sum fun in every maths move you make!
1. How easy was it to understand the rules of the game?
2. Did you enjoy playing the game?
3. How challenging was the maths in the game?
4. Did the game help you understand maths concepts better?
5. Did you feel more confident with maths after playing?
6. Was there anything you didn't like about the game?
7. What was your favourite part of the game?
8. Would you recommend this game to your friends?
9. Do you find maths harder than your other subjects?
10. Do you sometimes find it makes you frustrated or anxious?
11. Do think the board games would work well as an app?

Survey 2:
GoSmashMaths! Game Testing Survey: STUDENTS YRS 5-6

1. How easy was it to understand the rules of the game?

- Very easy
- Easy
- Just right
- Difficult
- Very difficult

2. Did you enjoy playing the game?

- Yes, it was loads of fun!
- It was fun
- It was okay
- It was boring
- I didn't enjoy it

3. How challenging was the maths in the game?

- Very easy
- Easy
- Just right
- Difficult
- Very difficult

4. Did the game help you understand maths concepts better?

- Yes, a lot
- Yes, a little
- Not really
- No, not at all

5. Did you feel more confident with maths after playing?

- Yes, definitely
- Somewhat
- No difference
- I felt less confident

6. Was there anything you didn't like about the game?

7. What was your favourite part of the game?

8. Would you recommend this game to your friends?

- Yes
- No

9. Do you find maths harder than your other subjects?

- Yes
- No

10. Do you sometimes find it makes you frustrated or anxious?

- Yes
- No

11. Do think the board games would work well as an app?

- Yes
- No
- Maybe

APPENDIX C

In-class User Testing Feedback
60 Students, 10 Teachers

STUDENT SURVEY SAMPLES

YEARS 3-4

Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- (●) Yes
- ( ) No

2. Did you enjoy playing the GoSmashMaths! game?

- (●) Yes
- ( ) No

3. What was the most fun part of the game?

The most fun part of the game was how we all had to add and subtract. I also liked how we had to go on the squares that said: go back 2 spaces.

4. Do you think your other friends would also like to play this game?

- (●) Yes
- ( ) No
- ( ) Not sure

5. Did you feel the game helped you understand maths better?

- ( ) Yes, a lot
- (●) Yes, a little
- ( ) Not really
- ( ) No, not at all

6. Did the game make you feel more confident about doing maths?

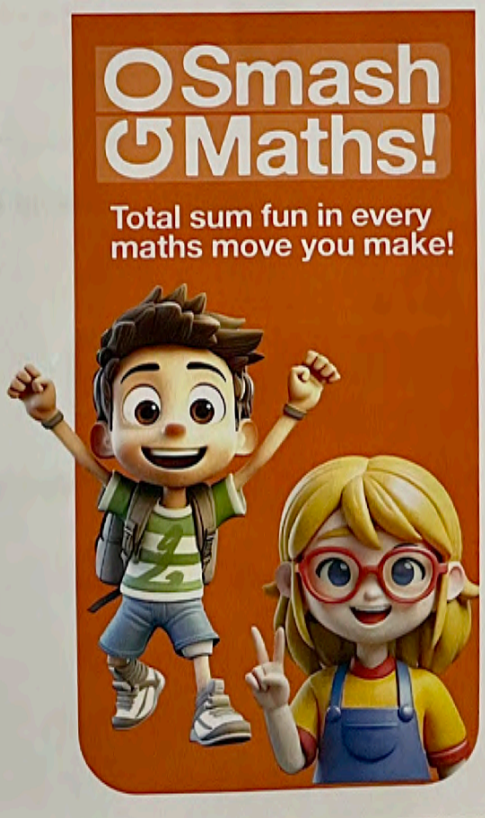
- (●) Yes, much more confident
- ( ) A little more confident
- ( ) No change
- ( ) I felt less confident

7. How easy was it to understand the rules of the game?

- ( ) Very easy
- ( ) Easy
- (●) A little difficult
- ( ) Very difficult

8. Did the game feel too long, too short, or just right?

- ( ) Too long
- ( ) Too short
- (●) Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- Yes
- ✓ No

2. Did you enjoy playing the GoSmashMaths! game?

- ✓ Yes
- No

3. What was the most fun part of the game?

The wild, reverse, and stay still so that way you can pass your opponent

4. Do you think your other friends would also like to play this game?

- ✓ Yes
- No
- Not sure

5. Did you feel the game helped you understand maths better?

- Yes, a lot
- ✓ Yes, a little
- Not really
- No, not at all

6. Did the game make you feel more confident about doing maths?

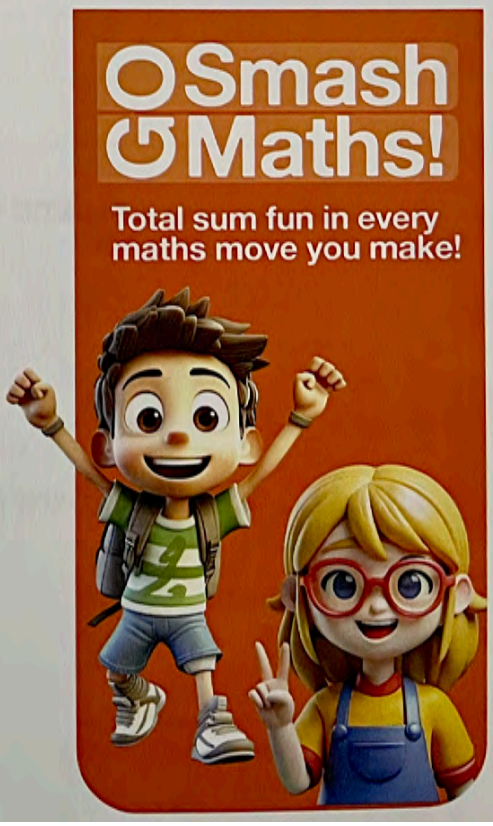
- Yes, much more confident
- A little more confident
- ✓ No change
- I felt less confident

7. How easy was it to understand the rules of the game?

- ✓ Very easy
- ✓ Easy
- A little difficult
- Very difficult

8. Did the game feel too long, too short, or just right?

- Too long
- Too short
- ✓ Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- Yes
- ● No

2. Did you enjoy playing the GoSmashMaths! game?

- ✓ Yes
- No

3. What was the most fun part of the game?

my favorite part was the addition and adding the numaraks up

4. Do you think your other friends would also like to play this game?

- ✓ Yes
- No
- Not sure

5. Did you feel the game helped you understand maths better?

- ✓ Yes, a lot
- Yes, a little
- Not really
- No, not at all

6. Did the game make you feel more confident about doing maths?

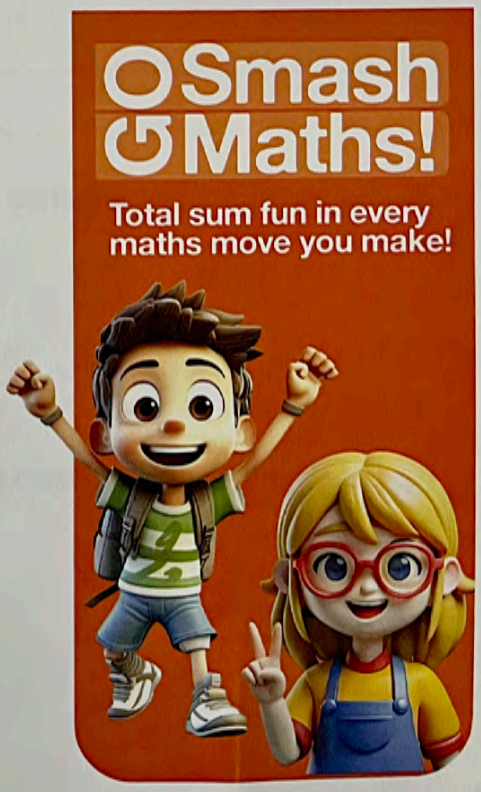
- Yes, much more confident
- A little more confident
- ✓ No change
- I felt less confident

7. How easy was it to understand the rules of the game?

- Very easy
- Easy
- ✓ A little difficult
- Very difficult

8. Did the game feel too long, too short, or just right?

- Too long
- Too short
- ✓ Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- [x] Yes
- [ ] No

2. Did you enjoy playing the GoSmashMaths! game?

- [x] Yes
- [ ] No

3. What was the most fun part of the game?

Beeing in second place.

4. Do you think your other friends would also like to play this game?

- [x] Yes
- [ ] No
- [ ] Not sure

5. Did you feel the game helped you understand maths better?

- [x] Yes, a lot
- [ ] Yes, a little
- [ ] Not really
- [ ] No, not at all

6. Did the game make you feel more confident about doing maths?

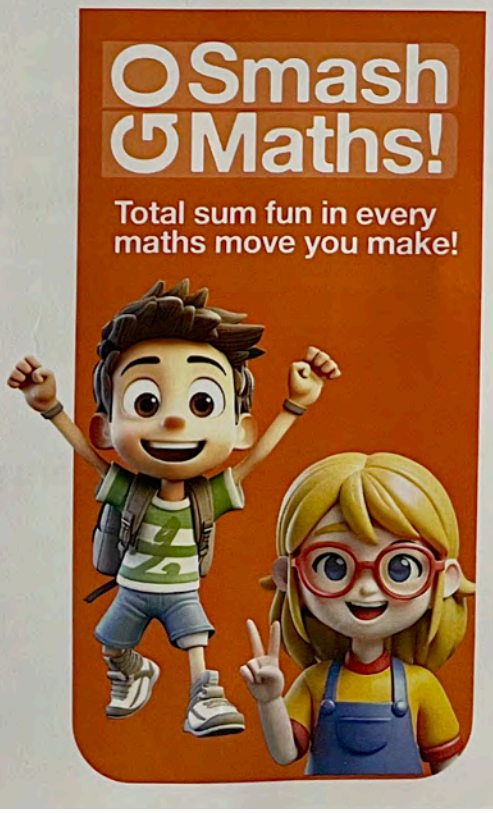
- [x] Yes, much more confident
- [ ] A little more confident
- [ ] No change
- [ ] I felt less confident

7. How easy was it to understand the rules of the game?

- [x] Very easy
- [ ] Easy
- [ ] A little difficult
- [ ] Very difficult

8. Did the game feel too long, too short, or just right?

- [ ] Too long
- [x] Too short
- [ ] Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- Yes
- No

2. Did you enjoy playing the GoSmashMaths! game?

- Yes!
- No

3. What was the most fun part of the game?

The most fun part of the game was that It had everything fun with subtraction and addition.

4. Do you think your other friends would also like to play this game?

- Yes
- No
- Not sure

5. Did you feel the game helped you understand maths better?

- Yes, a lot
- Yes, a little
- Not really
- No, not at all

6. Did the game make you feel more confident about doing maths?

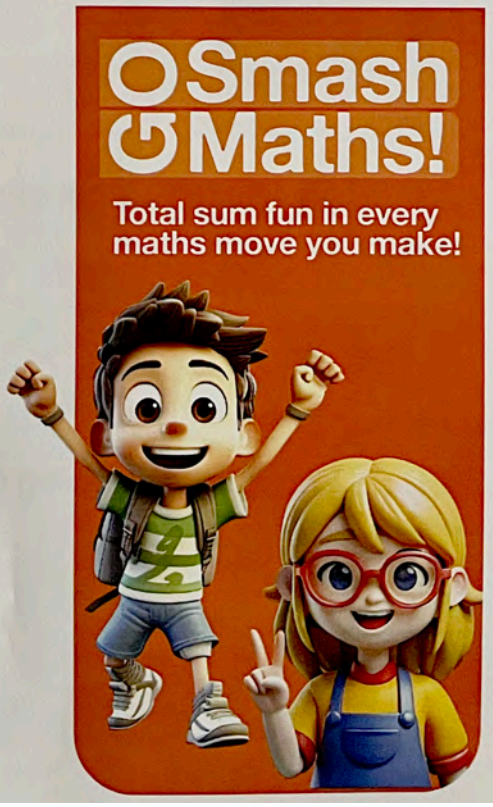
- Yes, much more confident
- A little more confident
- No change
- I felt less confident

7. How easy was it to understand the rules of the game?

- Very easy
- Easy
- A little difficult
- Very difficult

8. Did the game feel too long, too short, or just right?

- Too long
- Too short
- Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- (0) Yes
- No

2. Did you enjoy playing the GoSmashMaths! game?

- ✓ Yes
- No

3. What was the most fun part of the game?

Were you got to move up and be 1st in the lead,

4. Do you think your other friends would also like to play this game?

- ✓ Yes
- No
- Not sure

5. Did you feel the game helped you understand maths better?

- ✓ Yes, a lot
- Yes, a little
- Not really
- No, not at all

6. Did the game make you feel more confident about doing maths?

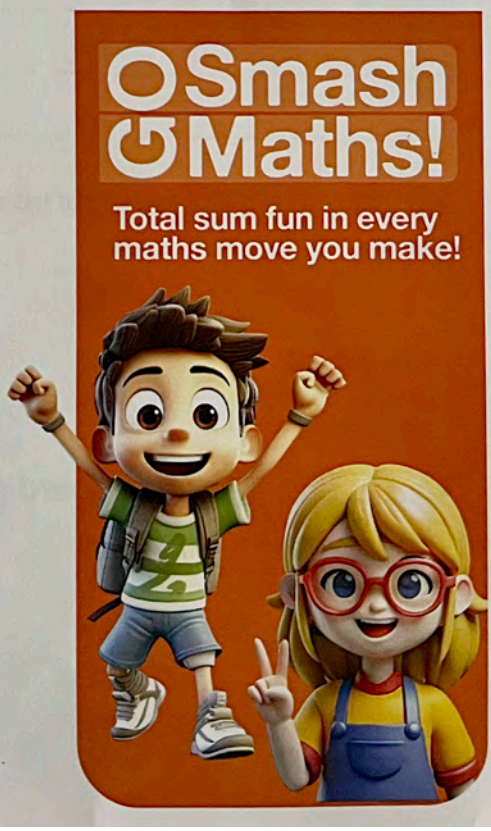
- Yes, much more confident
- ✓ A little more confident
- No change
- I felt less confident

7. How easy was it to understand the rules of the game?

- Very easy
- Easy
- ✓ A little difficult
- Very difficult

8. Did the game feel too long, too short, or just right?

- Too long
- Too short
- ✓ Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- [x] Yes
- [ ] No

2. Did you enjoy playing the GoSmashMaths! game?

- [x] Yes
- [ ] No

3. What was the most fun part of the game?

When we had to move on the board

4. Do you think your other friends would also like to play this game?

- [x] Yes
- [ ] No
- [ ] Not sure

5. Did you feel the game helped you understand maths better?

- [ ] Yes, a lot
- [x] Yes, a little
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- [ ] Very easy
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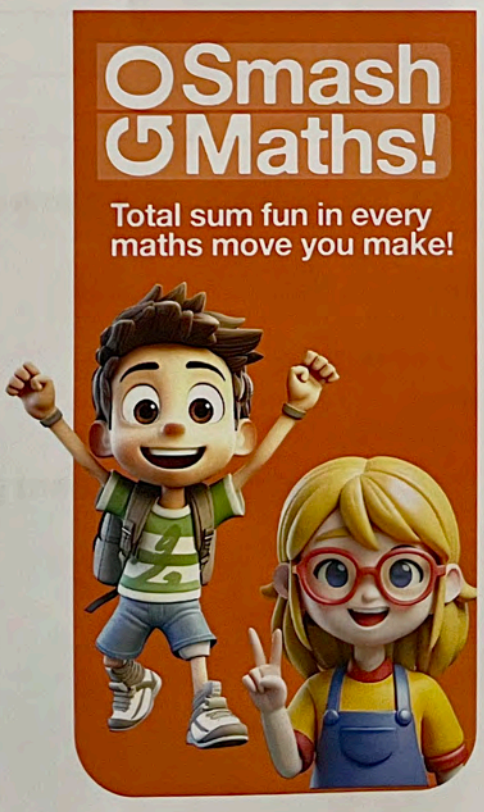
- [ ] Too short
- [x] Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- Yes
- (No)

2. Did you enjoy playing the GoSmashMaths! game?

- (Yes)
- No

3. What was the most fun part of the game?

minesing everything then getting the cards after wurds

4. Do you think your other friends would also like to play this game?

- (Yes)
- No
- Not sure

5. Did you feel the game helped you understand maths better?

- (Yes, a lot)
- Yes, a little
- Not really
- No, not at all

6. Did the game make you feel more confident about doing maths?

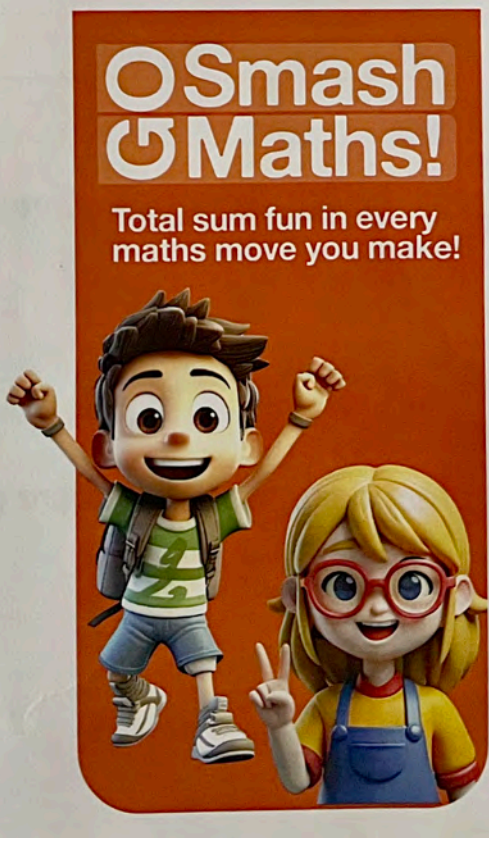
- (Yes, much more confident)
- A little more confident
- No change
- I felt less confident

7. How easy was it to understand the rules of the game?

- (Very easy)
- Easy
- A little difficult
- Very difficult

8. Did the game feel too long, too short, or just right?

- Too long
- Too short
- (Just right)



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- [x] Yes
- [ ] No

2. Did you enjoy playing the GoSmashMaths! game?

- [x] Yes
- [ ] No

3. What was the most fun part of the game?

The most fun part was when we got to add the number together.

4. Do you think your other friends would also like to play this game?

- [x] Yes
- [ ] No
- [ ] Not sure

5. Did you feel the game helped you understand maths better?

- [ ] Yes, a lot
- [x] Yes, a little
- [ ] Not really
- [ ] No, not at all

6. Did the game make you feel more confident about doing maths?

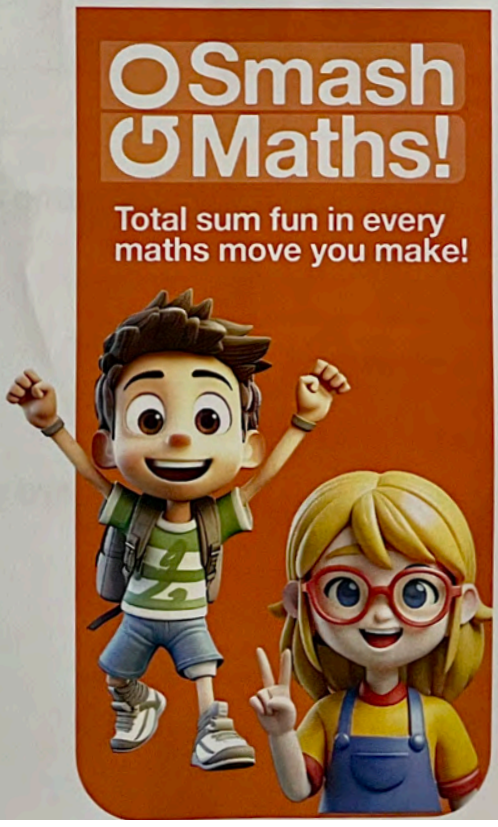
- [ ] Yes, much more confident
- [x] A little more confident
- [ ] No change
- [ ] I felt less confident

7. How easy was it to understand the rules of the game?

- [ ] Very easy
- [x] Easy
- [ ] A little difficult
- [ ] Very difficult

8. Did the game feel too long, too short, or just right?

- [ ] Too long
- [ ] Too short
- [x] Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?
- Yes
- No

2. Did you enjoy playing the GoSmashMaths! game?
- Yes
- No

3. What was the most fun part of the game?

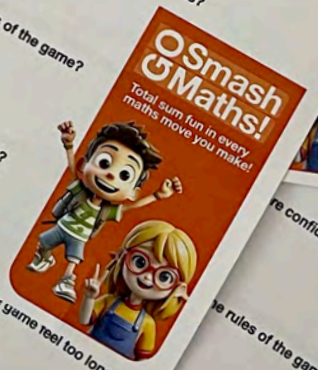
4. Do you think your other friends would also like to play this game?
- Yes
- No
- Not sure

5. Did you feel the game helped you understand maths better?
- Yes, a lot
- Yes, a little
- Not really
- No, not at all

6. Did the game make you feel more confident about doing maths?
- Yes, much more confident
- A little more confident
- No change
- I felt less confident

7. How easy was it to understand the rules of the game?
- Very easy
- Easy
- A little difficult
- Very difficult

8. Did the game feel too long, too short, or just right?
- Too long
- Too short
- Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

1. Did you sometimes find maths a bit tricky?

- Yes
- No

2. Did you enjoy playing the GoSmashMaths! game?

- Yes
- No

3. What was the most fun part of the game?

_____

_____

_____

4. Do you think your other friends would also like to play this game?

- Yes
- No
- Not sure

5. Did you feel the game helped you understand maths better?

- Yes, a lot
- Yes, a little
- Not really
- No, not at all

6. Did the game make you feel more confident about doing maths?

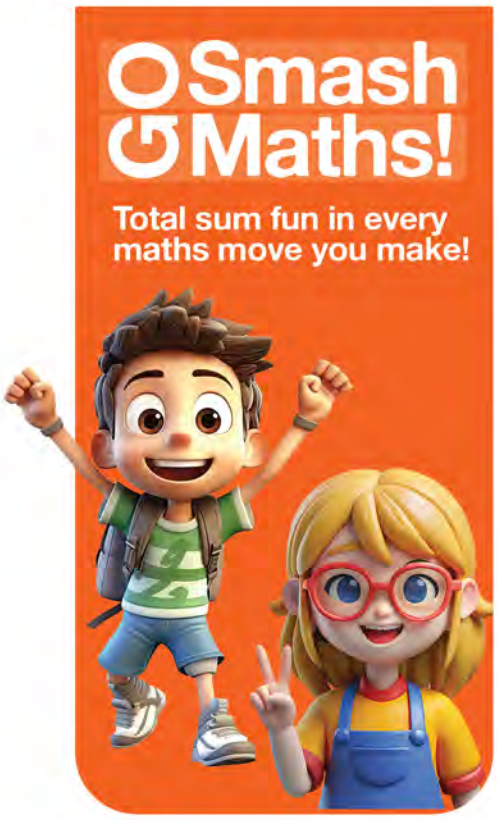
- Yes, much more confident
- A little more confident
- No change
- I felt less confident

7. How easy was it to understand the rules of the game?

- Very easy
- Easy
- A little difficult
- Very difficult

8. Did the game feel too long, too short, or just right?

- Too long
- Too short
- Just right



Survey 2: GoSmashMaths! Game Testing Survey: STUDENTS YRS 3-4

9. Did the game look fun (characters, colours, numbers, letters) and easy to play?

- Yes
- No

10. Were there any parts of the game that were confusing or hard to understand?

11. What was your favourite part of the game?

12.What would you change to make the game better?

13. Do you think this game could help students who don't like maths enjoy it more?

- Yes
- No
- Not sure

14. Do you think the board games would work well as an app?

- Yes
- No
- Maybe

APPENDIX C

In-class User Testing Feedback
60 Students, 10 Teachers

STUDENT SURVEY SAMPLES QUOTES

YEARS 3-6

10. Were there any parts of the game that were confusing or hard to understand?

No it was the best game ever.

11. What was your favourite part of the game?

everything was so fun I want to play again.

11. What was your favourite part of the game?

My favorite part was the addision.

12. What would you change to make the game better?

to be honest nothing

11. What was your favourite part of the game?

My favourite part was the coulour of it and how cool it looked

11. What was your favourite part of the game?

all of it

12.What would you change to make the game better?

nothing

10. Were there any parts of the game that were confusing or hard to understand?

no all of it was pretty easy to understand

11. What was your favourite part of the game?

collecting lots of cards and also there are stuff you need to do when you land on a certain spot

2. Did you enjoy playing the GoSmashMaths! game?

- [x] Yes
- [ ] No

3. What was the most fun part of the game?

weh! we got to leren how to play

11. What was your favourite part of the game?

my favrdurite part of the game was the plusing

12.What would you change to make the game better?

I do not now enething to chang it

2. Did you enjoy playing the GoSmashMaths! game?

- [x] Yes
- [ ] No

3. What was the most fun part of the game?

playing with my Friends

11. What was your favourite part of the game?

Where we got to challeng ourself uginst the question.

12.What would you change to make the game better?

nothing

---

11. What was your favourite part of the game?

I like how there was little things you need to do on the board

---

3. What was the most fun part of the game?

collecting the cards

No

10. Were there any parts of the game that were confusing or hard to understand?

no It was easy and enjoyable

9. Did the game look fun (characters, colours, numbers, letters) and easy to play?

- [x] Yes
- [ ] No

10. Were there any parts of the game that were confusing or hard to understand?

no, besides when we were reading the instusions

11. What was your favourite part of the game?

when it was my turn

12.What would you change to make the game better?

nothing

12.What would you change to make the game better?

nothing

APPENDIX D

Interviews with Experts and Professional Feedback

Dr Fiona Kerr

Dr Fiona Kerr, Neuroscientist and interviewee

Hi Willem,

Please find attached my response to you Willem, and a couple of things I cut and pasted from the internet that may be of interest to you.

Good luck with the assignment, and if you need to clarify anything let me know as I am now in situ and will be more able to respond.

Kindest regards,
Fiona

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Founder and CEO
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www.theneurotechinstitute.com
Aldgate, South Australia

The NeuroTech Institute

FOCUS

response for Willem.docx

Here is some online i...st.docx

A document created for my research by Dr Fiona Kerr, Neuroscientist and interviewee

Hi Willem,

At last I am in one place and can concentrate on giving you some information.

My qualifications and role

The first is to add my current job which I mentioned in the email to you – as the Director of MindChamps AIR (applied integrated research) I am specifically looking at the cognitive impact of technology and tools on learning and engagement vs excitement/distraction, related to encoding and retention,etc.

I have also just been made a fellow of ATSE, which is the Australian Academy of Technology, Science and Engineering for my work in the neurophysiology of human-human and human tech interaction.

Hopefully they will help as they are both particularly relevant, apart from founding NTI.

Info for the technological aid

I will outline the main things to think about when designing maths tools for neurodivergent students, the positives of such games / tools and also the negatives, and how to minimise them.

I have also found some lists that give good examples for you concerning design, and some examples of what are said to be good aids for you to look at.

The main things to think about.

Neurodivergent students will have widely individual needs – this can be:

- Sensory (ie visual, auditory, tactile, kinaesthetic)
- Trouble with executive function (which impacts organisation, planning, self regulation, problem solving - all changes how they will use a game)
- Where they are on skill range – from exceptional to struggling with foundational math concepts, number sense, abstract concepts (fractions, algebraic equations), symbolic representations, etc as well as problem solving.
- Executive function varies and impacts things like planning and self-regulation, which alters how long they will pay attention to an app or game activity.this also impacts problem solving as well as organisation of data and activities, impacting the management of maths tasks that need multiple steps or way to process the data.
- Although difficulty with social learning may not seem as relevant with mathematics tools, it becomes important if you are using them for collaborative activities, or to collect data for teachers or parents (which can be very useful in supporting them and tracking progress) or to help them ask for assistance.

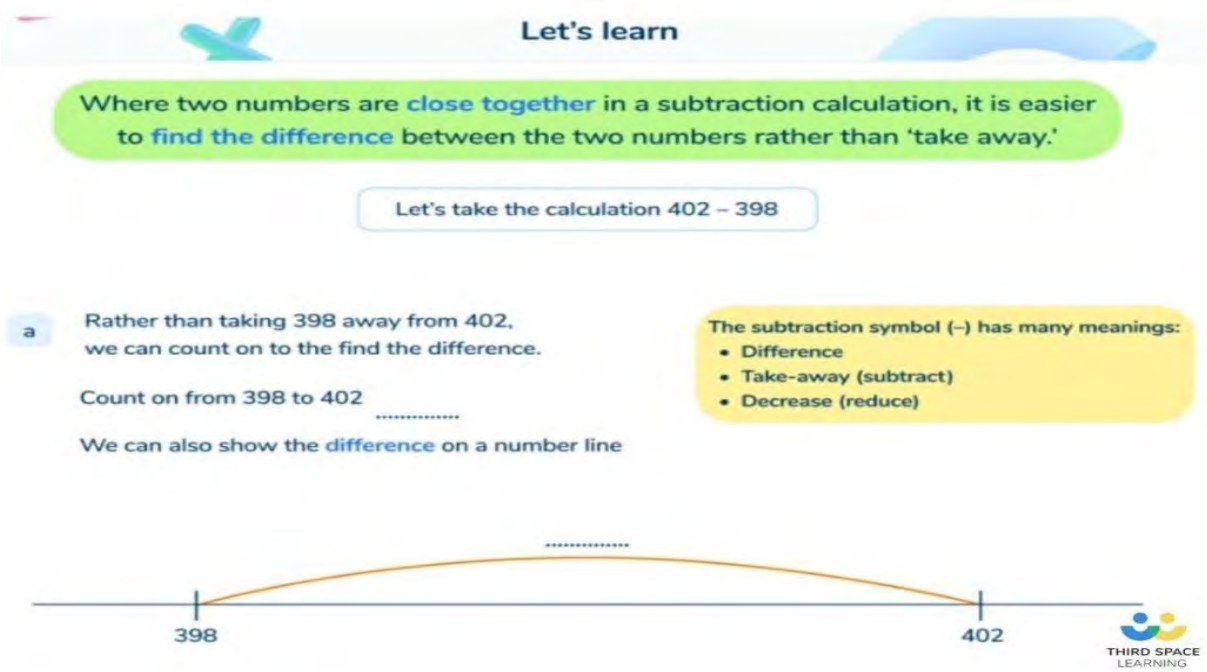
The sort of things that help in design.

The needs are often summarized as requiring visual supports, providing structured instruction, individualizing learning experiences, attention management and support.

If we take the design aspects one by one, visual supports and manipulatives include:

1) Visual representation of problem:

- This includes aids such as charts, diagrams, and other concrete representations such as this one from third space learning:

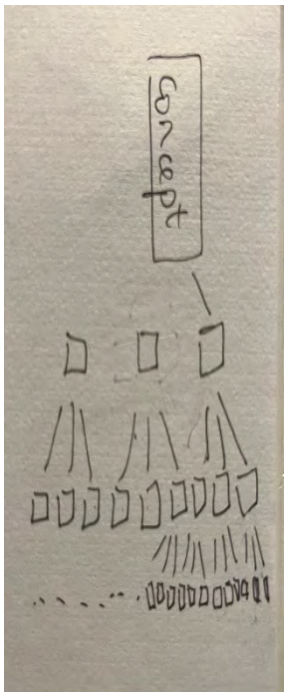


- grouping of information is also very helpful, and this along with visualisation is similar to the use of physical manipulatives in the classroom

- Colour coding often assists for the same reason

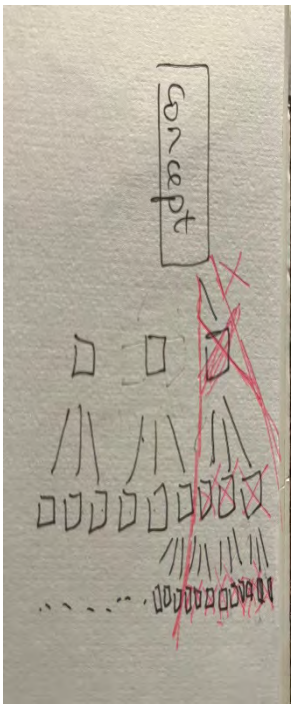
- These students are literal, so displaying the actual numbers can help – and concrete examples such as real world scenarios like baking or banking

- When the grade levels includes word problems, ensure the terms are explained as often the children are very literal (ie a table is not a thing we eat at)

2) 

Structured instruction

The way we ALL learn a concept is via encoding the basic building blocks, and then adding to each as we build up a large map of knowledge (fig 1)



If we miss one of the fundamental building blocks, then everything that hangs on that is also missed as we have nothing to anchor it to, so we end up with a blank that stops us fully grasping the concept unless we are taken right back to basics and the gap is filled in.

So, what this means here is:

- Break down concepts into smaller problems – this also helps to maintain attention and allows places for you to reward getting steps right!
- Decomposing the problem (such as addition) is needed twice as much with many neurodivergent students.
- It minimises overwhelm and ensures each building block is absorbed
- The structure also helps with automating record keeping of how well the student is doing for parents and teacher to help.
- Incorporate a function that lists relevant math facts so that the student can easily refer to it whenever they need.
- Structuring in praise as often as possible keeps students motivated.
- Using multiple-choice format rather than yes or no questions can be helpful too.

3) Individualizing learning experiences

There is a need to maintain attention, especially if there are issues with concentration, self regulation, etc. Having the options of using different approaches in the technology will greatly enhance the useability and maintenance of attention in order for encoding of information to occur. This includes such things as:

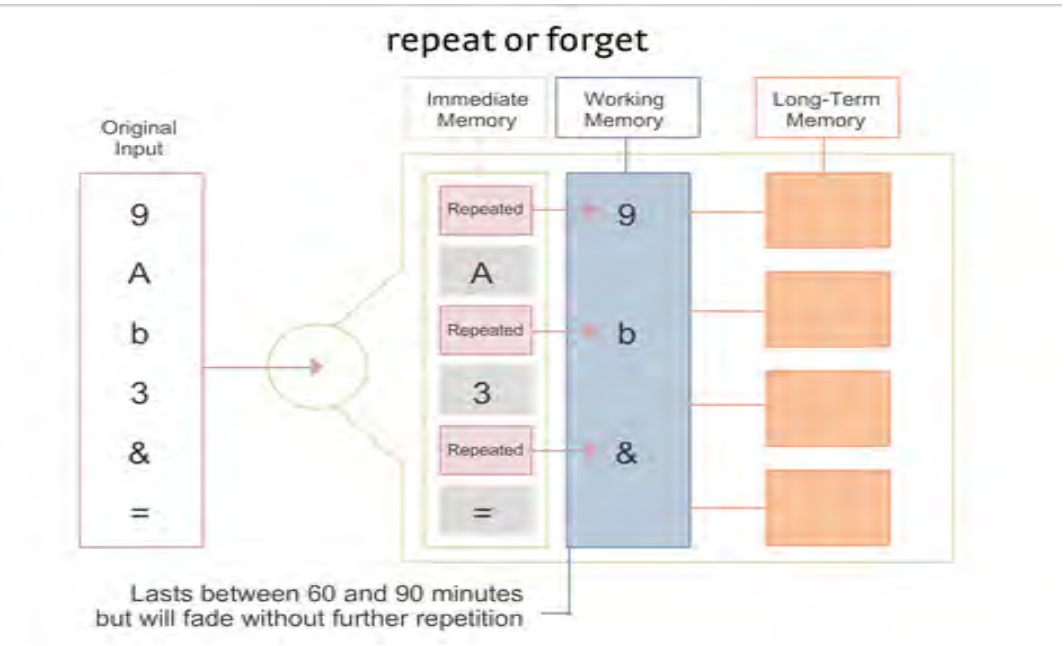
- Building in options for multiple grade levels to be played at once. This allows the quicker students to ensure they have covered the steps and even skip ahead if needed so they don't lose interest.
- It also lets those taking longer to stop and take their time, and to repeat if necessary until they close that gap in foundational pieces of knowledge – critical with core knowledge elements.
- Building in ways to practice and to test knowledge at each step is both useful and motivating, as well as letting them progress at their own pace.
- Incorporating the student's personal interest as options is a good design feature to include where possible (ie choosing animals, planes, or characters that are relevant to them in a game). If there is an option for the parent or teacher to identify the child's interest and use it to assist teaching when they are young, that is also motivating.
- Ensure that the sessions or math problems don't go for too long. A fairly commonly quoted time is 7 minutes for a problem (remember also that even adults become much less cognitively sharp when onscreen over 15 minutes).

4) Multisensory and interactive tools

- Adding to the former point, where possible design the technology tool so that the different learning styles (ie visual-spatial style) can be catered to by options that present the appropriate multimedia and options for interacting directly in different ways (ie gestures or hands-on activities for kinaesthetic learners, and appropriate levels of visual and auditory stimulation).
- Pairing visual and voice (verbal) instructions works 6 x better in non-neurodivergent children for encoding the information, and this is even greater for various kinds of neurodivergence
- Assistive technology - think of designing for those who's fine motor skills aren't as developed such as large buttons, or talking instructions for those with visual issues, etc.

5) Timing

- Ensure that there is enough time between activities or steps for the student to absorb and encode the information – this is a common error both for games and in the classroom as adding new information too soon overwrites the information just given, or cognitively distracts the student so that new information is missed.
    - A quick lesson in cognition of learning - After 30 seconds the neuron well reset without a repeat signal
    - It then fades or gets transferred
    - That is why to learn a concept, all critical bits of information need to be encoded



Here are the positives and negatives of using Interactive technology tools

As can be seen, interactive tools include visual representations, auditory feedback methods, interactive elements that suit the student and assistive technology design for those who need it. They can have many advantages if well designed, but also can be challenging, distracting and overwhelming, creating DISadvantage for the student if they are not appropriately designed or used. Here are the major positives and negatives of such maths tools:

Positives of these tools

- Many opportunities for success and positive reinforcement can be built in to the tools
- Problems can be broken down into their smaller parts for clear steps to be encoded
- Visual cues and prompts can be readily available, as well as concrete examples that help to capture the attention of the student
- The tools can be made to actively involve others where useful
- The ability for additional visual and hands on multi-modal instruction to be built into classroom activities that are reinforced by the technology tool is very useful

Negatives of these tools

- Distraction. Technology creates distraction which stops absorption for all humans, and in particular can be challenging for those with sensory issues as they overload such students as they can be too bright, too loud, too fast, too heavily decorated, etc.
- Focus. They drop the ability for the student to focus, blocking the ability for absorbing and encoding, and disrupting the flow of breaking down a problem into its logical parts
- Pace. The fast pace of many tools can keep those who have exceptional knowledge engaged but increase the potential for leaving holes and gaps in the laying down of building blocks that ensure the next part of a concept can be added and encoded.
- As above, it gets overwritten so the last piece is lost, or distracts so the next piece is not absorbed.

Last word – will they use it????

Above are all of the technical aspects of math tool design.

However, when designing such tools, remember that they can be great but not used at all if the student is not willing to use it for non-technical reasons. The main ones ar:

Will it make them feel conspicuous?

- this is a common issue for neurodivergent students who will not speak up or ask for help or want to be singled out or draw attention to themselves. Obvious assistant tools can put them off.

Is it compatible with other technology and should it be?

- this is commonly overlooked by app and tech designers. It may not be relevant that the tool interfaces with other tech, but think about whether it could be useful with other class activities

How easy is it to learn?

- The points we have discussed should help with this, but if it is too hard to early, many students (neurodivergent or not) will not persist, so take particular care in the initial stages of interaction.

Here is a final summary of the options to consider to cover the student's challenges:

- explain the context of a math problem
- organise the information clearly
- order the operation logically
- identify relevant data and having it available to refer to where possible
- don't assume knowledge of terms (assist with literal meaning of the words used)
- build in opportunities for immediate feedback, if possible with real time information on progress
- give explicit instruction, repetition and chunking up the information
- customizable use where it assists (pace, extra info available, abstract concept breakouts, multiple senses catered for) but also don't overwhelm with choice.

I hope this helps in your thinking about the design and use of the math tool – whenever I do this I spend a lot of time up front with the users and then get feedback regularly along the way so that I am clear on what the want and need as I go.

Good luck, and great idea Willem!

Fiona

A reference document created for my research by Dr Fiona Kerr, Neuroscientist and interviewee

Here is some online info that may be of interest

10 Teacher-Recommended Math Apps and Online Tools

Whether you teach online or in person this fall, these digital math tools may come in handy for grades pre-K through 12.

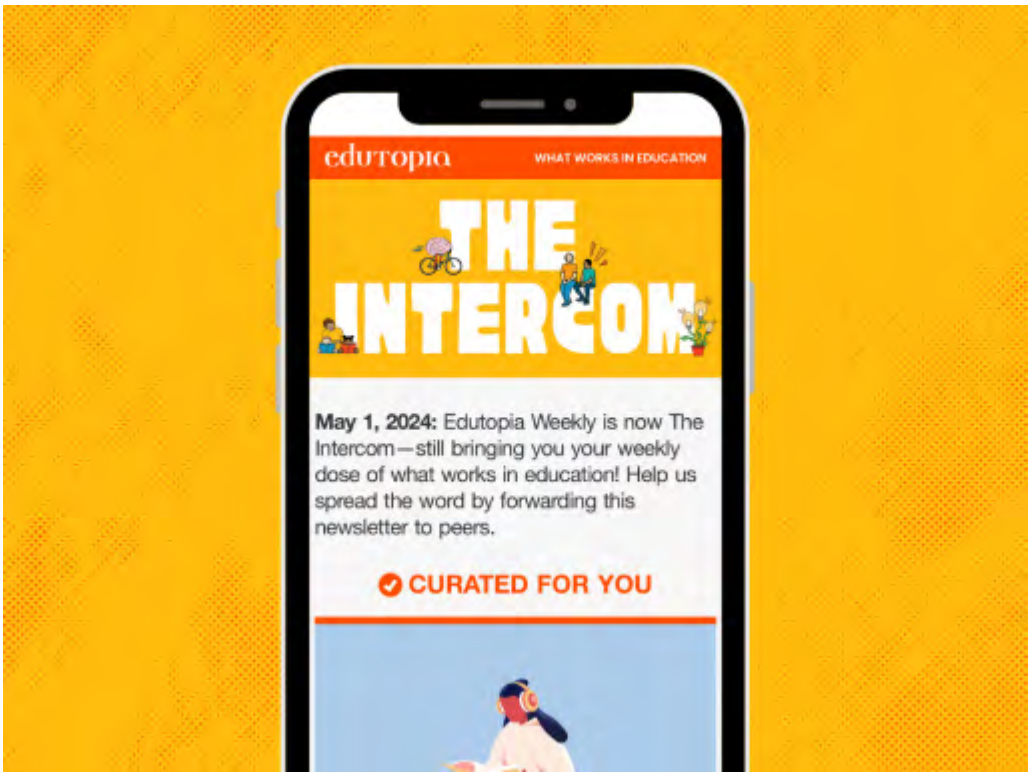
By Emelina Minero

July 27, 2020

For some math teachers, digital tools that help students visualize math concepts like Desmos or websites that encourage mathematical discussion like Fraction Talks were already a part of their repertoire before the pandemic. But for other teachers, remote learning pushed them to explore math apps and online resources for the first time.

We spoke to hundreds of educators and sifted through more than 500 comments to hear about what math tools they found helpful and unhelpful during remote learning this spring, and which are making the cut to use in the new school year.

Start of newsletter promotion.



Announcing…The Intercom

Sign up for our indispensable weekly newsletter, featuring must-read articles on classroom management, SEL, student engagement, assessment—and much more—all tailored to your interests.

I want that!

End of newsletter promotion.

Math Skills Practice

A number of math apps and online tools can help students develop the necessary foundational understanding of arithmetic operations they'll need as a baseline for more challenging math problems later on, math teachers told us.

To help younger students practice skills like counting, addition, and subtraction, Ashley

Blackwelder, an elementary STEAM coordinator in South Carolina, highly recommends Moose Math, a free app for iPhones and iPads. In Moose Math, students play math games that earn them points to help build a town. Blackwelder says the format is easy for kids to navigate and great for short attention spans.

Curriculum and instructional designer Cassie Tabrizi recommended Happy Numbers (pre-K–grade 5), a subscription-based website ($14.50 per student or $1,450 per site for first-time schools) that breaks down mathematical equations to help students build understanding of higher-order math concepts. To use it, students transform into a dinwosaur character and solve math problems to hatch dinosaur eggs. Tabrizi said that the website is helpful, but she recommends using it in moderation: It can feel tedious for students if they practice longer than 10 minutes a day.

Students fight monsters in the persona of a wizard in Prodigy (grades 1–8), a free game-based website (also available as an app for iPhone, iPad, iPod Touch, and Android). Prodigy is loved by kids, but less so by educators because it is more play based. Brittney Paige, a fifth-grade teacher in Seattle, says that even though it is more of a game, she likes that it automatically targets math concepts that students struggled with in its preassessment and tracks how much progress they make on target areas. Most teachers offer Prodigy as an option for students if they finish an assignment early.

Courtesy of Prodigy

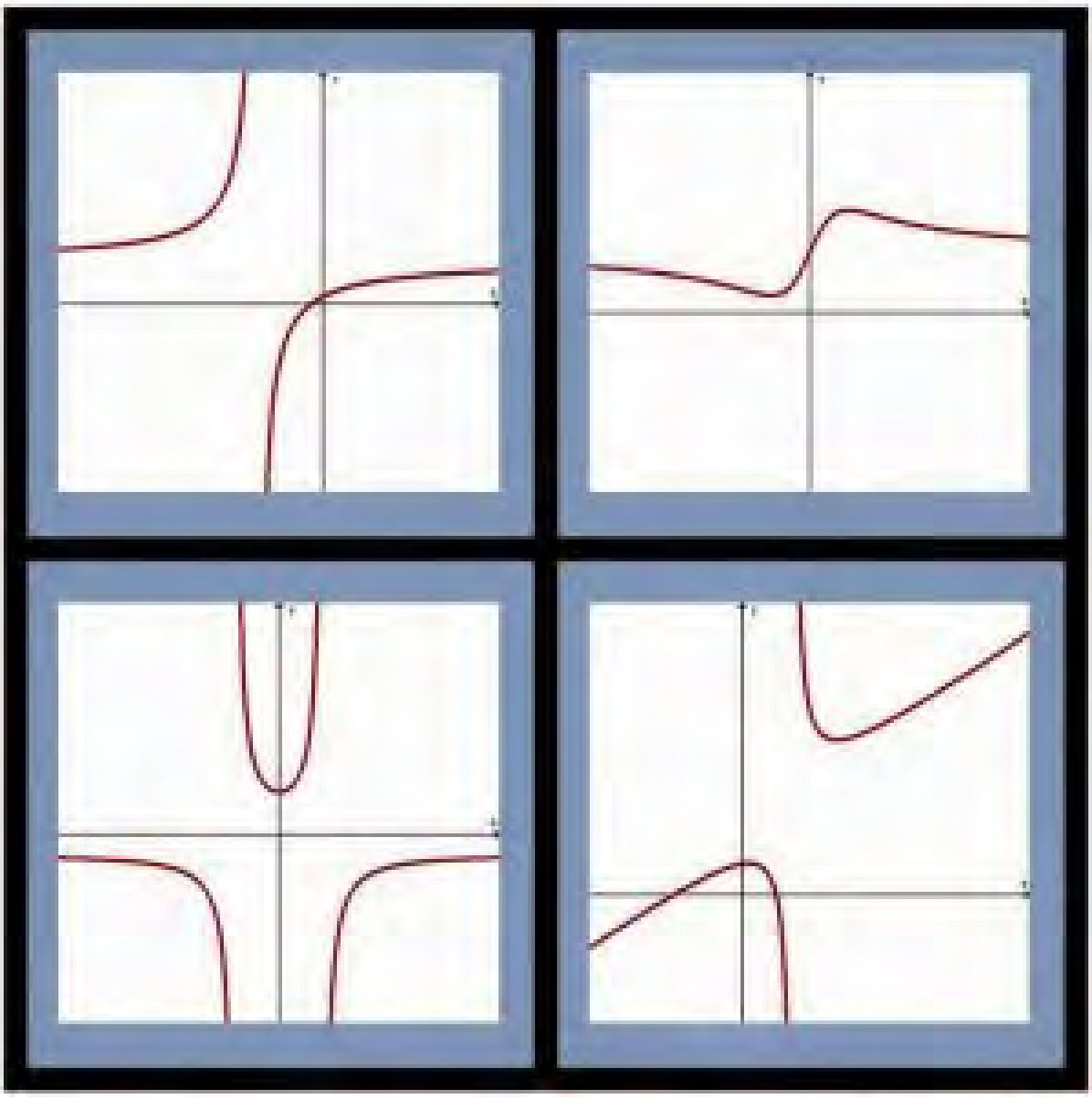
After successfully answering a math problem, a student's pet casts a spell in a battle.

Zearn (grades 1–5), a free, self-paced, web-based program aligned with Eureka Math—a free pre-K through 12 math curriculum—starts a typical lesson with fun warm-up activities, like adding up how many apples a cartoon fox eats, to engage students. As they work through the program, students complete timed arithmetic problems, watch instructional videos on new concepts, and solve practice problems. Shannon McGrath, an instructional coach in Western Springs, Illinois, says that Zearn is good "high-level, conceptual practice" and gives good feedback for both teachers and students, but can sometimes progress too slowly for kids who master concepts quickly.

Open Math Tasks

Open math tasks—problems that typically have more than one answer—help students develop a conceptual understanding of math rather than get hung up on memorizing facts, said math educators we talked to, who consistently mentioned three free websites to use for open math tasks.

Open Middle (pre-K–grade 12) leaves parts of an equation blank and asks students to fill them in to make it true. “I love Open Middle for remote learning, especially paired with a Google Jamboard,” says McGrath. “The problems inspire inquiry thinking, gamelike play, creativity, and perseverance.”



Courtesy of Mary Bourassa/Which One Doesn’t Belong

Using ‘Which One Doesn’t Belong?’ Mary Bourassa’s calculus students make a mathematical argument why each graph is the odd one out.

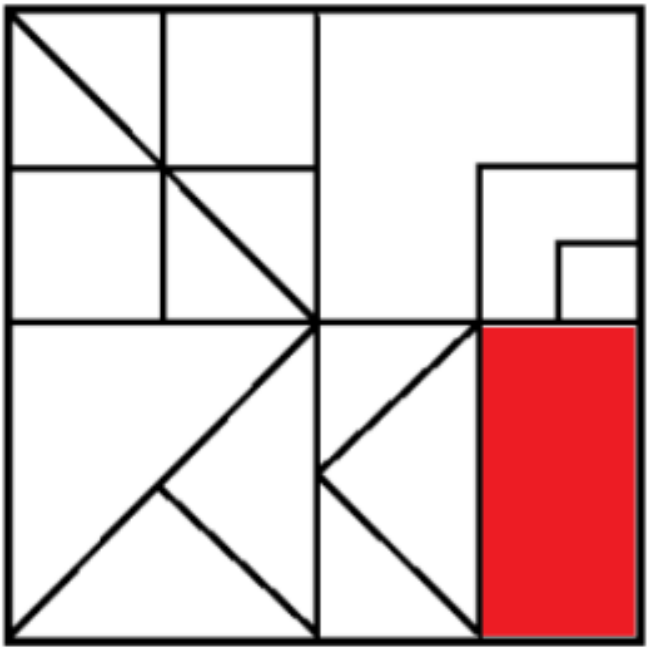
McGrath also likes Would You Rather Math (pre-K–grade 12) for community building. When using the site, students choose between two real-life examples—like a box of chocolates with five rows and 14 columns or a box of chocolates with seven rows and nine columns—and have to make a mathematical argument to validate their choice.

Which One Doesn’t Belong? (pre-K–grade 12), a similar site, showcases four shapes, numbers, or graphs and asks students to describe which one doesn’t belong, using math vocabulary.

“This is great for opening a synchronous discussion, as it is considered a low-floor, high-ceiling task,” says Joseph Manfre, a math specialist for the Hawaii Department of Education. High school math teacher Mary Bourassa has her calculus students identify reasons why each graph in a set of four doesn’t belong by indicating graph characteristics like asymptotes and non-differentiable points, and later has her students create their own WODB sets.

Rich Math Tasks

For rich math tasks—tasks that lend themselves to rigor, collaboration, and conceptual thinking—math educators noted a couple of websites.



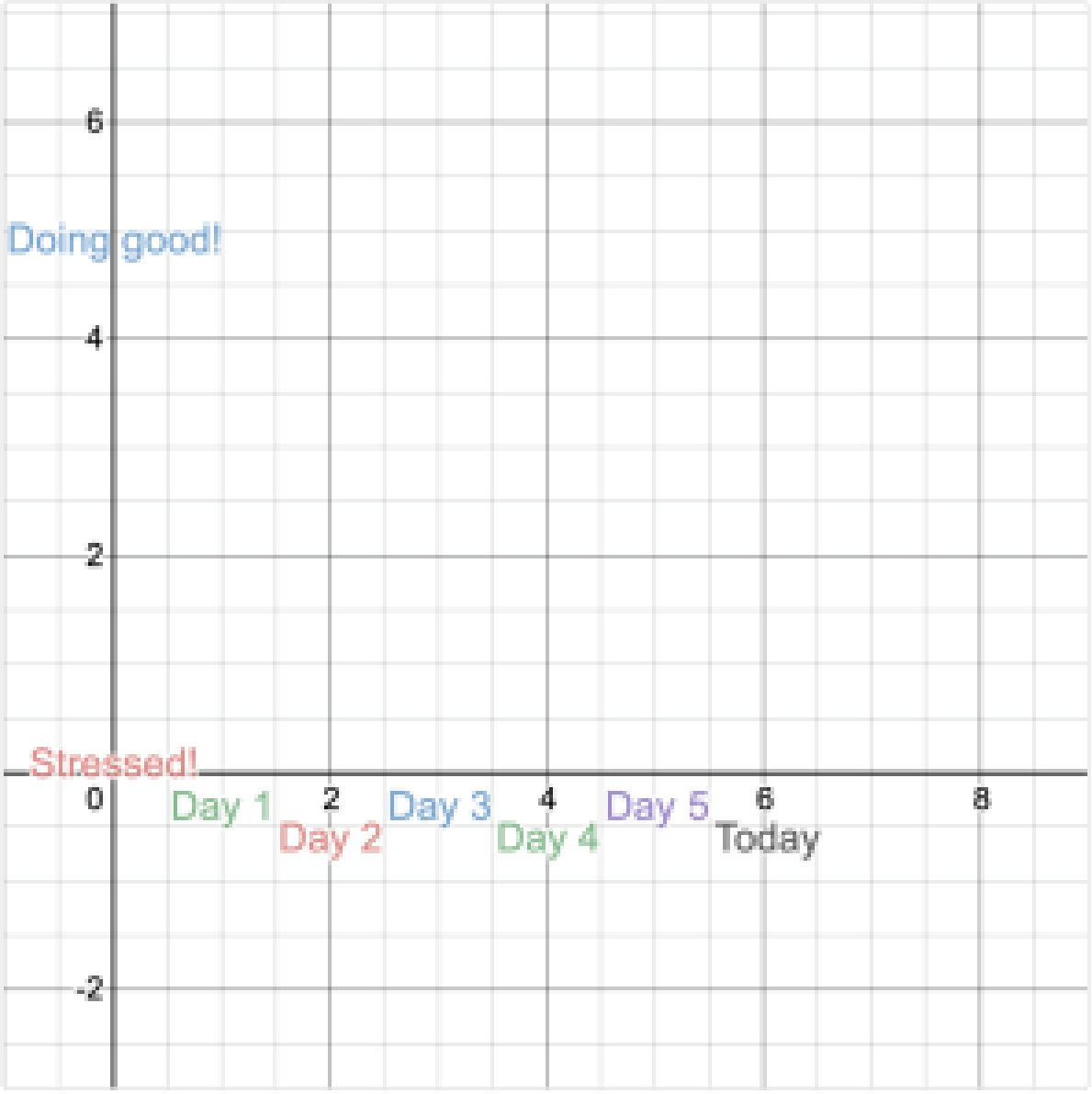
Courtesy of Bryan Penfound/Fraction Talks

Students use this image from Fraction Talks to practice adding and multiplying fractions. The bottom corner section represents ½ x ¼ = ⅛.

Fraction Talks (grades 1–12) is a website filled with images of shapes—triangles within triangles, for example—that encourages math discussions. Simply asking students, “What do you observe?” can prompt them to share what and how many shapes they notice, while asking “How many shapes are red or shaded?” encourages students to explore and understand fractions. Once students have a basic understanding of fractions, they can start to explore more complex concepts. By prompting students to look at subsections of a shape—and what fractions they created when combined—Bryan Penfound helped his seventh- and eighth-grade students to visualize adding and multiplying fractions.

Simulation Tools

According to math teachers, simulations, like manipulating an expression and seeing a change in a graph, are great tools to help students visualize math concepts.



Courtesy of Ashley Taplin

Ashley Taplin, a secondary math specialist, had her students graph how they felt during the first week of distance learning.

Applets—a simple code with a specific objective—were mentioned by a few teachers as a good resource. Emma Chiappetta's statistics students use applets from RossmanChance.com to manipulate and identify sampling distribution patterns in graphs, for example. She creates a basic guide on how to use the applet with which values to change, and then asks questions to get students thinking critically about those patterns. Chiappetta also uses applets from the Massachusetts Institute of Technology for her linear algebra students.

Desmos (grades 6–12), a website with interactive math activities and a graphing calculator (also available as an app on iPhone, iPad, iPod Touch, and Android), is another free tool and a favorite among teachers, we heard. While social and emotional learning (SEL) and math may not seem to go hand in hand, teachers integrated SEL into math lessons using Desmos. In the first week of distance learning, Ashley Taplin, a secondary math specialist in San Antonio, Texas, had her students graph how they were feeling, for example. Taplin says she particularly loves that teachers can make their own activities—like this one about parabolas and this card sort, where students match cards with the name, corresponding equation, and correct graphical representation of a function.

10 Best Math Tools for High School Students

In high school, the focus in math classes turns to college and career prep through advanced algebra, calculus, test practice, and lots of real-life problem-solving. Whether teachers need a tool to flip the classroom or one to engage students in collaboration, these apps and websites go above and beyond static math practice by offering the customization, tracking, and differentiation students need to be prepared for learning beyond high school. A few also focus on making math relevant, both to students' future career paths and to social issues that'll spark interest and discussion.

6 Mathematics Apps or Tools every Teacher must use in Classroom

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Teaching Mathematics could be a big challenge for educators as certain students are not endowed with mathematical, reasoning and critical thinking skills. In addition to this, a lot of students find Mathematics monotonous and irrelevant to real-world problems. Digital tools and applications can help teachers to make students discover the relevance of Mathematics in the real world and aid in teaching the topics and lessons in a manner that intrigues the students.

If you are one of those Mathematics teachers who are always on the hunt for finding the best tools and methods to help students with their math work then we have got you covered. We understand your struggle and have come up with a list of apps that you can use to make

your math sessions interesting, innovative and fun for your kids. To find out the relevant apps, upEducators – A Google for Educators Partner Company- has collected feedback from hundreds of Mathematics teachers and has done research on many Digital Tools like the total number of downloads, and ranking of the App on the Play Store, traffic on their website and other factors. Based on the research here are the 6 best apps that can be used for teaching Maths.

- Geogebra

Geogebra is a free and easily accessible tool that Math teachers can use in their classroom as well as in virtual classes to make Math interactive and interesting. It is a dynamic software that integrates Algebra, Geometry, Graphs, Statistics, Calculus, and spreadsheets in an easy-to-use pack. It helps students to visualise and manipulate numbers. Geogebra is absolutely free of charge and available on any device.

Useful Geogebra Features for Teachers:

Geogebra has become the leader in providing Mathematics software supporting Science, Technology, Engineering and Mathematics (STEM) education across the world.
GeoGebra includes a symbolic calculator. It allows you to solve equations and do derivatives and integrals.

- Interactive geometry environment(2D and 3D) – Geogebra can replace a graphic calculator for drawing the curves of functions.
- Built-in Spreadsheet – Helps to copy data from any external spreadsheets and create charts such as histograms and use them for statistical analysis

- EquatIO

EquatIO is an easily accessible google extension to make learning Mathematics easier, especially with difficult stuff like equations, formulas etc. It is an editor and can be used for google docs, sheets, forms, slides and drawings. Teachers sometimes find it a bit difficult to use equations or formulas while creating tests or quizzes, hence this is your go-to! You just have to sign in to your Google account and look for this extension.

Useful EquatIO Features for Teachers:

Helps teachers and students in creating Maths and Science equations by simply typing the problems into the editor. Use predictive texts to insert mathematical problems and expressions like fractions, formulae, symbols and even exponents.

- Graph Editor – Graphs are an important part of various mathematical concepts and topics like geometry and statistics. Teachers can use EquatiO to create and insert multiple graphs, tables, charts and other such components digitally.

- Voice Recognition – Teachers and students can use EquatiO to create mathematical problems using the speech input feature. This feature comes in handy for comfortable teaching and also aids visually-impaired students to learn mathematics with ease.

- Jamboard

Teaching and learning math become a tad easier using this app. It is a virtual whiteboard that can easily be used as it has access to pen tools. Teachers can post the sums on there, while students can also solve the sums or work out their problems. Jamboard can be used in Microsoft Teams and Google classrooms. The users can collaborate with fellow Jamboard users as well.

Useful Jamboard Features for Teachers:

Educators will get access to a wide community of learners who are already connected with Unacademy. Teach with flexibility and get the complete authority to create and share your lesson plans on the Unacademy learning platform.

- Share Quizzes – Some teachers love quizzing but there are only limited digital tools that can make online quizzing a seamless experience. Google Jamboard is a tool that can be used by teachers to make students collaborate on quizzes and assignments.
- Add Charts, Graphs and Images for better learning – Teachers can use the Jamboard application to insert images, graphs and diagrams into a document or a video lecture. These visual aids can help in enhancing the learning experience in a Mathematic class.

- Google Earth

Not many students like Math, so we get why Math teachers find it difficult to convince kids to learn Mathematics. Math is useful in everyday life and this app helps kids between grades 5 to 10 to learn lessons from the textbook with real-life examples. For instance, formulas for calculating distance or measurements of stuff that we learn in Geometry. Google Earth helps calculate using 3D images.

Useful Google Earth Features for Teachers :

- Learning About Shapes – Have you ever noticed the shapes displayed over various locations when you try to find an address on Google Earth? This feature can be used to make young students familiar with different shapes. Click on different shapes and let the students learn along.
- Find Real-World Problems – What's the best way to teach Mathematics lessons than using real-world problems? Using real-world problems can make the subject and topics more relatable to students who are usually disinterested in learning Mathematics. Teachers can integrate Geometrical concepts like distance and measurements and ask students to learn these concepts based on real-life problems.
- Webquest – Google Earth has an in-built Webquest feature that allows students to plan a virtual road trip and helps them in learning various concepts by asking them to calculate costs, speed and time for the trip.

- Nearpod for Simulation

Nearpod helps make boring Math class turn into a fun class by incorporating slide-based lessons, and game-based activities for an engaging and productive session. It is a presentation tool that provides data through activities to help teachers view the student's responses. Nearpod is available on the play store or cloud and can be used on any device.

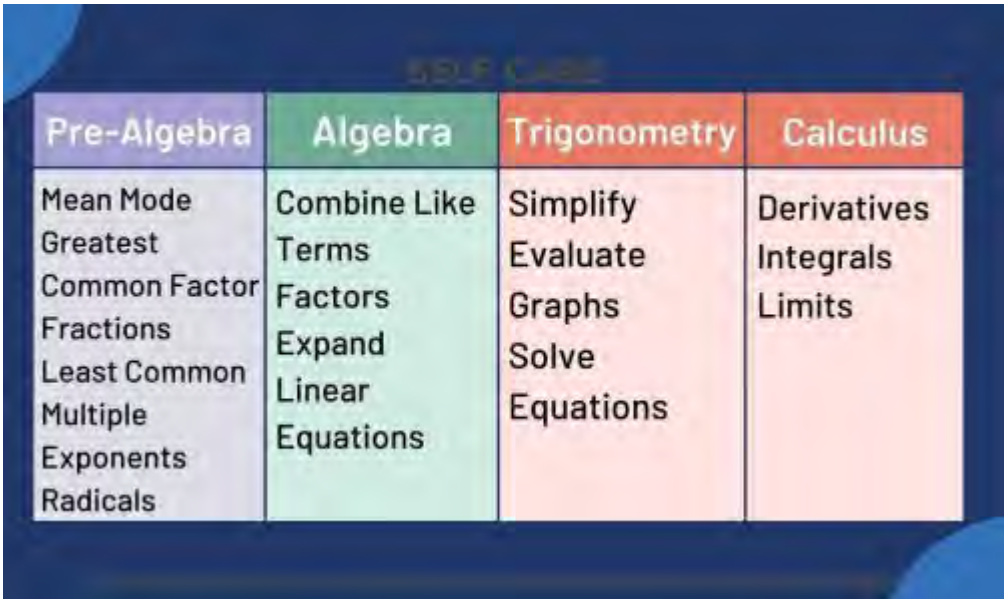
Useful Nearpods Features for Teachers:

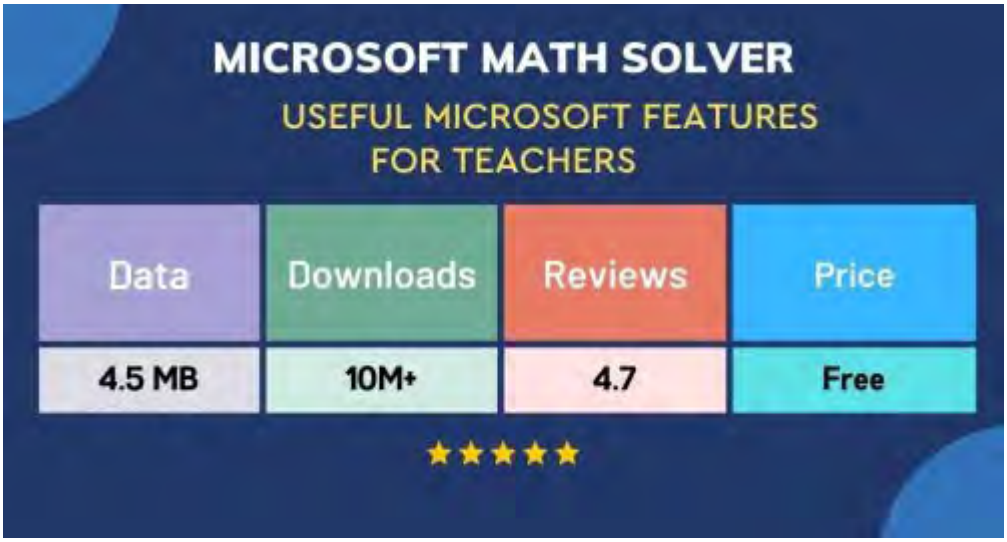
- Research-based instructional models – The lesson plans and sequences using Nearpods are designed with proper research-based models. The models like GRR and 5E are used in developing the instructional models in the Nearpods applications.
- Real-world problem solving – Virtual Reality tools and other such tech is used in Nearpods to enable learning with real-world problems. Mathematics can only be made fun and interesting by making students relate it to real-world problems.

- Learning through gamification – Teachers can use the Nearpod application and extension to gamify the learning experience. Students these days are into gaming and if this important part of their everyday lives can be integrated into the classroom lessons then it will help in enhancing the overall learning experience.

- Microsoft Math Solver

This is an entry-level learning tool that helps teachers and students solve Math and science problems. Initially developed for windows, it is now available on the web and also mobile devices and is free of cost. This application available for Android, web and iOs provides free step-by-step solutions to mathematical concepts like Pre- Algebra, Algebra, Calculus, and Trigonometry. Here are some of the topics covered by this application that can help teachers to make learning Mathematics easy and interesting.





Integrating tech and applications into teaching mathematics could be a game-changer for a lot of teachers. These applications, add-ons and tools can help teachers to make Mathematics interesting and even help students to develop a life-long love for the subject.

Teachers who are comfortable with self-paced learning can become tech-savvy and learn to use these applications and tools with the help of Youtube. But if you are looking for a live and interactive course to learn digital tools and applications for teaching, then upEducators offers courses designed for educators. The Google Certified Educators course, Microsoft Certified Educators Course or Coding Course for Educators can help teachers become tec-savvy and learn educational technology to teach not only Maths but all subjects using technology

Math Apps

These free apps are based on the visual models featured in Bridges in Mathematics. Apps are available in multiple versions: a web app for all modern browsers, and downloadable versions for specific operating systems and devices (such as Apple iOS for iPad).

Fractions

Represent fractions with denominators from 1 to 100 with circle and bar models.

Geoboard

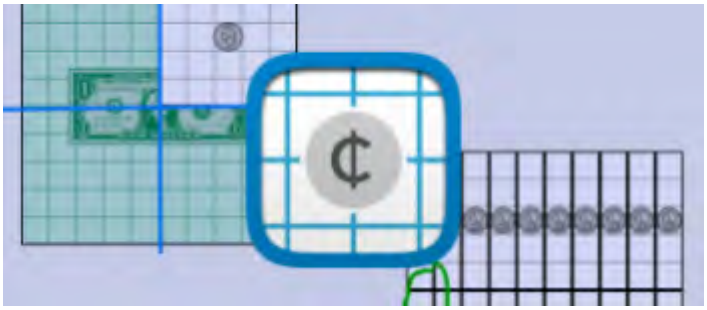
Stretch virtual bands around pegs to form line segments and polygons.

Math Clock

Explore time, fractions, and more on virtual clocks with geared or free-moving hands.

Math Vocabulary Cards

Deepen understanding of key terms in mathematics with written and visual definitions.

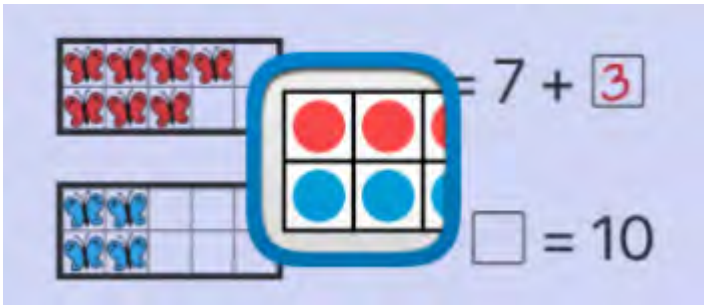


Money Pieces

Visualize money values and relationships with U.S. currency and money value pieces.

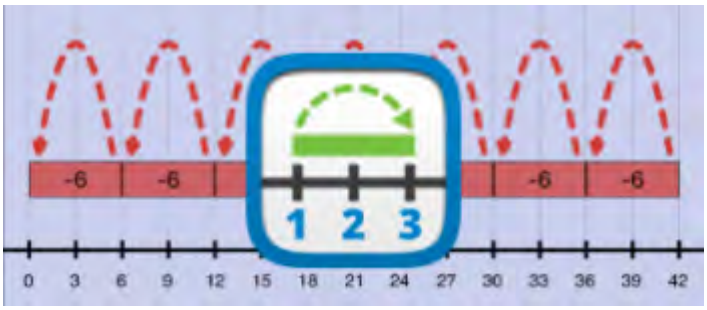
Number Chart

Count, explore number patterns, or create your own grid with fractions, decimals, and more.



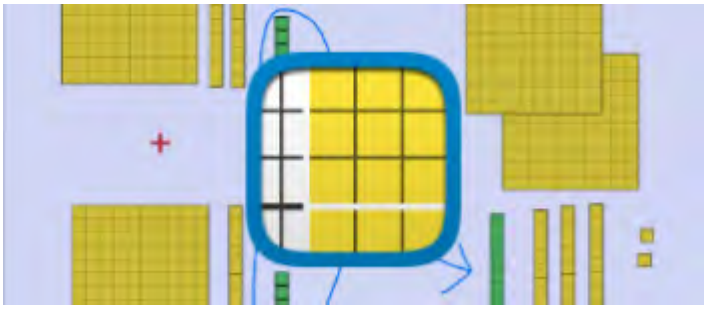
Number Frames

Represent numbers by placing counters inside of five-, ten-, double ten-, and custom frames.



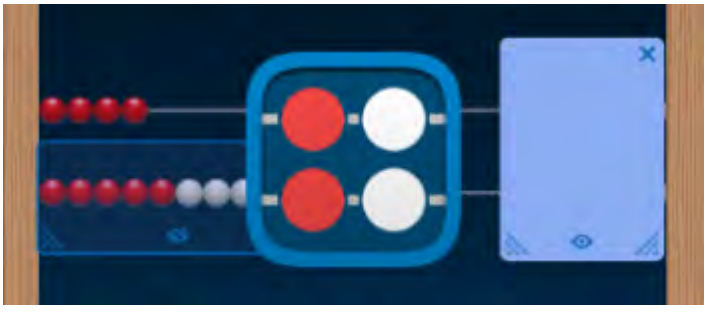
Number Line

Visualize and work with numbers in sequence on a virtual number line with or without tick marks.



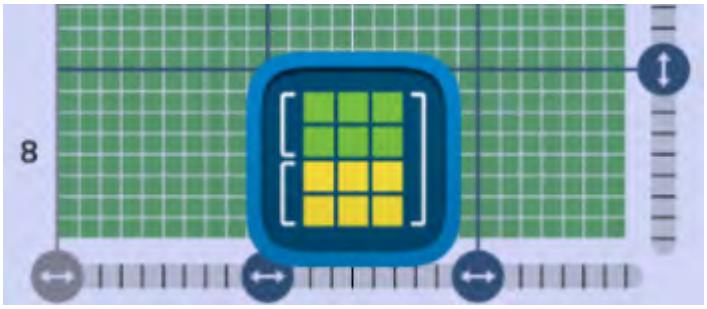
Number Pieces

Use virtual base ten pieces to represent and work with multi-digit numbers.



Number Rack

Slide beads to show and work with numbers and think in groups of 5s and 10s.



Partial Product Finder

Partial Product Finder allows multiplication combinations to be represented as a rectangle, or array, with dimensions that match the combination.

Pattern Shapes

Explore counting, geometry, fractions, and more with a set of virtual pattern blocks.

Whiteboard App

Solve problems and explain your thinking in a digital math workspace.

Top 10 Most Popular Maths Teaching Aids for Kids

24/11/2023

Maths is a core subject that's the backbone of various aspects of primary, secondary and tertiary education. It's not just about numbers and equations — it involves the essential skills of logical reasoning, problem-solving and the ability to think in abstract terms. These are essential skills for children to carry throughout their lives as they grow up and enter the workplace.

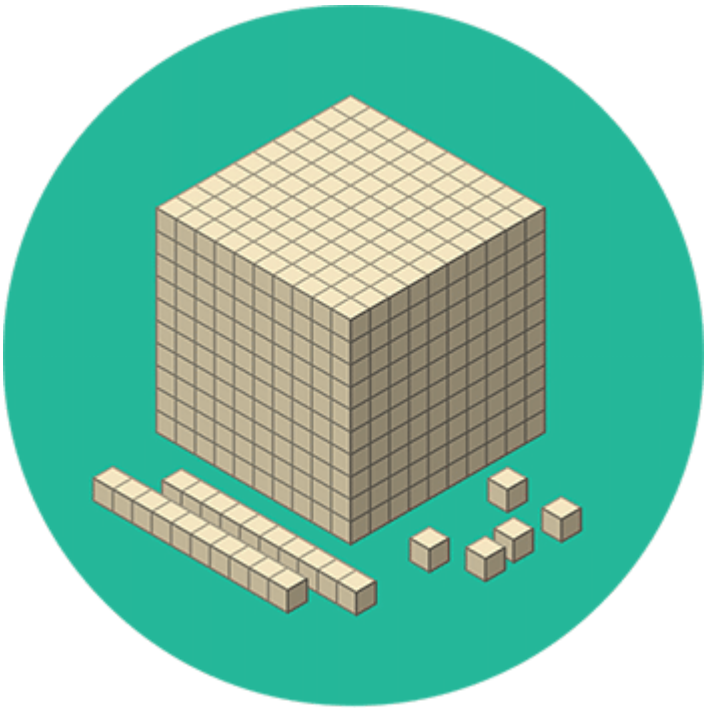
To many young learners, maths can appear daunting and dry to learn. That's where we at Tutoring For Excellence step in. We believe learning maths can be engaging and fun. The best way for kids to learn a subject such as mathematics is to make it as tangible as possible.

Using the right teaching aids can make a world of difference and transform the way that kids learn math. Over time, these aids have evolved through curriculum development. They are now highly effective and integral pieces of equipment that teachers and tutors use to support children in their learning of new mathematical concepts.

Here are the ten most popular maths teaching aids that we've found resonate with kids and support their educational journey.

Top 10 most popular maths teaching aids for kids

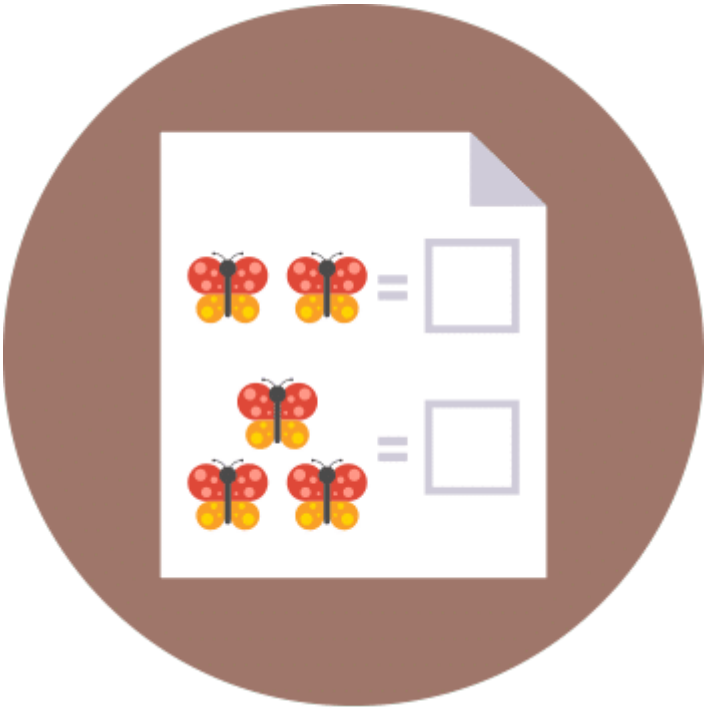
1.MAB wooden prisms



The iconic MAB wooden prisms, columns and blocks bring the decimal to life. These blocks, representing units, tens, hundreds and thousands, allow children to construct and deconstruct numbers physically for different maths problems. They can build a number and see the difference between 10 and 100, which can be an ‘aha’ moment for many young learners.

For processes such as subtraction, they are an excellent way to practice borrowing and paying back. Children who struggle with visualising numbers and problems can continue to use physical items to assist with their counting early into high school, including place value cards, matchsticks, buttons, ping pong balls and corks. This tactile process lays a foundational understanding of place value, a critical building block for all future math endeavours.

2.Online and worksheet resources



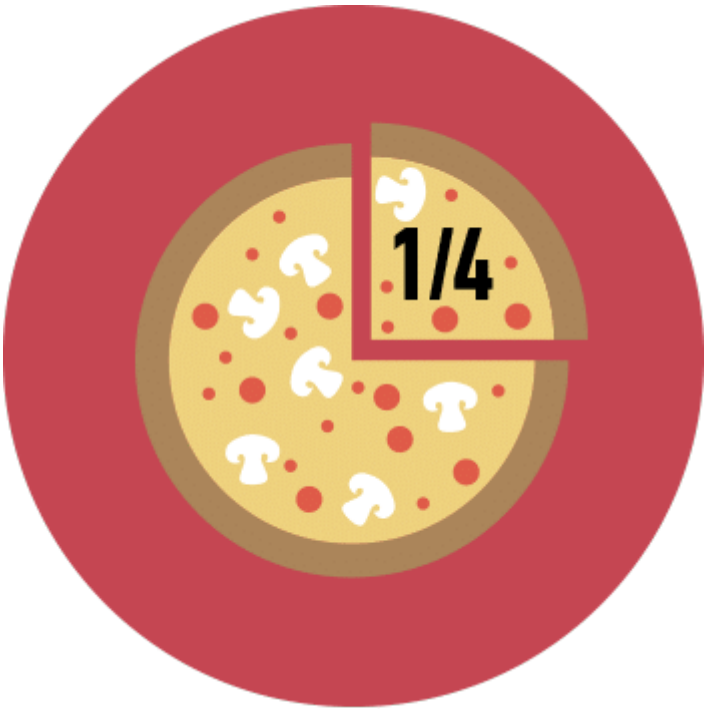
Whether you are a teacher, parent or tutor, having some ready-made worksheets can be a

great starting point for lessons. Online platforms and worksheets offer unlimited practice and immediate feedback tailored to each child's learning pace.

After all, each child has their own unique, preferred learning style. Whether students are visual learners and need drawings of shapes, graphs, diagrams or symbols to understand concepts or reading/writing learners who need a concept broken down to understand it, auditory learners who would benefit from having you read the sheet aloud to them, or kinaesthetic learners who learn using their senses, like touching blocks to recognise their shape.

Interactive games make learning feel like play, and printable worksheets allow for the repetition students may need to master a concept. The TES website has resources for all primary-based subjects, but the maths sheets are particularly useful. Worksheets cater to traditional practice and can easily integrate into any curriculum.

3.Food as teaching aids



Never underestimate the power of food to teach math. For many students, fractions can be pretty difficult to grasp. However, when you get a favourite food, such as pizza or cake involved, things usually become much clearer. They are great visual representations of fractions thanks to their shape and are excellent mathematical aids for learning about and practising creating fractions.

Pizza slices offer a delicious way to understand fractions and percentages. When children divide a cake or a pie, they explore division, fractions and the idea of parts of a whole in a tangible and, let's admit, tasty way. Sharing treats in this way can introduce concepts of fairness and equality alongside the math lesson, serving up life lessons alongside numeracy skills.

4.Time-telling tools

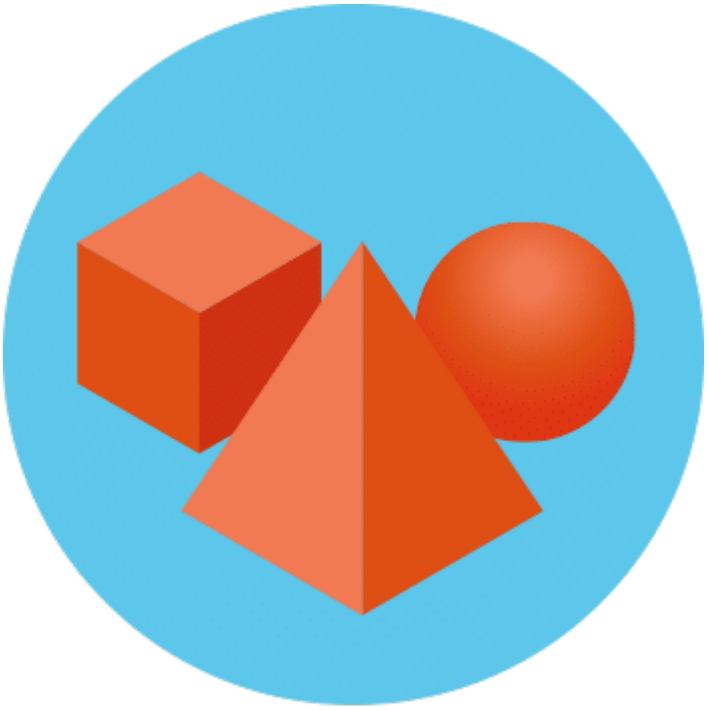
Clock dials, stopwatches and sand timers are not just for tracking the minutes until recess. They teach time-telling and introduce children to the broader concepts of time management and the basics of time measurement. These aids help make the abstract idea of time more concrete.

Telling time with analogue clocks, as well as counting and subtracting timings, can be a much-needed skill for various other mathematical problems, such as problem-solving. It is also an essential life skill.

5.Geometry tools

Protractors, set squares and compasses are the physical tools that introduce children to the precision of geometry. They learn to draw and measure angles, create perfect circles and understand the relationships between different geometric shapes. These tools not only help with visualising and constructing shapes but also with improving fine motor skills. These aids are essential classroom kits for students entering into a high school math environment.

6. 2D and 3D shapes with blocks



Using blocks to build 2D and 3D shapes bridges the gap between the flat world of paper and the three-dimensional world we live in. Handling cubes, pyramids and spheres can help children understand the properties of these shapes — from the number of edges and vertices to how shapes can fit together and interact with each other. These aids also allow students to use the shapes to problem-solve area puzzles, create and break down patterns and learn about symmetry and classification.

7. Pretend money

One of the most important real-world application skills in mathematics is the use of money. Sure, kids know what it is. They have probably seen it and perhaps earned their own, but can they count it, use it in problems and sort it?

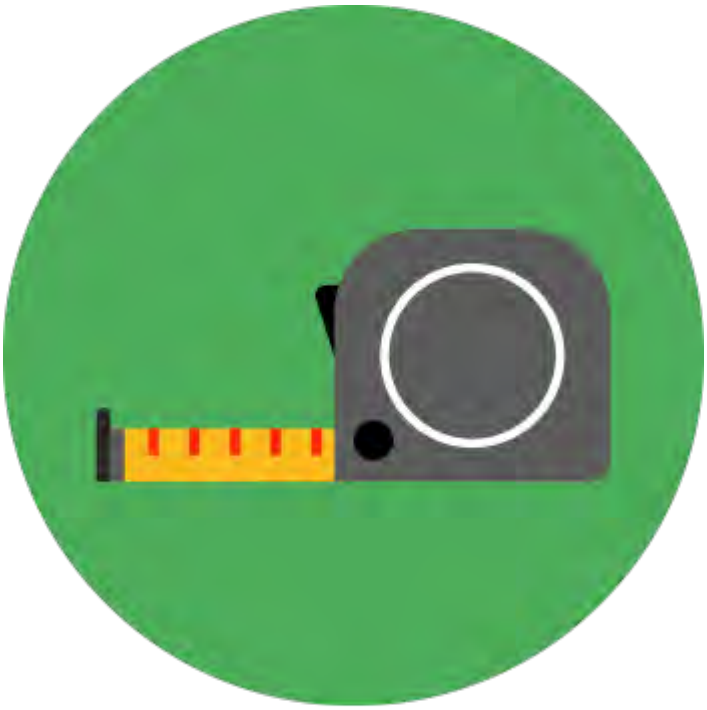
Pretend money is a classic educational tool — and for good reason. It teaches basic arithmetic, yes, but it also introduces the fundamental principles of economics — spending, saving and the value of goods and services. Children love playing shop, and as they do, they absorb lessons about money management that will serve them for life. The tangible effect of this teaching aid

means that students can easily address money problems in the classroom with visual reminders of the real thing.

8. Dice, cards, counters and spinners

Probability plays mostly into the skill of problem-solving. Many students need help with this mathematical skill as there is much innate knowledge and natural ability linked to its mastery. Dice, cards, spinners and the like are interactive and engaging math aids to get children involved in learning about probability, chance, number patterns and statistics and take the learning out of textbooks and into children's hands. They are great for teaching probability and basic operations. Through games, these aids develop a child's ability to predict outcomes, understand random events, and even strategise, all within the realm of fun.

9. Trundle wheel, and metre ruler



After a long day in the classroom, there's nothing more exciting for a child than to spend time outside — and not just for lunchtime! The trundle wheel and metre ruler help children make the leap from small, tangible measurements to understanding larger distances and the concept of

scale. Walking with a trundle wheel to measure the length of a playground imprints the idea of metres and kilometres in a child's mind more effectively than any diagram could.

10. Beakers, funnels, cylinders, scales and weights

Beakers, funnels, cylinders, scales and weights take maths off the page and into the lab. They introduce the ideas of volume and weight, and when children use them to conduct simple experiments, they learn measurement, cause and effect and even the basics of the scientific method. Being able to see the elements of the question, such as the volume of water, supports their understanding of not just calculating the answer but also understanding the parameters of it.

Assistive technology for math

By The Understood Team

Expert reviewed by Shira Moskovitz, MA

Updated October 20, 2023

Español

When kids and adults have trouble with math, assistive technology (AT) can offer a lot of support. Many AT tools for math — like calculators — are common, inexpensive, and easy to get. Others are lesser known, but can be just as useful.

Use this guide to learn about what tools are available, and where to get them.

Dive deeper

Types of assistive technology tools for math

Here are some of the most helpful AT tools for math.

Calculators can help solve math problems, both simple and complex. Most people know about basic electronic calculators. But kids who struggle with math may prefer calculators that have buttons with large numbers and symbols. There are many kinds of calculators, from graphing calculators to computer apps. Some can even solve equations with variables.

Math notation tools let you write or type out the special symbols and numbers used for math equations. For example, symbols like ± √ + − ∑ %. Writing out equations by hand can be challenging for people who have trouble writing numbers and symbols. And most traditional word processors aren't great at handling math symbols.

Graph paper has a grid that makes it easier to line up numbers and symbols in math problems. That's important when keeping track of things like place value. Students often write on traditional graph paper with a pencil. Some may prefer graph paper that has large squares. There's also digital graph paper.

Graphing tools help with graphing the path created by an equation. For example, graphing a parabola. Students who take algebra or calculus can use these tools to solve graphing problems.

Drawing tools help with drawing lines, shapes, angles, and other geometric features. Traditional classroom tools like rulers, stencils, and protractors can help with drawing. There also are specific computer programs for drawing. Students who study geometry or trigonometry may find them helpful.

Equation-solving tools are digital tools that help students work with equations. Unlike calculators, equation-solving tools don't solve a problem. They help students figure out how to solve a problem. For example, an equation-solving tool can help them figure out how to solve for x in $3 + x = 11$.

Manipulatives are objects that let you solve math problems in alternative ways. They can also illustrate math concepts. A classic example is the number line. You can use a number line to add or subtract numbers without having to write down any numbers or symbols. Another example is an abacus, which lets you do calculations by moving beads. Manipulatives can also be virtual objects on a computer.

Graphic organizers help break down and lay out the steps for solving math problems. For instance, a graphic organizer for a word problem may have spaces for writing and keeping track of important numbers. Graphic organizers can be digital or pen and paper.

Text-to-speech (TTS) reads aloud numbers and calculations. When used for math, TTS is often combined with other tools, like a talking calculator.

Dictation lets you write out math problems by speaking. Like TTS, dictation can be combined with other AT tools for math. For instance, math notation tools sometimes allow for dictating equations.

Some families worry that using a tool like a calculator will prevent kids from learning math. However, experts say math AT tools may help kids improve math skills, as long as they aren't overused.

Where to get assistive technology for math

There are many ways to get AT tools for math. You can find traditional "low-tech" classroom tools, like rulers, basic calculators, and graph paper at a school supply store. These stores may also sell calculators with large numbers and symbols, and graph paper with large squares. The school might provide these tools, too.

The school may also provide tools like number lines and blocks. But you can also buy them online or even make your own.

Today, many AT tools for math are being used on different computer platforms:

- Desktop and laptop computers: Most computers have built-in AT options like calculators. You can try out software programs to help kids with math.
- Mobile devices (like tablets and smartphones): Mobile devices also have built-in AT. And you can add math tools to mobile devices with apps.

Consider these questions when choosing AT tools. Learn ways to tell if an AT tool is not effective for you. And get tips on how to learn to use an AT tool.

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Interview with Dr Fiona Kerr

Inteview Questions for Dr Fiona Kerr

Interview Questions for Neuroscientist Dr Fiona Kerr, Founder and CEO of The NeuroTech Institute

Questions on general Neuroscience and Neurodiversity:

Can you explain how neuroplasticity works and its significance in the development of neurodiverse individuals?

What are some of the latest findings in neuroscience that could impact how we educate neurodiverse students?

How does the brain of a neurodiverse individual differ in its processing of information compared to a neurotypical brain?

What role does sensory processing play in the experiences of neurodiverse individuals, and how can we accommodate this in educational settings?

Can you discuss the potential impact of neurodesign on learning, particularly for neurodiverse students?

Specific to GoSmashMaths! and Educational Tools:

From a neuroscientific perspective, how might a tool like GoSmashMaths! benefit neurodiverse students in learning mathematics?

What cognitive or emotional challenges might neurodiverse students face when interacting with educational tools, and how can these be mitigated?

How important is it to integrate feedback and progress tracking in educational tools for neurodiverse students? What does the neuroscience say?

In your view, how can educators and designers best apply neuroscientific principles to create more effective learning tools for neurodiverse students?

What future developments in neuroscience do you think will most significantly influence how we approach education for neurodiverse learners?

Inteview with Rebecca Starling, Educator & Psychology/Systemic Consultant

Rebecca Starling Consultancy - Systemic Consultant

https://www.rebeccastarlingconsultancy.com

Some blurb from the website for your context…..

'In an era when understanding and celebrating neurodiversity in organisations, education and families is important, Rebecca crafts her consultancy as a sounding board to reframe problems and provide feedback about challenges that are unique to the context, individual and team.

By utilising a systemic framework, she helps identify the neurobiological drivers of behaviour, discuss solutions to complex problems and how to create psychologically safe environments'

Dear Willem,

I no longer work as a teacher in a classroom as such but can share refection's from my 20+ years of educating in the school context. Part of my work now as a consultant is with school leaders, educators and families (and as a family therapist) to be able to identify diverse developmental profiles and apply appropriate strategies. This is so that all the stakeholders around the child/ teen will respond to 'behaviour' in a way that enables the young person to experience autonomy and manage their own learning. My hybrid consultancy has many touch points, because I believe that 'no man is an island', and we are in fact a 'dance of parts'. In this way I am helping people to see and understand the ecosystems they operate within, and understand their role and their relationship within it, so they can find true belonging, a real purpose and success, both within themselves and with the people they interact with.

Willem's Questions:

1. **Can you describe the different types of neurodiversity you encounter in your classroom?**

   Autism Spectrum Disorder (ASD)
   *I specialise in a particular profile of ASD-Pathological Demand Disorder (PDA)
   Attention deficit hyperactivity disorder ADHD
   Dyslexia
   Dysgraphia
   Dysgraphia
   Dyspraxia
   Sensory Processing Disorder
   Tourettes syndrome
   Obsessive Compulsive Disorder
   Anxiety disorders

2. **What are some of the most effective teaching strategies you've found for supporting neurodiverse students? How do you adapt your teaching methods to meet the needs of students with different neurodiverse conditions?** As teachers we have sets of standards that must be adhered to when considering all of our students, including those we understand to be neurodivergent. Therefore, our teaching strategies must firstly be based in the real understanding of student's physical, social and intellectual development and characteristics to improve their learning. We will aim establish and implement inclusive and positive interactions to engage and support all students in the classroom activities. Because each learner has a unique set of needs, strategies will differ contextually. I would always begin with asking myself a set of questions which are guided around the idea that I want to engage their attention and sustain it, so that they can learn
   (and be emotionally safe getting there).

For example:

Is there difficulty around sustained attention?

Is there a certain cognitive flexibility that I can partner with. Often those with ASD have unique and innovative way to problem solve.

Is how I am teaching an efficient way to maximise their working memory?

Is there an existing frustration/ lack of tolerance around the way we are approaching the curriculum?

Is the neurodiverse learner responsive to the kinds of way I am giving feedback? How can I do this differently? Are there other modems I could explore?

Do I need to engage in reciprocal teaching strategies?

Have I modelled thinking adequately? Can I employ digital technologies to partner with this?

Have I privileged review/repetition for transfer?

Could I help the neurodiverse student's executive functioning with Graphic Organisers?

Have I considered the neurodiverse learner responsibility/authority & the wider system? Can I partner with the wider system to strengthen the learning? Who is on their team?

Currency? Have I pinpointed the neurodiverse learner's currency? Their giftings? Their genius?

Gain? Are we gaining? This is an important part of learning and development. We must be earning or learning to develop well.

Have I considered the presence of anxiety? How can we manage this down?

(Anxiety interferes with clear thinking and learning)

3. **What role does neurodesign play in your classroom, if at all?**

My belief around play is that it is an integral part of learning for life. I would include play in most learning sessions considering the principles from neuroscience. For example, that that all learners need to feel safe and capable and engaged. I know that play mitigates and manages down anxiety around learning, and it increases engagement & motivation. It releases the motivation molecule dopamine!
Further, I recognise that collaboration is developmentally mandatory for young people because it creates community inclusion, norms of how we work together, & social skills, addressing inequalities that come with neurodiversity.

4. **Can you share a success story where a neurodiverse student excelled because of a particular teaching method?**

When I work out how to reduce unneeded cognitive load for a learner, hook into their interests, genius and valuable prior knowledge, and provide real ways in which they can show their newly acquired knowledge, then we have success. We celebrate!

5. **What are some of the biggest challenges you face when teaching neurodiverse students?**
   Making sure that I am constantly considering any 'challenging or unhelpful behaviour' as a communication of a need. Therefore, I will always be looking through the lens of the learner in terms of the environment, their social/emotional world, their sensory world, their motor world, their unique learning profile. This takes the determination of planning adequately and constantly reviewing supports or adjustments to suit an ever-changing development.

6. **How do you collaborate with parents and caregivers to support neurodiverse students?**
   I privilege regular and intentional communication. Partnering with the parent/caregiver system is paramount to my practice. I believe that the school is an extension of the home.

7. **What tools or resources have you found most helpful in teaching neurodiverse children?**

   Positive Partnerships who provide ongoing strategies and support.
   https://www.positivepartnerships.com.au/

   Inclusive School Communities
   https://inclusiveschoolcommunities.org.au/

   Universal Design Learning –
   https://www.cast.org/impact/universal-design-for-learning-udl

   "UDL is really recognizing that one size fits all does not work."
   Universal Design for Learning (UDL) is more than just an educational framework; it's a powerful belief in the potential of every student to achieve high levels of learning. Rooted in neuroscience research and supported by numerous federal laws and the United Nations Convention on the Rights of Persons with Disabilities, UDL is recognized as best practice for teaching in inclusive environments. The essence of UDL lies in creating the right conditions for learning and ensuring that instructional methods are applied intentionally to benefit all learners. As Article 2 of the Convention outlines, universal design involves crafting products, environments, programs, and services to be universally usable, maximizing usability for everyone without the need for adaptations or specialized designs. This commitment reflects a broader vision where educational practices and environments are designed to accommodate everyone's learning needs without constant accommodations and modifications.

8. **How do you measure progress and success for neurodiverse students, considering their unique learning needs?**

   Teachers will use Individual Learning Plans to outline the personalised learning goals, adjustments and supports. We review these often as a teaching/support team to make sure we are experiencing progress and success.

9. **What advice would you give to future educators who will be working with neurodiverse students?**

   Focus firstly on the strengths and capabilities! What a gift a different mind can bring!

   Close knowledge of our neurodiverse learner builds the capacity to know what their underlying needs are.

Challenge the word ‘disorder’. There is nothing disordered about their brain… it is a celebration of difference.

One of my favourite quotes to share with other educators and parents…

Identifying as neurodivergent isn’t just another label; it’s also an identity, it’s a reclamation, it’s a song. When we call ourselves neurodivergent, we are reclaiming our differences that society calls abnormal or wrong. When we call ourselves neurodivergent, we are challenging you to consider what ‘normal’ actually means and perhaps even realize that maybe our normal isn’t your normal. When we call ourselves neurodivergent, we are rejecting the concept of disorders.”
— Sonny Jane Wise, We’re All Neurodiverse LOVE THIS!!!!!!!!!!

QUESTIONS ABOUT GOSMASHMATHS!

10. **How do you think the concept of GoSmashMaths! aligns with the needs of neurodiverse learners?**
    The key areas that you have identified as potential focus for adjustment are key areas that every teacher would consider reasonable adjustments.
    For example,
    Concrete to abstract tools
    Visual-spatial reasoning enhancements
    Problem solving scaffolds
    Techniques for building number sense
    Tools for understanding abstract concepts
    Remediation resources for learners that are finding it difficult – including ESO’s and inclusive ed team

11. **What do you believe are the key elements that make GoSmashMaths! an engaging and effective tool for teaching math?**
    ** face-to-face interview coming

12. **In what ways do you think GoSmashMaths! can help reduce math anxiety among neurodiverse students?**
    Through the element of play and collaboration.

Questions about GoSmashMaths! as a Board Game:

13. **How do you think the physical, tactile elements of GoSmashMaths! as a board game benefit neurodiverse students?**
    As a teacher, I would aim to include the physical and tactile elements in most of my lessons so that all learners would have a chance to be ‘hooked in’ and ‘engaged. I know that these elements enhance engagement and attention for longer.
    They engage students in applying fine and gross motor skills.
    They allow the student to experience sensory feedback and the experience of co-regulation with the educator.
    The physical and tactile elements of the board game will provide a means for collaboration to be learned and the application of important social skills.
    New ways of problem solving through the board that may include the neurodiverse innovative and unique perspectives. For example,
    A visual tool to acknowledge both success and failure - and that failure is an important way to learn new things!!

14. **Do you believe that a competitive element in GoSmashMaths! is helpful or potentially stressful for neurodiverse students?**
    It depends on the unique profile of the neurodiverse learner. Some would find it beneficial, and some perhaps may need support in accessing it… for example in increasing their tolerance for the demand of losing.

15. **Questions about GoSmashMaths! as an App: How might the digital format of GoSmashMaths! as an app offer unique advantages over the board game version for neurodiverse learners?**
    I have experienced many neurodiverse learners being insightful digital leaders in our classes. They have taught me much!!! It may be an excellent opportunity for leadership and guiding their 'neurotypical' friends into new learning.

16. **How important is it to include progress tracking or feedback mechanisms in the GoSmashMaths! app to help neurodiverse students and their teachers?**

    Feedback is a crucial element of any learning. We as teachers talk about the importance of learning cycles- and the feedback plays an integral role in this. We are also bound by The Australian Professional Standards for Teachers. This is what they say about it…

    https://www.aitsl.edu.au/docs/default-source/research-evidence/spotlight/feedback.pdf?sfvrsn=cb2eec3c_14

    The research is clear: improving feedback practices can significantly improve student learning and the quality of teaching in classrooms.

    Effective feedback practices provide the bridge between assessment and learning. High quality feedback can improve student learning by as much as eight months. There's a strong evidence base behind the impact of feedback. It is a cost-effective approach to enhancing student outcomes and it can be implemented in any education context.

    Teaching and learning activities, including formative and summative assessments, provide opportunities for teachers to gather evidence about students' progress. This informs teacher feedback to students about their learning and what they need to do next to move forward.

    The evidence also provides feedback to teachers, allowing them to evaluate and, if necessary, adapt or change strategies to ensure they are meeting the learning needs of their students.

    The Australian Professional Standards for Teachers make clear that teachers at all career stages are expected to be able to assess student learning and to provide feedback to students on their learning.

    Australian and international research can assist educators, especially school leaders and teachers, to understand the role of feedback in learning and to take action to improve the way feedback is used in classrooms.

Inteview Questions for Rebecca Starling

1. **Can you describe the different types of neurodiversity you encounter in your classroom?**
2. **What are some of the most effective teaching strategies you've found for supporting neurodiverse students? How do you adapt your teaching methods to meet the needs of students with different neurodiverse conditions?**
3. **What role does neurodesign play in your classroom, if at all?**
4. **Can you share a success story where a neurodiverse student excelled because of a particular teaching method?**
5. **What are some of the biggest challenges you face when teaching neurodiverse students?**
6. **How do you collaborate with parents and caregivers to support neurodiverse students?**
7. **What tools or resources have you found most helpful in teaching neurodiverse children?**
8. **How do you measure progress and success for neurodiverse students, considering their unique learning needs?**
9. **What advice would you give to future educators who will be working with neurodiverse students?**

Questions about GoSmashMaths!

10. **How do you think the concept of GoSmashMaths! aligns with the needs of neurodiverse learners?**
11. **What do you believe are the key elements that make GoSmashMaths! an engaging and effective tool for teaching math?**
12. **In what ways do you think GoSmashMaths! can help reduce math anxiety among neurodiverse students?**

Questions about GoSmashMaths! as a Board Game:

13. **How do you think the physical, tactile elements of GoSmashMaths! as a board game benefit neurodiverse students?**
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15. **Questions about GoSmashMaths! as an App: How might the digital format of GoSmashMaths! as an app offer unique advantages over the board game version for neurodiverse learners?**
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Inteview with Scott Xi, Lead Designer & UX Developer
Expert in User Experience, and App Development

Hi Willem,

Please find my answers below. Good luck, it's a great project, look forward to helping you with the prototype app!

Best,
Scott

Q: Can you explain how simplifying visual elements can improve the user experience in educational apps?
A: Simplifying visual elements can improve the user experience for all apps by:
Enhancing focus and clarity: allowing users to concentrate on important content without being distracted by unnecessary items.
Improving navigation: helping users find key features and resources quickly and easily.
Increasing accessibility, making the app more user-friendly for people with different age groups.
Reducing cognitive load, enabling users to focus more on the task at hand.
A good UX design is like a door handle—when you see a flat metal plate, you instinctively push, but when you see a handle, you naturally want to pull.

Q: How do you balance aesthetics with functionality when designing for neurodiverse audiences?
A: If functionality and design are two distinct areas, the designer's job—whether in UI, graphic, industrial, or architectural design—is to find common ground between them.
I believe there's no special secret; it's all about continuously trying and learning.

Q: What design techniques do you use to make navigation more intuitive for neurodiverse students?
A: Keep the design simple: Use a clean, uncluttered layout with only essential buttons visible.
Provide clear progress paths: Use steps like progress bars to guide kids.
Limit sound effects: Use sound sparingly to reinforce learning, not distract.
Avoid pop-ups: Keep kids focused by avoiding external links or pop-ups.
Simple rewards: Use motivating rewards like stars without interrupting learning.
Use Colour wisely: Highlight key actions with colour while keeping the rest neutral.

Q: How can visual consistency contribute to a smoother user experience in educational apps?
A: Visual consistency makes apps easier to navigate, reduces cognitive load, and helps users focus on learning by providing a familiar, intuitive experience. (check first one)

Q: What strategies do you recommend for reducing cognitive clutter in educational tools?
A: Simplify the interface: Use a clean layout with only essential elements visible.
Use clear navigation: Provide intuitive, easy-to-follow paths for users.
Minimize text: Present information concisely and use visuals where possible.
Organise content: Break content into manageable chunks or steps.
Limit distractions: Avoid unnecessary animations, sounds, or pop-ups.

Q: How do neurodesign principles reduce cognitive load for users, particularly neurodiverse learners?
A: Neurodesign principles help by aligning visuals with how the brain processes information, so users can interpret content faster and more intuitively.
This is especially useful for neurodiverse learners, as reducing visual and informational clutter can make navigation and learning feel natural rather than overwhelming. Design strategies like grouping related items, using familiar shapes, and reducing bright colours create a calmer environment, lowering cognitive strain.

Q: How can we minimize distractions in an app like GoSmashMaths! to enhance focus and learning?
A: Distraction minimisation in GoSmashMaths! can be achieved through careful use of sound and animation, keeping both to a minimum and only using them to reinforce learning.
Consistent visual styles, intuitive pathways, and predictable actions ensure the student's attention remains on tasks without extraneous pop-ups or notifications.
Simple rewards, like badges or stars, work better than flashy animations, maintaining engagement without pulling focus away from learning.

Q: What role does user feedback play in refining the design of educational apps for neurodiverse students?
A: User feedback is essential. It allows us to refine the app by understanding what actually works versus what we assume works.
Neurodiverse students can have unique needs, so direct feedback helps us adjust colours, layout, sounds, and reward systems to suit their preferences, ultimately creating a more personalised and effective learning experience.

Q: How do you prioritise design features that support both neurodiverse learners and general users?
A: Balancing needs involves prioritising universal design principles that simplify and clarify user experience, as these are beneficial for all users.
Emphasising accessibility settings, like adjustable fonts and colour contrasts, allows neurodiverse students to customise their experience without affecting the usability for other users. The aim is to create a flexible foundation that serves diverse learning needs seamlessly.

Q: Can you share insights on how to make an app's user interface more accessible to students with ADHD or dyslexia?
A: For students with ADHD, a clean interface that limits distractions and uses a clear layout helps maintain focus.
For dyslexic students, readable fonts (like sans-serif), spaced letters, and calm colour contrasts reduce visual strain. Customisable settings, such as background colours or font sizes, further empower users to tailor the app to what feels comfortable for them.

Q: How important is real-time feedback in educational apps, especially for neurodiverse learners?
A: Real-time feedback is crucial as it reinforces correct actions immediately, helping learners connect their efforts with outcomes.
For neurodiverse students, this can be especially helpful as it reduces the need for delayed validation, building confidence and engagement in real-time, which leads to a more supportive learning experience.

Inteview Questions for Scott Xi

Interview Questions for App and UX Designer Scott Xi

General Questions about Design & UX:
How do you approach designing for inclusivity, particularly when considering neurodiverse users?

What principles of neurodesign do you think are most important when developing educational apps?

How do you balance aesthetics with functionality to ensure that the app is both engaging and easy to navigate for neurodiverse users?

Can you share a previous project where neurodesign played a key role in shaping the user experience?

How do you incorporate user feedback, especially from neurodiverse learners, into your design process?

Specific to GoSmashMaths! App:

How do you envision the app version of GoSmashMaths! engaging neurodiverse learners in a way that traditional tools might not?

What features or design elements in GoSmashMaths! will specifically cater to reducing cognitive load and enhancing user engagement for neurodiverse students?

Can you describe the challenges in adapting a physical board game into a digital app, particularly for neurodiverse users? How do you overcome these challenges?

How important is the app's interface design in facilitating smooth transitions between different types of math activities?

What role do interactive elements like animations or sound feedback play in reinforcing learning for neurodiverse students?

Technical & IT-related Questions:
What tools or platforms are you using to ensure the app is accessible to users with different neurodiverse conditions (e.g., dyslexia-friendly fonts, sensory-friendly designs)?

How does the backend development ensure that the app runs efficiently across devices while maintaining all necessary features?

What strategies are in place for user data collection (e.g., progress tracking) to provide useful feedback to students and teachers while ensuring privacy and security?

How do you integrate features like progress tracking or customisation into the GoSmashMaths! app to enhance both engagement and personalised learning?

How do you anticipate the app scaling, and what role do you see neurodesign playing as the app grows in complexity?

APPENDIX E

References

References

These sources were essential to my understanding of neurodesign, maths anxiety and educational approaches. They supported my work with valid, up-to-date research.

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