Scaffolding Zoombinis: Adding Executive Function Scaffolds to the Popular, Classic Game

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Abstract: The popular, award-winning game *Zoombinis* has been around since the 90s, with an updated version launched in 2015 for new devices. Since that relaunch, research has been conducted on the effectiveness of the game and related bridging activities for the teaching and learning of computational thinking (Asbell-Clarke et al, 2021; Rowe et al, 2021b; Almeda et al, 2019). Recently, efforts have been made to design and test executive function (EF) scaffolds that surround puzzles from the game, permitting learners who may have EF challenges, such as issues with working memory, attention, and metacognition, to demonstrate their skills with computational thinking (CT), a logical approach to problem solving which can be applied to any problem, task, or system. On this poster, we present the *Zoombinis* scaffolds, the intent of their design, and the results of their use with teachers and students, grades 3-8, as part of a larger CT-education project.

Zoombinis

For decades, the game *Zoombinis*, originally *The Logical Journey of the Zoombinis*, has successfully reached both education and commercial audiences, engaging players age 8 through adult in enjoyable and challenging logic puzzles. Players help the Zoombinis, small blue creatures with different combinations of Hair, Eyes, Noses, and Feet, escape the evil Bloats and travel through 12 puzzles, each with four levels of difficulty, to a new home in Zoombiniville (Figure 1). The puzzles challenge players' computational thinking (CT) skills, including Problem Decomposition, Pattern Recognition, Abstraction, and Algorithm Design.

Figure 1
A student playing *Zoombinis*

Neurodiversity

In previous research, neurodiverse students often became class leaders with *Zoombinis* (Asbell-Clarke et al, 2021), which kicked off new research into computational thinking, neurodiversity, and executive function (EF). For this research, neurodiversity refers to learners with autism, ADHD, dyslexia, and other related cognitive differences. And underlying many neurodiverse conditions is differences with EF.

Neurodiverse learners may have particular areas of strength in tasks related to CT, including detailed pattern recognition and systematic thinking (Baron-Cohen, 2020). And some of these CT strengths have interesting connections to EF, the set of processes the brain uses to coordinate sensory, emotional, and cognitive aspects of learning (Meltzer, 2018).

EF Scaffolds

As part of a larger project, intended to provide differentiable teaching and learning CT activities for grades 3-8, the Authors designed EF scaffolds for an array of digital and non-digital materials, including select *Zoombinis* puzzles. The *Zoombinis* scaffolds include flashlight tools that draw attention to salient info, graphical organizers that enable visual recording of info to support working memory, and expression tools that support metacognition by promoting explicit expression of learning (Figure 2).

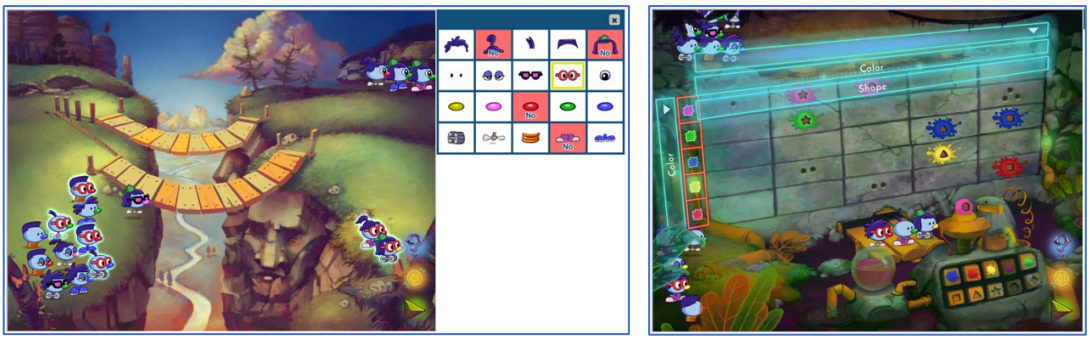

Figure 2
Screenshots of Zoombinis puzzles with EF scaffolds

Participatory Design and Implementation Research

During Spring 2021, CT materials, including the *Zoombinis* scaffolds, were designed with iterative feedback from teachers, parents, and other educators of neurodiverse learners in grades 3-8, who used them with 300+ students (about 20% considered neurodiverse). Two rounds of research, in Fall 2021 and Spring 2022, tested the materials with treatment teachers, as part of an implementation study that also involved control teachers, and provided data logs and other information on use of the *Zoombinis* puzzles and scaffolds. Additional research studies are being conducted with educators and students. Preliminary findings, as of June 2022, on the use and effectiveness of the scaffolds for both neurotypical and neurodiverse students are presented.

References

Asbell-Clarke, J., Rowe, E., Almeda, M., Edwards, T., Bardar, E., Gasca, S., Baker, R., & Scruggs, R. (2021). The development of students' computational thinking practices in elementary and middle-school classes using the learning game, Zoombinis. *Computers in Human Behavior, 115,*1-14. https://doi.org/10.1016/j.chb.2020.106587

Rowe, E., Asbell-Clarke, J., & Almeda, M. Scruggs, R., Baker, R.S., Bardar,E. & Gasca, S. (2021). Assessing implicit computational thinking in Zoombinis puzzle gameplay. *Computers in Human Behavior, 120.* https://doi.org/10.1016/j.chb.2021.106707

Almeda, M., Rowe, E., Asbell-Clarke, J., Baker, R., Scruggs, R., Bardar, E., & Gasca, S. (2019, October 3-5). *Modeling implicit computational thinking in Zoombinis Mudball Wall gameplay.* [Paper presentation]. Technology, Mind, and Society Conference, Washington D.C., United States. https://www.apa.org/members/content/2019-technology-mind-program.pdf

Baron-Cohen, S. (2020). *The Pattern Seekers: How Autism Drives Human Invention*. Basic Books.

Meltzer, L. (Ed.). (2018). *Executive function in education: From theory to practice* (2nd Edition). The Guilford Press.