

No child behind nor singled out!

Adaptive instruction combined with inclusive pedagogy
in early math software

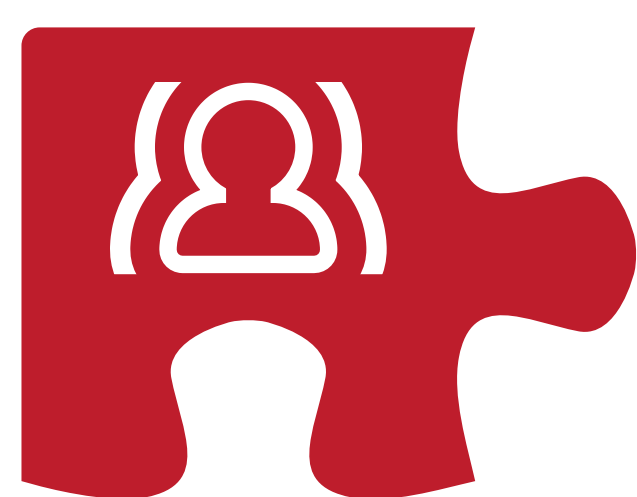
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Magical Garden is a unique play-&-learn game for early math, designed to provide adaptive instruction with respect to support and challenge combined with an inclusive pedagogy where no child, whether far behind or far ahead, is exposed as being “different”.

Why early math intervention and why via adaptive instruction?



A child that is weak in early numeracy at school start is likely to continue to stay behind all through school. More children than we think are too weak in early numeracy and lack the conceptual foundations for numbers at school start.

Yet the majority of these children have no learning difficulties. Their low performance

primarily stems from little exposure and training in early math at home and at Kindergarten.

Early math interventions at Kindergarten are desirable. But since the individual variation is so large, “one-size-fits-all”-interventions will not do. We need interventions that use *adaptive instruction*, where support and levels of difficulties are adapted to each individual child.

Why digital intervention?



Several successful early math interventions have been conducted – but none has been implemented on a large scale. Here, digital interventions are promising. They do not require preschool teach-

ers to be particularly knowledgeable and interested in early math. They can be implemented with reasonable time investment by teachers, as children often can explore educational software with little instruction.

Why inclusive pedagogy?

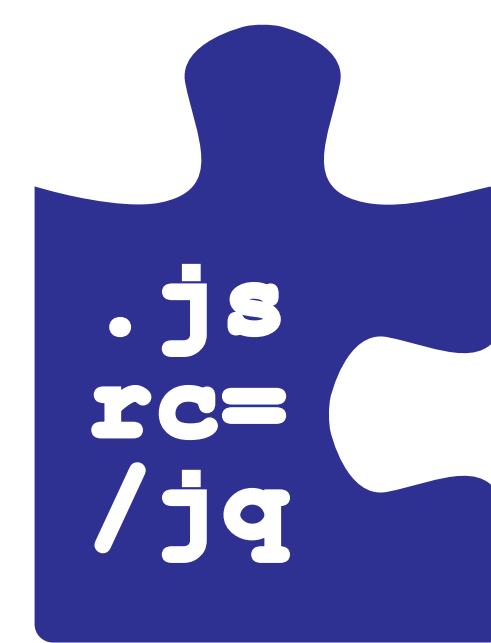


Inclusive pedagogy means: including all learners in an activity while (i) responding to individual differences between them, but simultaneously (ii) counteracting the marginalization that can occur when learners are treated differently.

The challenge is to actually treat children differently depending on their particular need for support and challenge – but not make the differential treatments visible. Why?

- The idea of oneself as bad in math develops early in children. Already by the age of 7 or 8 many children see themselves as unsmart and some even fear mathematics. It is important to avoid that already Kindergarten children develop such self-conceptions and attitudes.
- Being exposed as different can be detrimental for learners, in particular for those who struggle but also for those who are far ahead.

Implementing adaptation and inclusion in early math software



Magical Garden (MG) is designed to improve number sense and offer meaningful tasks in this domain with respect to challenges and support for all 4- to 6-year-olds in a preschool group. To our knowledge, MG is the only educational software that combines *adaptive instruction* with an explicit catering for *inclusion*.

The game makes use of *teachable agents* acting as friends: the child needs to help her friend collect water drops for the magical garden to flourish by solving different tasks. 60 different pedagogical scenarios are ordered according to difficulty. Each scenario is repeated in three subsequent modes: child learns and practices on her own, child shows her friend how to play, and child supervises and helps her friend play.

Each child progresses at her own pace and is scaffolded according to her performance on each given level.

The *inclusive strategy* bases on: (i) the main reward system of collecting water drops: solving a task means gaining water drops regardless of the difficulty level of the task; (ii) the type of plants in the garden being randomly generated – thus the gardens will look different and not allow straightforward comparisons on “how far one has got”; and (iii) the different mini-games being randomly distributed over the 60 pedagogical scenarios making typical “game level” comparisons difficult.

Thus, the educator – but not the children themselves – can recognize differences in advancement. Although competition can be used in education to inspire and motivate children, we argue that competition should be downplayed for this young age group in this domain. The costs risk to be larger than the gains.

During the past year (2014/15) over 100 preschool children have been using MG; we have observed children play and interviewed children and teachers. All children seem to experience progress when they enter a novel level (as they all do, even if at different paces). Overall, the *individual adaptation* works, except for the very high-performing children, where more challenging tasks need to be added.

Notably children spontaneously find many ways to compare what happens on their respective screens, but none of these comparisons map to being stronger/weaker in early math. Evidence from both children and teachers indicate that the *inclusive strategy* works well.

Cultural note: The concept of *inclusion* reported in this paper has been very positively received by teachers and parents in Sweden. It is, however, an open question whether this will be the case in other countries, where the view of competition in educational settings may differ. We look forward to cross-cultural studies.

