Immediation: Embedded Assessment of Prerequisite Knowledge to Guide Cross-Game Feedback

We are exploring the idea of immediate remediation (*immediation*), which performs "prerequisite diagnosis" to facilitate cross-game feedback (i.e., to suggest games a student is ready for). To understand how immediation works, imagine a student sitting in an advanced arithmetic class while the teacher goes through a typical explanation of how to find prime factors—the kind that would normally be presented in a lecture, in a textbook, or by an existing instructional system (e.g., Assistments; Razzaq et al., 2005). Without understanding what a factor is, this student has little chance of comprehending any explanation of how to find prime factors. In a game environment, however, this student would have a chance. The student could take a break from the harder game and learn the material in the prerequisite game. When ready, the student can go back to the original game.

People who already have a foundation when learning something new are likely to learn it faster, remember it longer, and transfer what they have learned to new situations (Chi, Glaser, & Rees, 1982; Shute, 1994; White & Frederiksen, 1986). Learning is optimized when the difficulty of the activity lies in the learner's zone of proximal development (Vygotsky, 1978), where it is a challenge for the learner, but can still be accomplished with scaffolding. Immediation will suggest games learners are ready for, either for remediation or challenge, in order to optimize learning.

The past several decades have seen numerous approaches toward automated diagnosis and tutoring of students engaged in problem-solving. These approaches typically involve detailed analysis of potential solution paths for problems, formal representations of correct and incorrect answers, and support in the form of feedback or explanations to students during the process of solving a problem. While many systems have displayed impressive results in laboratory studies (Shute & Psotka, 1996), the analyses necessary to develop these approaches are expensive to produce (e.g., Anderson, Corbett, Koedinger, & Pelletier, 1995). Immediation is promising because its tenets are supported by research as being effective, it is cheaper to implement than problem and error analysis, and has not yet been automated.

We are developing an educational web portal for middle school mathematics and science games. The games will be connected to each other via a map of the content areas to support individualized cross-game feedback, which will be based on student areas of strength and weakness as displayed in their game play. For example, finding prime factors requires the prerequisites of understanding prime numbers as well as factors, each the focus of different games; one game can be recommended to a learner in order to remediate a skill or to create a challenge. Embedded assessments will collect and analyze in-game performance data from educational games already created by our current partners (e.g., NYU, NMSU, Vanderbilt University).

This project will explore the effect of cross-game feedback on math and science interest and learning. We are also looking to extend the portal to other educational games, providing a rich data resource for developing immediaton.

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