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Research Note

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Needs Assessment for the Development of Learning Objects

In a review of 125 needs assessments conducted in educational settings, Witkin (1994) identified multiple deficiencies: mono-method bias (use of a single data source to identify needs), confusion between solutions (instructional actions) and needs (gaps in student performance), use of unsystematic procedures, and overreliance on data from a single group. We attempted to avoid these problems in selecting the focus for CLIPS being developed for lower-achieving mathematics students in grades 7-10. In our study, CLIPS (Critical Learning Instructional Paths Support) are learning objects: short multimedia programs focused on specific learning objectives. In this research note we describe how we applied systematic needs assessment procedures (Witkin & Altschuld, 1995) to focus five CLIPS. Figure 1 summarizes our strategy.

Step 1: Link to a formative assessment system

We framed CLIPS development in a formative assessment system to ensure that the CLIPS fitted the structure of the curriculum and met the criteria for formative assessment (Black & Wilem, 1998). Fit means that (a) there is a diagnostic procedure for placing students on a developmental continuum; (b) the CLIPS provide instruction for moving students from one level of the continuum to another; and (c) the instructional strategy embedded in the CLIPS complements standards-based mathematics teaching (National Council of Teachers of Mathematics, 2000).

We used the grade 6 diagnostic tests of PRIME: *Professional Resources and Instruction for Mathematics Educators* (Thomson Nelson, 2005). These tests place students on a developmental continuum for mathematics that has been empiri-

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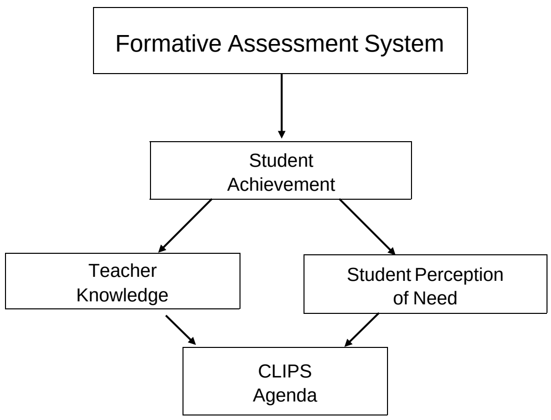

Figure 1. Procedures for development of CLIPS agenda.

cally validated using samples of Canadian students (Small, McDougall, Ross, & Ben Jaafar, 2006). PRIME provides a conception of the curriculum organized around a small set of concepts and skills (e.g., for the Number and Operations strand there are five organizing concepts and three organizing skills). For each curriculum outcome there are five phases of performance. For each level of the continuum, PRIME provides examples of developmentally appropriate instructional strategies to be used with Standards-based texts (Small, 2005a, 2005b).

Step 2: Select learning objectives that are poorly achieved

In 2005-2006 we collected data from underachieving grade 7 and 8 students (Ross, Ford, & Xu, 2006). We identified 21 problem types for Number and Operations in which student achievement was consistently low. All problems involved fractions.

Step 3: Select learning objectives that students believe they need to learn

We assembled pairs of examples for each of the 21 problem types. Students used a 1-6 scale to show how confident they were about their ability to solve each pair of problems. The scale was anchored by *not confident at all* (1) and *very confident* (6). Each pair of problems was flashed on an overhead screen. It was essential that the problems not be visible on the screen for long enough for the students to solve them. We were measuring students' self-efficacy beliefs, that is, their expectations that they could solve each problem type (Bandura, 1997). Following Schunk (1996), we started with a two-second display, but this was not enough time to process both items in the pair. After considerable experimentation, we found that the time taken by the teacher to read each pair aloud was sufficient for students to determine whether they could successfully complete the problem pairs.

We conducted an exploratory factor analysis (principal axis with Varimax and Promax rotation) on 405 grade 7-10 students' responses. There was a single factor solution: the first eignenvalue=12.541, accounting for 60% of the variance; second eigenvalue=0.984. We concluded that the 21 items were measuring a single construct (*confidence in solving fraction problems*) rather than a cluster of themes. We calculated the mean confidence level for each item pair for the total sample, for students who were in the lowest quartile of self-reported mathematics ability, and for males and females. We found that mean confidence levels were very high for all students, including those in the lowest quartile. Confidence was higher for boys than girls, although there were no gender achievement differences in Ross et al. (2006).

Step 4: Select learning objectives that teachers believe to be important

We focused on two dimensions of teacher knowledge: (a) Teachers' pedagogical content knowledge: which areas of the curriculum were most likely to cause learning problems and generate misconceptions. We provided 33 grade 7-10 teachers with the same set of problem pairs and asked them, "How much difficulty do students in your course have in mastering the learning expectation shown in this pair of items?" (b) Teachers' disciplinary knowledge: knowledge of mathematics content and the substantive structure that organizes this content. We asked them to estimate for each problem pair, "How important is it to produce additional CLIPS to help students master the learning expectation shown in this pair of items?"

We added the two teachers' scores together to rank the problem pairs from highest to lowest priority. Teachers rated the top 10 problem types in exactly the same order for difficulty and importance. In contrast, there were substantial differences between students and teachers. For example, the item rated as the highest priority by students (i.e., they were least confident about their ability to deal with problems of this type) was only the 10th highest priority for teachers.

Step 5: Set CLIPS Agenda

A team of eight expert teachers used the teachers' and students' data to identify the learning objectives to be addressed by the CLIPS. The decision-making process was not a straightforward application of an algorithm, but a thoughtful discussion of all the sources of information. In general the teacher team started with the teachers' results and then factored in the students' confidence results. After exploring several ways of combining the data, the team decided that the Number and Operations CLIPS would focus on two themes: representing fractions and equivalent fractions.

Lessons Learned

Our procedure provided a rigorous foundation for CLIPS development and had other benefits: teachers' ownership increased by their participating in the data-collection; we discovered that students, especially boys, overestimated their competence in solving fractions; the 21 problem pairs provided items for the summative evaluation of the CLIPS.

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