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Imagination Station (Istation):

Development of Teacher Resources for Grades 3 - 8

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**Imagination Station (Istation):
Development of Teacher Resources for Grades 3 - 8**

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Abstract

This technical report describes the development of the Imagination Station (Istation) Teacher Resources for Grades 3 through 8, research-based instructional recommendations to support students who struggle in mathematics. The grade-specific mathematics knowledge and skills presented in the Teacher Resources are informed by state and national content standards. Each resource contains two categories: (1) content standards and (2) research-based instructional recommendations. This report contains the content standards and research-based instructional recommendations used to create the Teacher Resources, the components within the Teacher Resources, and the procedures used to write and review the Teacher Resources. To document the content-related evidence for validity, this technical report details the process and outcomes of reviewing and editing the Teacher Resources.

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Imagination Station (Istation) Development of Teacher Resources for Grades 3 - 8

Introduction

The Teacher Resources for the Imagination Station (Istation) are research-based, standards-aligned instructional tools that support students who struggle in mathematics. The purpose of the Teacher Resources is to provide teachers with research-based instructional recommendations and accompanying sample lessons to implement with students who have been identified as struggling in mathematics by any data source. In addition, the Teacher Resources are designed to integrate evidence-based instructional recommendations with state and national content standards. Using these Teacher Resources will enable teachers to quickly identify common misconceptions students have about a mathematics topic and, as a result, anticipate the difficulties children may face and adjust their instructional plan accordingly to fit students' needs.

The purpose of this technical report is to describe the development of the Teacher Resources for Grades 3 – 8. This description includes: (a) the content standards and research-based recommendations used to create the Teacher Resources, (b) the document-writing process, and (c) the reviewing and editing procedures used to ensure content-related validity.

Content and Format of Teacher Resources

Each Teacher Resource is organized into five sections: (1) overview of the content, (2) overview of the research-based instructional practice, (3) integration of the content and research-based instructional practice, (4) sample instructional sequence, and (5) references. A description of each section follows.

Overview of Content

This section describes the Teacher Resources content, which is based on the Curriculum Focal Points (CFP) published in 2006 by the National Council of Teachers of Mathematics (NCTM). We aligned the mathematics content standards from the states of Texas, Florida, New York, California, and Virginia, as well as those published by the Common Core State Standards Initiative to the NCTM CFP. See Appendix A for the content standards for each state. For each grade level, we created an additional CFP (CFP4) that encompasses measurement and geometry standards assessed across all the states since there was a lack of measurement and geometry standards at every grade level. See Appendix B – G for an abbreviated description of the specific content standards used in the Teacher Resources for Grades 3 – 8. In addition, for each CFP we note several common misconceptions and error patterns students may exhibit and the concepts students will need to master by the end of their current grade level.

Overview of the Research-Based Instructional Practice

This section of the Teacher Resources incorporates evidence-based instructional practices based on research reported in two documents (Gersten et al., 2009a ; Gersten et al., 2009b). The first report, published by the Institute of Education Sciences (IES), outlines eight research-based recommendations for instructional strategies that support mathematics achievement for struggling students (Gersten et al., 2009a):

- IES Recommendation #1: Screen all students to identify those at risk for potential mathematics difficulties and provide interventions to students identified as at risk.
- IES Recommendation #2: Instructional materials for students receiving interventions should focus intensely on in-depth treatment of whole numbers in kindergarten through grade 5 and on rational numbers in grades 4 through 8.
- IES Recommendation #3: Instruction during the intervention should be explicit and systematic. This includes providing models of proficient problem solving, verbalization of thought processes, guided practice, corrective feedback, and frequent cumulative review.
- IES Recommendation #4: Interventions should include instruction on solving word problems that is based on common underlying structures.
- IES Recommendation #5: Intervention materials should include opportunities for students to work with visual representations of mathematical ideas and interventionists should be proficient in the use of visual representations of mathematical ideas.
- IES Recommendation #6: Interventions at all grade levels should devote about 10 minutes in each session to building fluent retrieval of basic arithmetic facts.
- IES Recommendation #7: Monitor the progress of students receiving supplemental instruction and other students who are at risk.
- IES Recommendation #8: Include motivational strategies in tier 2 and tier 3 interventions.

IES Recommendation #1 and #7 are not included in the Teacher Resources since these recommendations address assessment and the Teacher Resources emphasize instruction. Each of the Teacher Resources provides an in-depth description of a single IES Recommendation (#2, #3,

#4, #5, #6, or #8), strategies to improve student outcomes, justification for the strategies, and potential roadblocks to its implementation.

In the second report Gersten and his colleagues (2009b) reviewed 42 studies that used randomized control trials or quasi-experimental methods in order to identify evidence-based strategies for effective mathematics instruction. The meta-analysis included studies reporting mean effect sizes that ranged from 0.21 to 1.56. The Teacher Resources incorporate strategies from this study such as the use of heuristics, student verbalizations, visual aids, explicit instruction, student feedback, goal setting, and peer assistance.

Integration of the Content and Research-Based Instructional Practice

This section describes how the content and research discussed in the second section can be applied to instructional practice and learning outcomes. This section presents instructional strategies that integrate the content from the CFP with the research-based IES Recommendations, a rationale for each instructional approach, and how they can be used to improve student outcomes. In addition, we include several types of difficulties students may face and how using the instructional strategies supports and promotes future mathematics learning.

Sample Instructional Sequence

This section includes a description of an instructional sequence that teachers might use to implement the research-based instructional practice when teaching the content. This instructional sequence contains multiple parts that together form a sample lesson, showcasing how to integrate the CFP with the research-based instructional practice. First, we provide teachers with an overview of a sample lesson consisting of lesson objectives, prerequisite skills and knowledge, mathematical vocabulary with accurate yet developmentally appropriate definitions of the terms, and materials and resources to be used in the lesson. Next, we provide teachers with tiered intervention strategies. Lastly, this section includes suggestions about how to modify and extend the lesson to support students with different learning needs.

The instructional sequence contains a complete sample lesson, including teacher modeling, verbalizations, and notes. The lesson contains examples of explicit instruction, teacher modeling, and questioning strategies. Teacher notes, included throughout the lesson plan, provide teachers with additional information about student misconceptions, possible student responses, and materials. Beyond content-related examples and practice problems, the sample lesson includes additional problems for guided and independent practice. The last section of the instructional sequence provides suggestions for re-teaching and extensions, evaluation and feedback, and closure. Each section in the lesson has research-based components incorporated in order to increase the practical significance of the lesson. See Appendix H for the lesson template.

The sample lesson was purposefully designed using evidence-based components of effective lessons such as “think a-louds” (Ellis & Larkin, 1998), guided practice, and differentiated instruction (Gresham & Little, 2012). For example, lessons use guided practice as a scaffolding strategy to model and think through new information presented during the lesson, providing a foundation upon which they can apply burgeoning skills until they can do so independently (Gresham & Little, 2012). The included lessons encourage teachers to model the cognitive

processes needed to solve problems by using “think a-louds”, followed by gradual release of responsibility from tasks being completed in whole or small groups, to students working independently to demonstrate mastery (Ellis & Larkin, 1998). We incorporate differentiated instruction strategies tailored to the learning environment and the needs of individual learners by varying interests and readiness levels, and by using manipulatives and visuals aids (Gresham & Little, 2012).

References

This section includes a list of helpful websites, articles, and/or books used to develop the Teacher Resources, as well as those relevant to the sample lesson.

Document-Writing

Document Specifications

There are 144 Teacher Resource documents across grades 3 – 8, a total of 24 per grade level (i.e., each document integrates one of four NCTM CFPs with one of six IES instructional recommendations). Figure 1 depicts the matrix of 24 documents created for one grade level.

The Teacher Resources are written in a manner that is both accessible to teachers and developmentally rigorous for students. All research references included in the Teacher Resources achieve readability while maintaining research integrity. When creating examples and practice problems for teachers to use during instruction, document writers carefully considered the developmental age of the target student population. All student examples use language that is accessible, yet mathematically precise. In addition, sample lessons include graphics as needed in order to convey important mathematical concepts.

Document Writers

Six writers contributed to the development of the Teacher Resources.

Writer 1. Writer 1 received her B.A. in Mathematics from the University of Texas at Austin with the UTeach program, and her M.Ed. in Educational Leadership and Policy Studies from the University of Texas at Arlington. She taught elementary and middle school mathematics for four years. She also served at the Texas Education Agency for three years in a variety of roles, including the Assistant Director of Mathematics and Mathematics Curriculum Specialist in the Curriculum Division and Mathematics Assessment Specialist in the Student Assessment Division. She is currently pursuing her doctoral degree at Southern Methodist University.

Writer 2. Writer 2 earned her B.A. in Biochemistry and Mathematics from Austin College. She then earned a M.S. degree in Biochemistry from Baylor College of Medicine. She has taught high school algebra and geometry and has tutored middle school, high school, and college level math. She has a M.Ed.

degree from Southern Methodist University and is currently pursuing her doctoral degree at the same university. Her interests are in the field of mathematics measurement and assessments.

Writer 3. Writer 3 graduated from Texas Christian University with a B.S. in Mathematics Education. She then taught high school Geometry and Pre-Calculus for three years. While teaching, she earned her M.Ed. degree from The University of Texas at Arlington in Mathematics Curriculum and Instruction. She has also privately tutored students in all levels of mathematics courses ranging from eighth grade mathematics to Pre-Calculus. She is currently the professional development coordinator for the Research in Mathematics Education unit at Southern Methodist University in Dallas, Texas.

Writer 4. Writer 4 has a B.A. in German from the University of Texas at Austin. She has taken multiple courses in Early Childhood Education at the University of Texas at Dallas and Eastfield Community College. She obtained her alternative teacher certification from Texas A&M University. She has taught pre-school and elementary school and has 20 years of teaching experience.

Writer 5. Writer 5 received her B.A. in Psychology from University of California, Davis, and her M.S. in Education with an emphasis in Mild/Moderate Special Education from California State University. She then obtained her Ph.D. in Educational Leadership with an emphasis in Learner Assessment/Systems from the University of Oregon. She has worked as a resource specialist at the elementary school level to provide individualized instruction to students, and has written and implemented Individualized Educational Plans (IEPs). She is currently working as a postdoctoral research associate at the University of Oregon.

Writer 6. Writer 6 graduated from Northwestern University with a B.A. in Comparative Literary Studies. She also has a M.A. degree in Math Education from DePaul University. She has her middle school and high-school math certification and has taught 7th and 8th grade algebra. She has also previously worked as a content specialist to plan and implement campaigns for education materials. She currently works as a content developer to develop, write, and review interactive whiteboard presentation, practice, and assessment content for mathematics and reading lessons.

Document-Writing Training

All document writers received training to write the Teacher Resources in alignment with targeted content expectations and IES Recommendations. A face-to-face training was conducted to provide the document writers with: (a) information on the content and research-based instructional practices, (b) the Teacher Resources format, and (c) procedures for writing, submitting, and reviewing the Teacher Resources. As part of this training, writers reviewed and discussed a sample lesson plan that illustrated clear and accessible language, relevant graphics,

developmentally appropriate content, and precise mathematical terminology. Writers received an Istation Teacher Resources Training Manual with procedural information, a review checklist, a list of mathematics resources and websites, and research articles to reference during lesson development.

Document-Writing Process

After completing the training, document writers received a template to create the Teacher Resources. Document writers referenced research articles, books, and websites to develop ideas for lessons and strategies to integrate the IES Recommendations with the CFP-specific mathematics content. The document writers completed approximately two Teacher Resources each week.

Content-Related Evidence for Validity

To evaluate the accuracy and appropriateness of the content of the Teacher Resources, the Teacher Resources underwent a two-tier review process, beginning internally with the document writers and followed by project manager reviews. To begin, two document writers reviewed each Teacher Resource to provide feedback to the original document writer. The first reviewer provided comments, feedback, and edits on the Teacher Resource and then sent it to the second reviewer, who also provided comments, feedback, and edits. Each reviewer utilized the Istation Math Teacher Resource Review Checklist included in the Istation Teacher Resources Training Manual. The criteria used to review the Teacher Resources are described below:

- Content alignment: Is the mathematical content aligned to the NCTM CFP? Does the instructional practice align with the IES Recommendation?
- Appropriateness of content: Are the materials appropriate for the specified grade level? Are the materials free from bias based on gender, ethnicity, race, social class, disability, geography, or experiences unique to a subset of students?
- Mathematical precision: Is the mathematical content accurate and precise?
- Language: Is the language consistent across Teacher Resources? Is the language clear, concise, complete, and grammatically correct? Is the language in the lesson materials grade-appropriate for students? Are the directions unambiguous?
- Graphics: Are the graphics relevant to the mathematical concepts?

Reviewers returned comments to the original document writers, who then made revisions based on the feedback. Next, the Teacher Resources were sent to the two project managers for review. Project Manager 1 is a research specialist and a PhD candidate in the Education Department at Southern Methodist University. She has over 18 years of experience as a classroom teacher and administrator. Project Manager 2 has a Ph.D. in Educational Leadership from the University of

Oregon. She works as an Associate Professor at the Education Policy and Leadership Department at Southern Methodist University, and is currently also the Director of the Research in Mathematics Education Unit at SMU. The two project managers reviewed the Teacher Resources based on the criteria outlined above. Document writers made final revisions based on the project managers' feedback and suggestions.

Conclusions

The purpose of this technical report was to describe the development of the Teacher Resources. We described the content standards and the research-based recommendations that were used to create the Teacher Resources, the qualifications of the document writers, the document writing process itself, and finally, the reviewing and editing procedures to document content-related evidence for validity.

References

Ellis, E. S., & Larkin, M. J. (1998). Strategic instruction for adolescents with learning disabilities. In B. Y. L. Wong (Ed.), *Learning about learning disabilities* (2nd ed., pp. 585-656). San Diego, CA: Academic Press.

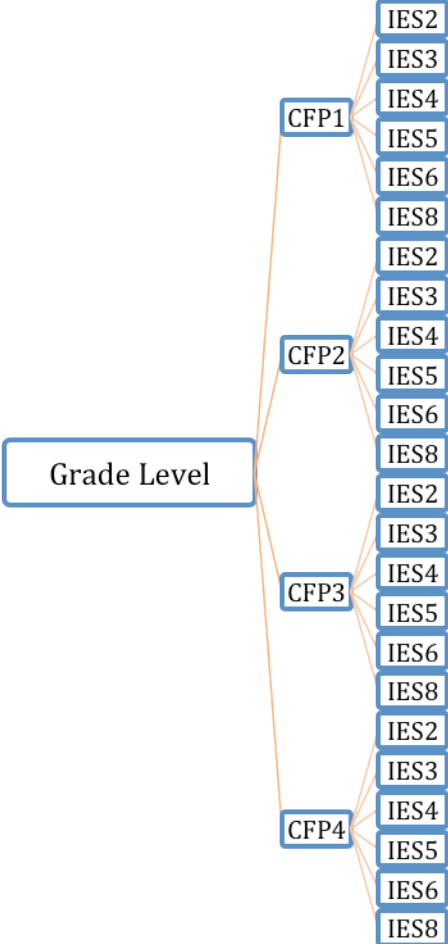
Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009a). *Assisting students struggling with mathematics: Response to Intervention (RTI) for elementary and middle schools* (NCEE 2009-4060). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from <http://ies.ed.gov/ncee/wwc/publications/practiceguides/>

Gersten, R., Chard, D. J., Jayanthi, M., Baker, S. K., Morphy, P., & Flojo, J. (2009b). Mathematics instruction for students with learning disabilities: A meta-analysis of instructional components. *Review of Educational Research*, 79(3), 1202–1242.

Gresham, R. H., & Little, M. E. (2012). *RTI and mathematics: Practical tools for teachers in K-8 classrooms*. Upper Saddle River, NJ: Pearson Education, Inc.

Figure 1

Teacher Resource Matrix for a Specific Grade Level



Appendix A - State Content Standards Referent Sources

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

Florida

Florida's Next Generation Sunshine State Math Standards (adopted 2007) were retrieved on July 5, 2012 from <http://www.floridastandards.org/Standards/FLStandardSearch.aspx>.

California

California's Math Content Standards (adopted 1997) were retrieved on July 5, 2012 from <http://www.cde.ca.gov/be/st/ss/documents/mathstandards.pdf>. California Green Dot Standards are the selected standards that appear 85% of the time on California state tests.

Common Core Standards

The Common Core Standards in Mathematics were retrieved on July 5, 2012 from <http://www.corestandards.org/the-standards/mathematics>. These standards were published in 2010. They were developed as part of an initiative led by National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO).

New York

The New York State Standards (revised 2005) were retrieved on July 5, 2012 from <http://www.p12.nysed.gov/ciai/mst/math/standards/core.html>.

Texas

The Texas State Standards for Math (Version 2.1; revised 2010) were retrieved on July 5, 2012 from <http://ritter.tea.state.tx.us/rules/tac/chapter111/index.html>. The Texas Education Agency (TEA) released a 2010 document entitled *Texas Response to Curriculum Focal Points*:

Kindergarten through Grade 8 Mathematics that included coordinating TEKS.

Virginia

Virginia's Standards for Learning Document for Mathematics (adopted 2009 for full implementation in 2011-12) were retrieved on July 5, 2012 from http://www.doe.virginia.gov/testing/sol/standards_docs/mathematics/index.shtml.

Appendix B - Grade 3 Content Description

Appendix C - Grade 4 Content Description

Appendix D - Grade 5 Content Description

Appendix E - Grade 6 Content Description

Appendix F: - Grade 7 Content Description

Appendix G - Grade 8 Content Description