Who is Number 3? Long Division Proposal

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Introduction

This instruction is designed to teach long division to students in the fourth grade. State standards require these student to demonstrate division skills during standardized testing. Mastery of these skills are necessary to the students as they continue in their academic careers, and important for the students' schools to show the curriculum and instruction are effective. At the conclusion of the instruction, students will successfully solve long division problems with one-digit divisors and up to four-digit dividends.

This module is instructor-led, and is designed to be delivered in a typical public school classroom, with minimal equipment required. Instructional materials will include a "Math Facts" job aid, which will be developed during the design process. This will provide an addition/ subtraction table, multiplication tables, and the Dad, Mom, Sister, Brother, Rover mnemonic for the long division algorithm. The designers will also provide practice problem sets with worked examples for use during instruction. The school will need to provide individual dry-erase boards for each student, and a whiteboard or overhead projector for the instructor.

Analysis

Learner Analysis

The learner analysis will be conducted through interviews with teachers and students, examination of student test results and academic records, and observations of the school culture. Data from academic records will indicate which students have mastery of multiplication, basic division, and subtraction. If the students do not have a firm grasp of multiplication and its relationship to division they will be supported with a multiplication table. Multiplication tables are readily available in classrooms and in the students' daily planners.

Students will be expected to have already begun developing their understanding of division using grouping and the inverse relationship with multiplication. This expectation will be verified through student interviews and available school data.

There will be a range of student attitudes towards mathematics, discovered through student and teacher interviews. Certain students may be intrinsically motivated to learn the content, while most will be extrinsically motivated to get acceptable marks in their class. Some students will not be motivated, due either to a lack of entry skills or prior knowledge. There may be a need to offer scaffolding support for these students like supplying multiplication tables.

Needs Assessment

The California Common Core Standard: Mathematics, Grade 4, Number and Operations in Base Ten section includes "6. Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors" (California Department of Education, 2013, p. 30). The state target is for all students to score "proficient" or above on the Standardized Testing and Reporting (STAR) test; in 2013, 72% of fourth graders achieved this score (Torlakson, 2013). This lesson is designed to allow fourth graders to master this particular objective as part of a broader curriculum that would address the entire standard.

Entry Behaviors

Students know the multiplication facts. Students know how to express numbers in fraction form, including mixed numbers and improper fractions. Students know the definition of dividend and divisor. Students are able to do simple division. Students are able to do multi-digit subtraction. Students are able to identify place value.

Context Analysis

Instruction will take place in a standard public school classroom. There is time set aside each day in a 4th grade class for mathematics, typically before break. The classrooms may be set up in desks or in small group tables; the instruction will work well in either. There will be all appropriate pencils, papers, and worksheets for the students. Students will also have individual dry-erase boards available to respond to the teacher's checks for understanding. The instructors will have a whiteboard or overhead projector to demonstrate examples.

Goal Statement

Students will find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors.

Goal Analysis

1. 0 Students will be able to identify the dividend, divisor, and quotient of a division problem in long division format.

2.0 Students will be able to calculate long division problems.

2.1 Students will solve long division problems with no remainder.

2.2 Students will solve long division problems with a remainder.

2.2.1 Students will write the answer with a remainder.

2.2.2 Students will express the answer as a mixed number.

Objectives (Bloom's Domain)

Entry Skills Objective: Given simple division problems, students will demonstrate the relationship between multiplication and division. (Cognitive: Application)

1.0 Given a division problem in long division format, students will correctly identify the dividend, divisor, and quotient. (Cognitive: Knowledge)

2.0 Using the long division algorithm, students will correctly solve long division problems with one-digit divisors and up to four-digit dividends. (Cognitive: Application)

2.1 Using the long division algorithm, students will correctly solve long division problems that result in no remainder. (Cognitive: Application)

2.2 Using the long division algorithm, students will correctly solve long division problems that result in a remainder. (Cognitive: Application)

This objective will be evaluated by assessing the sub-objectives 2.2.1 and 2.2.2.

2.2.1 Given a long division problem that results in a remainder, students will solve the problem using the long division algorithm and correctly express the solution as a whole number plus remainder. (Cognitive: Application)

2.2.2 Given a long division problem that results in a remainder, students will solve the problem using the long division algorithm and correctly express the solution as a mixed number. (Cognitive: Application)

Design and Development

Assessments are designed first, in accordance with the Dick and Carey model (Dick, Carey, & Carey, 2009). Answer keys for the assessments show the correct use of the algorithm to allow teachers to identify what part of the algorithm the students had trouble with. Each question is chosen to show a different step of the algorithm, or is linked to a specific objective. For this reason, the designers recommend using the assessments provided with the instruction (see Appendix A for samples). If instructors choose to use their own worksheets and test items, they must verify that the expressions used meet the same criteria.

Instructional Strategies

The instructional strategies are based on Gagné's nine events of instruction (as cited in Dick, Carey, & Carey, 2009).

1. Gain attention. Show students a division problem that they cannot complete, because it is not on the multiplication table and is impractical for repeated subtraction.

2. Inform the learner of the objectives. State, "Today we will learn long division, which will allow you to solve problems like these."

3. Stimulate the recall of prior knowledge. Ask, "How did we divide 15 by 3 in the past?" Show examples of repeated subtraction and using the multiplication table.

4. Present the stimulus material. Introduce the outline of the algorithm. Show the students a set of examples, with no remainders.

5. Provide learning guidance. Lead the students in guided practice. First say the step, and have a non-volunteer student respond. On subsequent examples have students tell you which step comes next and do the calculations for them. Students will be provided with a "Math Facts" job aid containing an addition/subtraction table, multiplication tables, and the mnemonic for the long division algorithm.

6. Elicit performance. Have students practice on a problem set. The first two problems of the set will be solved with all steps shown to provide additional guidance for the students.

7. Provide feedback. Correct a portion of the assignment with peers; allow students to share their worked problems (correct and incorrect) with the class and provide positive and constructive feedback.

8. Assess performance. Let students finish the assignment. This will result in a set of questions to evaluate their understanding. Students will also be evaluated using a posttest at the end of the long division unit.

9. Enhance retention and transfer to new situations. Teach the Dad, Mom, Sister, Brother, Rover mnemonic for the algorithm. Students will also keep the "Math Facts" job aid for future reference.

Utilization of Materials

Description of Process

The instruction is based on the cognitive learning theory; that is, the instructor will activate prior knowledge then present content in the form of examples (Silber, 1998). The instructor then follows up the new information by allowing students to practice the skill, moving it into long term memory. Each objective will have its own set of division problems; the instructor will have a sheet of example problems. These examples will be developed to give the instructor several problems to choose from, to prevent the instructor from having to make more during the lesson. The instructor may already have a bank of questions available in their class text. If this is the case, guidelines will be suggested in the selection of these examples with collaboration of the subject matter expert. The selected examples must support the appropriate objective; inappropriate examples would fail to meet the needs of the students and may lead to misconceptions.

After formative practice the students will complete a worksheet developed to match the examples used during instruction. On the worksheet there will be a problem completed, for the students to use a reference if there are completing the work independently. Worksheets may be available with the in-class text; these will need to be reviewed by the subject matter expert to verify that the problem set supports the instructional goals. Because the teacher cannot guide the student at home, this completed problem will be needed to provide stimulus if the student needs it.

Students will use individual dry-erase boards to practice the examples with the teacher and to give the instructor a chance to formatively evaluate the students' progression. If more guidance is needed, the instructor can add more examples for demonstration or individual practice. The teacher will be using a class-centered dry-erase board, or projection, to deliver the examples to the students in the class. Since some of the student work will be done on individual white boards, the work can be brought to the front of the class for the instructor to show both correctly completed work and work that needs revision.

When the instruction is still in the design stages, there will need to be communication between the instructor and designer to determine if the length and problem selection of the in-class examples and worksheet are sufficient to move the skills into the students' long term memory. There will also need to be an evaluation of the problems sets, to determine if the instructional goals are met. This is a recurring evaluation throughout the formative levels of the instructional design, final problem sets will be typed to be included in the final product.

Evaluation

Formative Evaluation

The process of selecting students to evaluate materials for our Long Division module that are target population is an important part of our introduction of the material that are being covered. The selection of learners will be approximately thirty students ranging from Far Below Basic to Advanced based on the California STAR Test. The instructor first informs the learners that the materials are in their formative development and it is very important that the learners give feedback. The instructor leads the instruction session leaving the designer as an observer.

The learner's attitude toward instruction is determined by taking an attitude questionnaire followed by another interview. The instructor may be able to adjust the instruction to meet the

needs of the group; the designer will make notes of all changes. This procedure is to identify any strengths and weaknesses in the instruction. The outcomes of this evaluation are to revise the final instruction making it feasible for the learners to have clear and precise instruction.

In conducting a field trial of our long division module, we will be seeking information on the appropriateness of our multiplication and subtraction entry skills, the time required for tests and instruction, and the attitudes toward the instruction of the learners and instructors. Because the lesson will be led by an instructor, we will also collect data on the interaction between the instructor and the students, and the feedback given. By making notes of questions asked and problems experienced by the learners, deficiencies in the design may be identified.

Pretests will be administered to check for knowledge of identified entry skills, and their relation to success in the instruction. The designer will observe the field trial to make note of the time taken for the instruction and calibrate the time allotted for assessments. A posttest will be used to measure the students' attitudes toward the instruction.

The instructor will ask students to write a response to a question aligned to an objective on individual dry-erase boards, then raise their boards to show their answer when prompted. Correct answers would suggest the instruction is being successful, an incorrect response would suggest that the instruction is not working. A non-response would indicate the instruction was not successful. An observer can note how many incorrect responses were given, and how many non-responses. In practice this would be done by the teacher and not recorded, but used to inform whether re-teaching is necessary. However, with an observer for the formative assessment of the design there would need to be an accurate count. This will create data at each objective in the instruction.

After the individual practice portion of the instruction, including the teacher feedback section of Gagné's 9 events, the students will be asked to explain to an absent student how to use the long division algorithm on an "exit ticket." An exit ticket is a small, nameless scrap of paper that students are required to turn in before leaving class for a class change or break. There are four possibilities to the responses from the students to be considered. First, a complete response with an example. This would suggest overall instruction was successful. Second, a student is able to produce a viable example that shows the process being used, but no explanation of steps. This suggests that the student has some mastery of the skill, but the instruction may need more verbal models or graphic organizers of the process. Third, if the student is able to explain the long division process in their own words, then the instruction can be considered successful. Fourth, a student may not respond completely, or respond with inaccuracies in the long division algorithm.

By grouping the incorrect responses by the misconceptions, there can be a comparison between the dry-erase board responses. A correlation between these responses and the exit ticket would provide evidence that the corresponding part of the instruction was unsuccessful.

Management of the Project

Our team collaborated with the goal to work as one unit. Once we received our assignments, an email would go out to set up our Thursday meeting and discuss any issues related to our group instructional design project. We met in Google Hangouts to exchange ideas and views. We found the best way to work on the project was to assign a duty for each of us, with a follow-up meeting to finalize the assignment before it was submitted. We alternated the responsibility of turning in the various deliverables. We used Google Docs for the assignments, which made it easy to make comments and also make quick changes while we were meeting online.

REFERENCES

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Dick, W., Carey, L., & Carey, J. O. (2009). *The systematic design of instruction* (7th ed.). Upper Saddle River, NJ: Pearson.

Silber, K. H. (1998). The cognitive approach to training development: A practitioner's assessment. *Educational Technology Research and Development*, *46*(4), 58-72.

Torlakson, T. (2013). State Schools Chief Tom Torlakson Releases 2013 STAR Results [Press release]. Retrieved from http://www.cde.ca.gov/nr/ne/yr13/yr13rel73.asp

APPENDIX A

Sample Assessments

Entry Skills Objective:

Find the answer to the following problems using the multiplication chart.

$4 \times 5 =$ $20 \div 4 =$

Objective 1.0:

On the sample problem below label the dividend, the divisor, and the quotient.

$$5\overline{)20}\,\,4$$

Objective 2.0:

Use long division to solve the following problems:

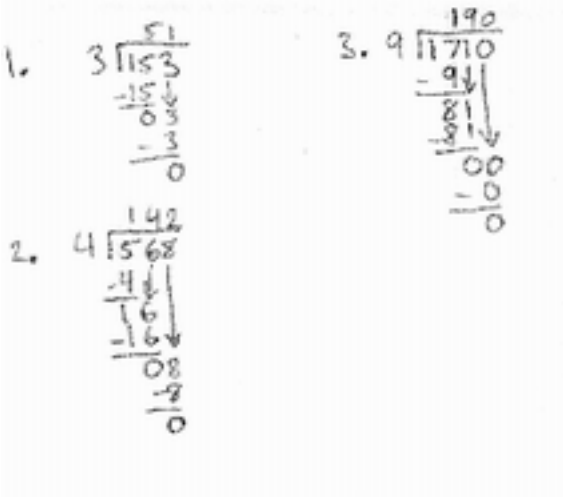
1. $4\overline{)204}$ 2. $5\overline{)4530}$

Objective 2.1:

Use long division to solve the following problems:

1. $3\overline{)153}$ 2. $4\overline{)568}$ 3. $9\overline{)1710}$

Assessment key:



Objective 2.2.1:

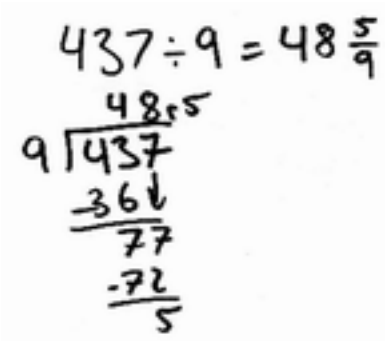
Solve the problems using the long division method. If there is a remainder, write it with "rem." For example, if the problem is $2\overline{)5}$, you would write your answer as 2 rem. 1.

$5\overline{)184}$

Objective 2.2.2:

Use long division to answer 437 ÷ 9. Write your solution as a mixed number.

Sample assessment key:



APPENDIX B

Task Timetable

Time (hrs)	**Member**	**Activity**
1	EW	Collected works from previous group assignments together to start a draft document.
1.5	EW	Gange's events
1	DS, AS	Gagne's events
2	DS, EW	Aligning Goals and Objectives
.5	AS, DS, EW	Creating assessment items
1	AS, DS, EW	Collaborative revision for team proposal update.
1	DS	Introduction for proposal document.
1	EW	Description of instructional process.
.5	AS	Description of team management.
.5	AS, DS, EW	Team planning session for consultation with Dr. Strong.
.5	DS	Consultation with Dr. Strong.
.5	AS, DS, EW	Collaborative revision and presentation brainstorming.
1	DS	Creating table of contents and final formatting of proposal document.
3	AS, DS, EW	Team collaboration for presentation.