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ABSTRACT

Recent calls for high standards and hard content for all students have brought a growing interest in Opportunity-To-Learn (OTL) measures. OTL indicators provide valuable information for anyone interested in knowing what instruction is like, whether it is equitably distributed, and whether it is improving over time. This paper describes an effort to develop OTL indicators for science education through a collaborative project of 14 states. The Council of Chief State School Officers is working with the State Collaborative on Assessment and Student Standards (SCASS) Science Project to develop innovative approaches to assessment in elementary and secondary science education. A project component of high interest and potential application for local educators is information on students' opportunity to learn the science, content, knowledge, and skills that are assessed. The SCASS member states anticipate using methods of collecting and reporting on opportunity to learn the science content in conjunction with science assessments. The paper discusses the approach to OTL data used in SCASS and some of the issues in designing OTL data collection instruments. The questionnaire is appended. (LZ)

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Council of Chief State School Officers

DESCRIBING THE ENACTED CURRICULUM:

Development and Dissemination of Opportunity To Learn Indicators in Science Education

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Recent calls for high standards and hard content for all students have brought a growing interest in Opportunity-To-Learn (OTL) measures. There are several reasons for this interest. External assessment programs hold students accountable for academic achievement and states and districts would like to insure that students receive an adequate opportunity to learn the material for which they are being held accountable. Many states report indicators at the school level on a variety of indicators such as attendance, graduation, and test scores. Data on curriculum, instruction, resources, and classroom activities may be very helpful to educators in analyzing how schools can improve performance indicators. However, what comprises OTL, and how data on OTL should be used, is anything but straightforward. This paper describes an effort to develop OTL indicators for science education through a collaborative project of 14 states.

SCASS Science Project and OTL

The Council of Chief State School Officers is working with the State Collaborative on Assessment and Student Standards (SCASS) Science Project to develop innovative approaches to assessment in elementary and secondary science education. An early step in the collaboration was completion of a document on *Consensus Guidelines for Science Assessment* (SCASS, 1994) that outlined the goals of the SCASS Project, the expected outcomes, principles to be used in development of science assessments, and a "Science Consensus Matrix." The SCASS matrix is organized by interdisciplinary science content themes, disciplines of science, and dimensions for knowing and doing science. The matrix provides states a common direction for development of assessment exercises, field testing and revision of assessment modules, and preparation of assessments for use by states. The SCASS project was planned for the period 1993 to 1996.

State representatives to SCASS Science expect the assessment tools will be used by member states to "monitor student performance at the state level and to assist local educators in the assessment of students in a manner consistent with emerging reforms aimed at redefining what and how students should be learning about science" (*Consensus Guidelines*, 1994). In addition to the assessment exercises, a project component of high interest and potential application for local educators is information on students' opportunity to learn the science content, knowledge, and skills that are assessed. The SCASS member states anticipate using methods of collecting and reporting on opportunity to learn in conjunction with the science assessments. SCASS is focusing on indicators of the "enacted curriculum"in science, i.e., the content and instructional practices actually provided in the classroom. Draft questionnaires, linked to the science assessments, are being field tested during the 1994-95 school year. The instruments developed through the SCASS project are intended to ~~may~~ assist states in interpreting assessment results and reporting on the nature and condition of science education in classrooms.

The following section discusses the approach to OTL data used in SCASS and some of the issues in designing OTL data collection instruments.

Purposes of OTL Data as Indicators

Porter (1991) identifies three main purposes for OTL data: to provide descriptions of the enacted curriculum, to monitor the effects of reform efforts, and to provide a means for diagnosing problem areas in classroom content related to education achievement.[1]

At the heart of OTL is a description of the opportunities for learning experienced by students. First and foremost, CTL data provides a picture of classroom practice across a broad array of schools to an equally broad audience of policy-makers, researchers, practitioners and parents. A key to sound policy and program decisions lies in having accurate and relevant information available for consideration. OTL data are intended to provide such information.

Descriptions of the enacted curriculum make it possible to assess the effects of policy on practice. Knowing the extent to which goals are being reached is valuable for all levels of the policy-making hierarchy, including teachers, site-level administrators and planning teams, as well as district and state offices.

Procedures to diagnose problems in the delivery of quality instruction has the potential to be another important tool in implementing change. Knowing where goals are not being met, and having some guesses as to why, makes fine-tuning and corrective measures possible. Here again, school and district level policy-makers can benefit as much from diagnostic data as can state level personnel.

Of these three purposes, the first (description) is both essential and fundamental; monitoring and diagnostic purposes presuppose and hinge upon the descriptions of the enacted curriculum obtained. Without an adequate description of classroom practice, monitoring and diagnosing functions are severely hindered. If OTL indicators are designed with the purpose

[1]A fourth potential purpose of OTL data, accountability, is not discussed here. Our view is that school accountability is more appropriately focused on school outcomes, and this purpose is likely to have a negative impact on the validity of data on enacted curriculum See Porter (1991) for a more complete discussion of the purposes of OTL data as indicators.

of description in mind, monitoring and diagnosing functions should fall naturally into place.

Enacted curriculum central to OTL. Underlying efforts to develop indicators of opportunity to learn is the idea that education outputs (generally measured by some type of assessment of student achievement) are mediated and influenced by a variety of inputs to and processes of the delivery of instruction. Any useful analysis of OTL requires information pertaining to all three -- inputs, processes and outputs. Of course, any successful implementation of an OTL indicator system depends upon selecting the most salient characteristics from each of the three categories.

Inputs cover such things as teacher characteristics (e.g. educational background, years of experience, professional development opportunities, job satisfaction, attitudes towards teaching and reform, etc.), student characteristics (prior ability, attitudes toward school, etc.), school characteristics (school climate and safety, teacher collegiality, instructional leadership, etc.), instructional materials and resources, amount of instructional time available, and parental involvement. In addition, other input variables are likely to be of interest for analysis purposes, such as racial/ethnic heritage, socio-economic make-up and geographic location (urban vs. suburban vs. rural).

However, no matter what other OTL indicators within formal education's direct sphere of influence one may wish to pursue, it is the activities that actually occur in the classroom that have the most immediate impact on student achievement. It is the indicators of these processes of education that serve to provide a description of the enacted curriculum that is central to any analysis of opportunity to learn.

Process indicators provide information on how teachers go about planning and organizing instruction, the instructional objectives they have in mind, the physical and cognitive activities that students engage in, the materials and modes of instruction teachers employ, the manner in which students are grouped, the types of assignments students receive, and the manner in which teachers measure student progress and learning.

It is through the combination of such information on the inputs and processes of education with outcome measures of achievement that it becomes possible to monitor and diagnose the progress of reform efforts. The SCASS Science project is designed with all three of these components in mind, along with a vision of practice set out in the *Consensus Guidelines* to guide developmental efforts.

Selecting indicators of enacted curriculum. Which of all of the possible components to opportunity-to-learn should we select in designing instrumentation? Which will best serve the needs of policy-makers and practitioners? The enacted curriculum has been at the core of OTL designs since they were initiated with the IEA studies in the 1960's. But, we have now learned that adequate and meaningful measures of the enacted curriculum have a number of dimensions, including content areas, teaching strategy or practice, expected student skill or learning, and materials and resources. The teacher's knowledge, preparation and attitudes are also variables in OTL. Measuring enacted curriculum is a very complex phenomena with multiple components and perspectives. The extent to which any component is missing from data collection efforts will necessarily narrow the resulting picture of instruction and could lead to insufficient information for adequate policy guidance. Ideally, we would include all, or as many as possible of the salient components in order to provide a comprehensive description.

Providing such a comprehensive description of the enacted curriculum is an ambitious undertaking. The use of data on OTL to inform education policy and practice is still relatively new and in many cases policy-makers are riding close on the back of researchers as they grapple with the conceptual and technical difficulties of making the concept a reality. A variety of obstacles, both technical and pragmatic, need to be overcome in order to create a set of indicators of enacted curriculum that adequately portrays what happens in classrooms and explains student performance. For the short term, we may have to resort to indicators with a somewhat limited scope. As experience grows and technical problems are solved, a more complete set of indicators should become possible.

One strategy is to design OTL instruments to match an educational model or framework. In this way it is possible to make decisions about what kind of information is most relevant and thus target collection efforts to those items that will indicate the extent to which classroom practices reflect the model or framework. The SCASS project is based on a framework, the *Consensus Guidelines for Science Education*, which was used to begin developing survey items on OTL. However, care was taken not to design too narrow a focus for the survey instruments that would result in insufficient information for adequately describing and reporting on science education classroom practices and content.

A design for indicators of enacted curriculum can fail to provide the kind of information that is important for a variety of uses of the indicators. First, if only those forms of practice associated with some desirable vision or framework are included in collection instruments, and current practices are excluded from data collection, the resulting description of the enacted curriculum will be incomplete. In addition, teachers may perceive a survey based on one vision as incapable of providing a worthwhile picture of their practice, or as merely an attempt to coerce a top-down vision of practice upon them.

OTL data can serve multiple purposes of description, monitoring, feedback and informing school improvement. The data should inform all levels of the education system. Schools, districts and teachers also have visions and goals for practice. If collection efforts fail to collect information relevant to these diverse goals, the resulting analyses and reports may not prove useful for local actors.

Design issues. In order for OTL data to succeed in meeting their multiple purposes, they must meet the needs of various stakeholders in the education process. As Blank (1993) points out, the selection of an indicators system and specific data elements needs to build upon the needs, interests, and expertise of teachers, policy-makers and researchers. To insure that these diverse interests are met and that the available expertise is utilized Blank recommends that development efforts allow for interaction and consensus building among the various stakeholders be an integral part of the development and design process.

How information is to be collected and organized are also important considerations in designing OTL instruments. In order for the data collected to be turned into easily comprehended descriptive data, and in order to perform certain analyses, it is necessary to condense some of the data into scales or composite measures. This suggests that care be taken to insure that any such scales represent easily conceptualized components of the enacted curriculum, and consist of survey questions that hang together both conceptually and statistically.

For example, the SCASS framework indicates a preference for active learning; having students actively engaged in constructing their own knowledge. Scales on active learning can be developed from various survey items relating to content, instructional strategies, teacher and student activities, etc. Such scales then provide a summative measure on some important constellation of classroom variables. It is also possible through careful organization of the data to develop "profiles" along various dimensions of the enacted curriculum. The uses of profiles is addressed in more detail below, but for the moment note that such profiles make descriptions of the enacted curriculum easier and more effective to communicate.

Finally, survey instruments must allow for a range of responses. The components of the enacted curriculum can be organized into several broad categories; content, instructional strategies and mediums, student activities, intended outcomes, and instructional resources. Each category in turn requires a set of survey questions that allow for a range of responses from traditional to innovative, and from common to rare. Both traditional and reform approaches to practice must be represented in survey instruments if they are to give a balanced description of the enacted curriculum.

SCASS Science OTL Design and Instruments

The SCASS OTL development team has attempted to balance the needs for focus and comprehensiveness in their efforts at developing OTL instruments. Items were designed and selected based on the *Consensus Guidelines*, and with special attention paid to the model of science instruction emphasizing three kinds of activities-- (a) acquiring information, (b) using information, and (c) extending information -- in the process of knowing and doing science, while also taking into account more traditional forms of practice. In addition, the instruments were designed with the inputs and processes of education in mind, and has been consciously linked with both the vision of practice and SCASS assessment exercises to provide a coherent set of tools for understanding and managing science education among member states.

Questionnaire items for the SCASS Science OTL component are a combination of items designed specifically for SCASS Science and items adapted from several other surveys. The **student questionnaire** is written for three grade levels-- elementary, middle, and high school. Students are asked three kinds of questions:

- o Questions about the content and skills in the science assessment exercises they have just completed;
- o Questions about frequency of student experience with a range of science classroom activities and instructional practices;
- o Class time spent on science (elementary) and science courses taken (middle, high school)

An initial design for items measuring students previous learning with the science assessment exercises was completed by Leigh Burstein and Lynn Winters (UCLA/CRESST). The approach was revised and adapted to the specific SCASS assessments by a team of state specialists and researchers comprising the SCASS OTL development team during summer and fall 1994. The items surveying students on the frequency of different classroom activities and instructional practices were drafted by the OTL team based on the Consensus Guidelines. Some of the items were based on items used in the Reform Up Close study (Smithson and

Porter, 1994), National Education Longitudinal Study of 1988 (NCES), and NAEP student background questionnaires (NCES). A draft version of the SCASS Student Questionnaire for Middle Level Science (CCSSO, 1995) is attached.

A **teacher questionnaire** was developed in the SCASS Science OTL design that could be used at all three levels. The teachers were asked questions about:

- Student experience with content of science assessments and classroom activities (same questions asked of the students)
- Characteristics of the science class
- Teacher education background and professional development
- Opinions and attitudes of the teacher
- Influences on what is taught and on student grading
- Instruction with recent science unit.

Many of the items in the SCASS teacher questionnaire on teacher background, opinions, and influences on the class were adapted from the National Survey of Science and Mathematics Education (Horizon Research, 1993). Keeping some items unchanged provided a way for the SCASS data to be directly compared with results from the National Survey.[2] The teacher questionnaire expanded beyond enacted curriculum to include the science knowledge and preparation of the teacher, classroom resources, and the school environment for science education.

[2]see *SCASS Teacher Questionnaire Draft*, Council of Chief State School Officers (1995).

Reporting SCASS OTL Data. In reporting on the enacted curriculum, straightforward descriptive data is preferable to complicated statistics. The reader of an indicator report should be able to make comparisons between the picture of the enacted curriculum revealed, and his or her own picture of either how the curriculum should look, or does look at one or another level of the system. OTL data should be understandable, relevant, and informative for a broad audience. Providing descriptions of the enacted curriculum that are useful and meaningful to teachers gives them a vested interest in providing quality and accurate information. It also empowers school personnel to set and strive for their own collaborative goals.

Earlier, it was mentioned that "profiles" could be developed to describe the enacted curriculum. Such profiles could well provide the nucleus of a concise yet comprehensive description. To provide the reader with some idea of what these profiles might look like, and how they could be reported and used, the following illustration is offered.

Figures 1 and 2 present examples of how data from the SCASS student questionnaire can be reported. Means are reported for three hypothetical groups-- A, B & C -- which could represent disaggregation of student data on any number of variables including grade level, course type, race, gender, etc. The SCASS vision of desirable practice prefers more active modes of acquiring information, such as observing, collecting, classifying and organizing data over passive forms of information gathering such as reading and listening. With this vision in mind we can begin to look at the practice of each group with an eye toward the changes in practice that need to be emphasized in future professional development efforts. For example, from the profiles all three groups have few opportunities for measuring or investigating (Fig.

1), as well as little involvement in designing, making, applying, integrating and developing experiments (Fig. 2). We also can observe that Group B has many more opportunities for collecting data and reading charts.

Profiles from SCASS data can also provide information on how much progress has been made toward one or another goal when measures are taken over time. One could thus get an indication of whether instruction is becoming increasingly aligned to the SCASS vision of acquiring, using and extending science knowledge. Also, when analyzed with information on achievement and previous ability, promising practices could be detected and used to further inform policy and professional development efforts. The SCASS model also collects information more specific to each of the various assessment tools, so that information will be available regarding how much and what types of activities similar to the assessment activities have been engaged in by which students.

The example above makes use of only two of several dimensions upon which a description of the enacted curriculum should be based. Others might be more concerned with issues surrounding the kind of content being taught[3], or the instructional resources and materials available. Scales might also be created in order to highlight information on some important aspect of the curriculum. For example, active learning is a desirable characteristic in the SCASS model, and an "active learning" scale could be created from the data to provide a summary measure on this characteristic of the enacted curriculum. Though standard deviations are not reported in the samples provided, this basic descriptive statistic provides a

[3]For a discussion of how profiles of content might be used, see Porter (1994).

valuable indication of how consistent practice is across teachers. Again, it is through comprehensive descriptions that multiple audiences benefit, even if they have differing agendas or areas of interest.

CONCLUSION

Central to any conception of OTL is a description of the enacted curriculum. Such a description should be comprehensive, its definitions of indicators should be stable over time, and easily interpreted by a broad audience. Descriptions of the enacted curriculum need to provide useful information for teachers as well as administrators, policy-makers, and even parents.

OTL indicators provide valuable information for anyone interested in knowing what instruction is like, whether it is equitably distributed, and whether it is getting better over time. Making descriptions of the enacted curriculum available to teachers provides them an opportunity to reflect upon their own practice and compare it with that of others. It further has the potential to provide teachers, administrators and policy-makers information on the effectiveness of various instructional techniques. Perhaps most importantly, it initiates and provides a language for conversation among all levels of the system concerning education practice. The larger the audience to whom such data are reported, the more inclusive that conversation becomes and the greater the likelihood that indicator data will actually lead to improved instructional practice and ultimately, improved student learning.

Sample Format for Reporting SCASS Science Data on Enacted Curriculum

Figure 1

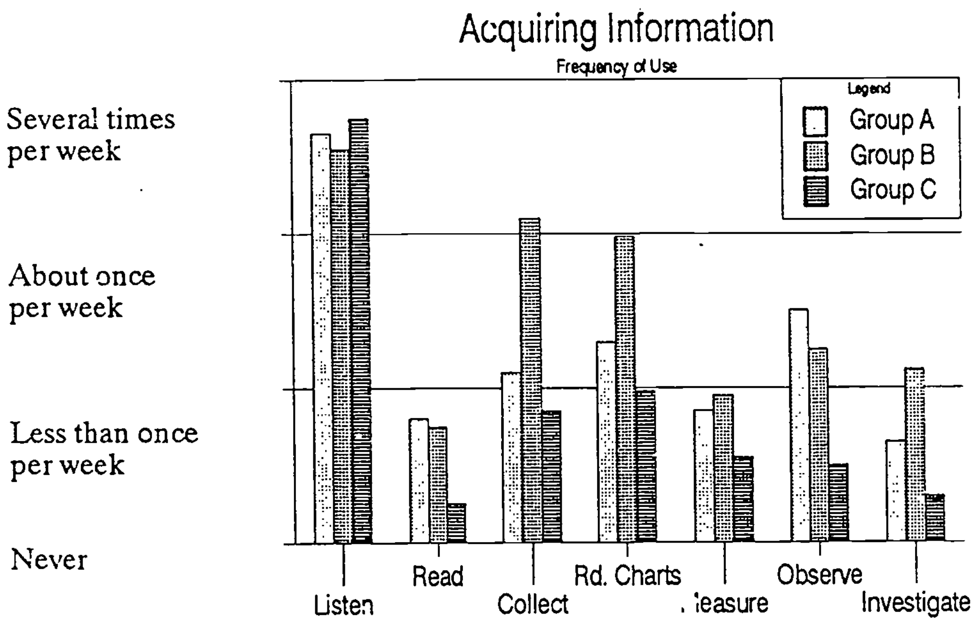
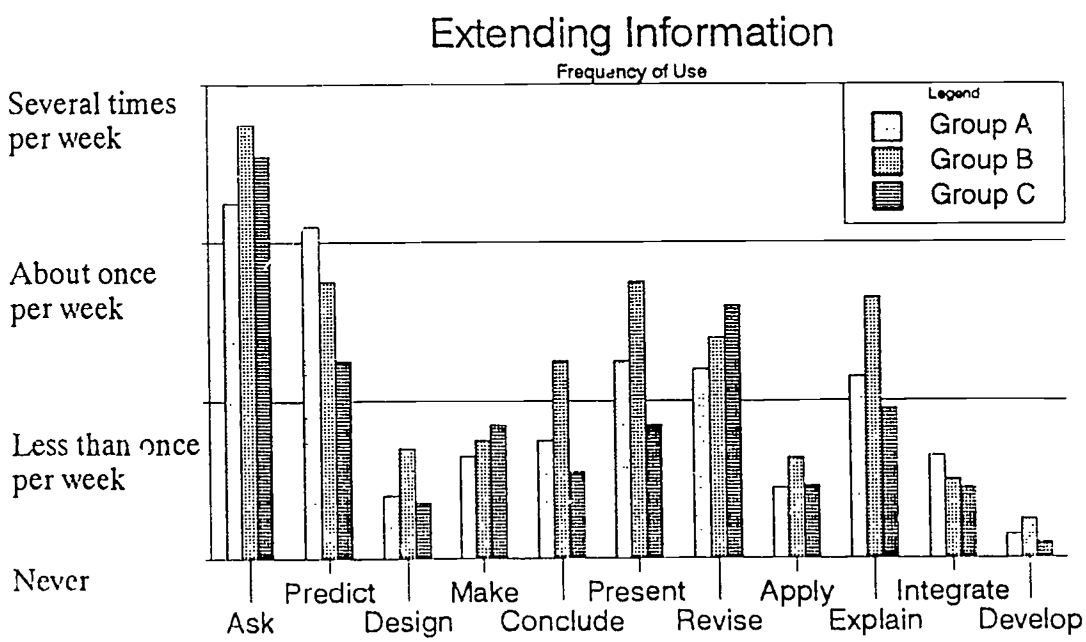


Figure 2



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DRAFT
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Student Questionnaire - Middle Level Science
Water Pollution and Fish

Directions: Please read each question carefully. Then read the list of possible answers to it. After you decide which answer is the right one for you, fill in that circle on the answer sheet. Mark the answers to these questions on the right hand side of the answer sheet under "Booklet Number."

Listed below are some questions about what you do in your science class this year. For each activity, pick ONE of the choices (A, B, C, D, or E) to show how often you do the activity in your class. Then fill in that circle on your answer sheet.

How often do you do the following activities in your science class?

A	B	C	D	E
Nearly every science period	**About once a week**	**Once or twice a month**	**Once or twice a year**	**Never**

1. Listen to your teacher or someone else explain things about science.
2. Read about science in books, magazines, or articles in class.
3. Collect data from sources such as an experiment or the library.
4. Read tables, graphs, or charts.
5. Use measuring tools such as rulers, thermometers, balances, computers. etc.
6. Do a laboratory activity, investigation, or experiment.
7. Observe experiments or investigations that others do, including teacher demonstrations.
8. Watch films or videos.
9. Use laboratory equipment.
10. Work in small groups.
11. Participate in school planned and supervised activities outside the classroom.
12. Work on assigned science projects or activities on your own away from school.
13. Use the computer in science.
14. Answer questions from your science book.
15. Take a quiz or test.

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How often do you do the following activities in your science class? (cont.)

A	B	C	D	E
Nearly every science period	About once a week	Once or twice a month	Once or twice a year	Never

16. Write about science (e.g. lab reports, science papers).

17. Make your own tables, graphs, and charts.

18. Change something in an experiment to see its effects.

19. Design experiments.

20. Ask questions to improve your understanding.

21. Make predictions, guesses, or hypotheses.

22. Make maps/drawings or models to show scientific ideas.

23. Reach conclusions about scientific data.

24. Choose a method for expressing an idea to your class.

25. Revise and improve your work.

26. Apply scientific concepts to your everyday life.

27. Explain how what you learn in science relates to real-world issues (such as the environment).

For questions 28-30, pick one choice (A, B, C or D) to show the number of semesters of science you had in grades 6, 7, and 8:

How much science have you taken in grades 6, 7, and 8?

A	**B**	**C**	**D**
None	**1 semester**	**2 semesters**	**3 semesters**

28. Grade 6 science: How many semesters?

29. Grade 7 science: How many semesters?

30. Grade 8 science: How many semesters?

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[For question 31, fill in either the circle marked A or the one marked B on your answer sheet.]

31. Is English the language spoken in your home?

If your answer is YES, fill in the circle marked..A
If your answer is NO, fill in the circle marked...B

Water Pollution and Fish:

Directions: Listed below are some questions that refer to the Water Pollution/Fish activity (or assessment) that you did recently. For questions 32-38, pick one of the choices (A or B) that is the right one for you. Then fill in that circle on your answer sheet.

A	**B**
Yes	**No**

32. Before this activity, have you ever studied Water Pollution in school?

33. Have you ever studied Fish in school, before this activity?

34. Have you studied pH, before this activity?

35. Have you studied dissolved oxygen, before this activity?

36. Have you used indicators to test solutions, before this activity?

37. Have you been asked to use data to propose a solution to an environmental problem, before this activity?

38. Have you presented the results of an experiment in a report to help someone make a decision, before this activity?