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ABSTRACT

Critical pedagogy, an ideology which opposes education as domination, views knowledge and learning as constructed by the student and teacher together. Its goal is personal and social emancipation and empowerment. The purposes of this paper are to (1) indicate problems in science education which can be addressed by teaching science from a critical, popularized, emancipatory approach; (2) present the views of teachers at different stages in their pedagogical development in biology; and (3) suggest strategies for teachers to use. The document discusses commonly held beliefs about science, the Critical Pedagogy for Science, the development of generative themes in biology, the views of several teachers in the field, and four recommendations for teaching from a problem-posting, critical perspective. A teacher questionnaire is appended. (CW)

DEVELOPING GENERATIVE THEMES FOR THE TEACHING OF BIOLOGY

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Introduction: Science Education in Crisis

What's going on in today's middle and high school science classrooms in the United States? The answer, unfortunately, is that little has changed in the last 20 years; while science as a discipline has undergone revolutionary changes, the teaching of science remains largely uninspired and conservative:

> (There continues to be) a heavy emphasis on encyclopedic coverage of descriptive and factual information, too little attention to problem-solving and critical thinking skills, little connection of abstract concepts with everyday experience, and inadequate opportunities for active experiential learning....Abstract concepts are taught in a vacuum with little connection to the student's personal interests or larger societal issues. Courses are centered on the textbook and classroom recitations; the laboratory experience is disappearing; and little advantage is being taken of the new technologies (Knapp et al., 1987, p. 7).

It is thus hardly surprising that "most students in the third, seventh, and eleventh grades appear to be unenthusiastic about the value and personal relevance of their science learning" (Mullis & Jenkins, 1988, p.132).

How can theory be linked to practice in science education? How can science be made more meaningful to the lives of students? These are not unconnected questions; in order for theory to be incorporated into practice it must be relevant to that practice, whether that practice is teaching or living one's life. Paul Hurd (1986, p. 353) has stated that "the movement to reform science education is faltering for lack of intellectual nourishment." Educational reform is faltering, and will continue to do so until a theory can adequately explain and critique what is actually going on in the schools, is committed to substantive change in them, and most importantly, is linked in a personal and relevant way to practice in schools.

It is our belief that critical pedagogy, an ideology which opposes education as domination, views knowledge and learning as constructed by student and teacher together, and whose goal is personal and social emancipation and empowerment, can do this. Our goals in this paper are: 1) To point to problems in science education which can be addressed by teaching science from a critical, popularized, emancipatory approach; 2) To present some representative voices of teachers at different stages in the development of a critical pedagogy approach to the teaching of biology; and 3) To suggest strategies for teachers to use which bring students into the world of science in a way in which they can act on this knowledge in order to improve our lives.

Commonly Held Beliefs About Science

In order to change the deadening pattern of science teaching observed in classrooms throughout the country (Mullis & Jenkins, 1988), we believe it is important to begin with a critical examination of our beliefs about science. How we teach and learn about science is a reflection of our perceptions of science and how it relates to our lives.

Most of us learn from the time we are very young that science is something mysterious and foreign that eccentric older white men do in white lab coats, in laboratories far removed from the everyday world. Consequently, most of us don't conceive of science as something _we_ can actually _do_; rather, it is something that is done by the few, mostly white, male, and odd "experts." Nonetheless, we also learn that science is extremely important; that scientific "facts" are absolutely true, and that the "scientific method" is an objective, impartial way to arrive at the truths of the universe. These lessons - that science is "truth" but is also something alien and inaccessible to us - have a profound influence on the way we think about and learn about science. Rather than learning science by doing science, we learn _about_ science; we learn a "rhetoric of conclusions", a collection of "facts" to be memorized, and later forgotten. Science becomes, in most classrooms, little more than content: the "how" of science, its process, is either ignored or trivialized by standardized multiple choice exams emphasizing content recall, and cookbook laboratory exercises with the "right" results in the teacher's edition.

Thus it is hardly surprising that science, as it is typically taught in middle and high schools in the United States, holds little interest for most students. For not only do students feel little investment in the proceedings of science, few attempts are made to connect science to their lives. If science is viewed as irrelevant to the interests and concerns of students (as it is by most), then few of them will be motivated to pursue science as an interest or a profession. The results will be not only a citizenry ill-equipped to make intelligent choices about science and technology in a world increasingly influenced by scientific and technological discoveries and problems, but also a serious shortage in the number of trained scientists and engineers in the very near future. According to the final report of the Task Force on Women, Minorities, and the Handicapped in Science and Technology (1989), commissioned by the White House and Congress, some 500,000 science and engineering positions may go unfilled in the next ten years, due to retirements and declining interest in careers in science. Women and minorities are especially underrepresented in these careers, comprising less than 10 percent of all employed scientists and engineers. The task force recommends immediate action to raise the numbers of women and minorities entering these fields; teachers are singled out to strive to make science hands-on and relevant to students' lives.

How can science be made more interesting and compelling to students, especially for those typically the least interested in pursuing careers in science? This question is our central concern. We believe that the answer to this question lies in rethinking our view of science as well as our ways of teaching science, from something objective, neutral, generic, inaccessible, and containing abstract "truths" to something relevant, immediate, contextual, changing, and participatory. A "science for the people" stresses the importance and relevance science has to our lives, and how all of us can get involved in the proceedings of science, affect its course, and thus transform ourselves and our world.

Critical Pedagogy for Science

Critical pedagogy for science seeks to demystify the changing laws of science by connecting them to the social world of the learners through the generation of themes which arise from the concerns and daily life problems of learners in their interaction in the world; local, national, and global communities (Freire, 1970; Shor, 1987). The goals of a critical pedagogy for science are to popularize science by making it accessible to everyone, and to help people become scientists in their own right, working in the laboratory of their everyday lives on crucial problems our world currently faces. Critical pedagogy for science education encourages teacher and student to develop curricula which arise out of the daily interests, problems, and experiences of the students and on which students are able to act in the interests of creating a better, more aware, and critical world. Generative themes for science education provide students with the opportunity to "extraordinarily reexperience the ordinary," to look more critically at our daily lives in order to see how change might occur (Shor, 1980, p. 5).

Science teachers with this perspective facilitate students' voices so that they can become conscious of themselves as knowers, conscious of their own history, and able to name their world in order to act on it. Through dialogue and problem-posing, teachers and students engage in critical reflection so that they not only critically examine their own viewpoints, but also come to consider alternative perspectives. By this process teachers and students become engaged in using their understanding of problems and possibilities, and their awareness of the need for change, to demystify what were previously considered overwhelming, insoluble problems.

The ultimate goal of critical pedagogy for science, according to Freire (1970), is "to unveil reality" so that students no longer feel powerless or oppressed when faced with seemingly insurmountable problems or obstacles in their lives. By enabling students to view the world as changeable rather than fixed, critical pedagogy for science empowers students to view these obstacles as temporary situations which they have the power to solve in order to transform their lives as well as the lives of others in their community or the world.

We have chosen to focus on the field of biology for theoretical as well as pragmatic reasons. First, we believe that biology, the study of life, is the field of science most immediate and accessible to students. We are naturally curious about our bodies and living things around us, and it is easier to learn about that which is concrete and real to us. Second, we have been involved in teaching biology, supervising beginning biology teachers, and/or research in biology education for several years, and have personal experiences and insights which we believe are useful. Finally, we have visited a number of biology teachers over the last year who are experimenting with alternatives to the textbook approach to teaching biology through the use of generative themes with their students. We feel it is essential to publicize and promote these efforts, in the interest of radically transforming the methods, content, and goals of teaching science in our schools.

Developing Generative Themes in Biology

Knowledge is meaningful and education is liberatory when, according to Freire (1970), the learners generate, explore, and challenge the ideas, problems, and experiences which give meaning to their daily lives. These "generative themes" are posed as problems, revealing the interconnections and complexities of real-life situations where "often, problems are not 'solved', only a better understanding of their nature may be possible" (Conolly, 1981, p. 73). In other words, it is not always possible or desirable to attempt simple solutions to complex problems, but much of the important work is to comprehend the problem in its complexity and to design preliminary responses to it. This problem-posing must occur dialectically, with students in dialogue and co-investigation with the teachers. The teachers, while not "experts" depositing knowledge in the minds of their students (Freire's notion of "banking" education), do however listen to the students, help them organize and present problems which challenge their perceptions, and also suggest potential generative themes. Freire's remarks concerning the role of teachers are important:

> The opposite of manipulation is not an illusory neutrality, neither is it an illusory spontaneity. The opposite of being directive is not being non-directive - that is likewise an illusion. The opposite both of manipulation and spontaneity is critical and democratic participation by the learners in the act of knowing, of which they are the subjects (1981, p. 28).

How might such problem-posing critical education take place in a biology classroom? One way to begin is by acknowledging the tentative, problematic nature of the curriculum (and the knowledge upon which it is supposedly based). For instance, one might begin by posing the simple questions, "What in biology is worth knowing," followed by "How do we know it?" An alternative to asking this question initially is to brainstorm generative themes relating to biology, which could be focused on particular problems in biology as they relate to students' lives. Examples that have frequently come up in our teaching of biology are toxic waste disposal, the pollution of the environment, the threat of nuclear war, and the future of life on our planet.

Once generative themes are agreed upon, a method for investigating them becomes critical. Problem-posing content within a traditional didactic "banking" method of teaching is counterproductive, and no less oppressive than the traditional content-based curriculum taught in a student-centered way. We have used the "group investigation model" (Sharan, 1980) as a framework for a student-centered method of teaching, which is a cooperative learning method of group research that gives students joint choice and control over what they investigate. This, of course, is not enough for a method to be critical, action-based, and liberatory; the curriculum must not only be situated in the students' experiences, but must also be dialectical, questioning, reflective, and, most importantly, linked to action. Wallerstein notes that

> Action for students means learning to see themselves as social and political beings, with rights to access to the political systems in their workplaces or their cities. Plans for action evolve from students understanding the immediate and root causes of problems, as well as having visions of better conditions (1987, p. 42).

Regardless of the level of action taken, students learn through the experience of action itself, that people can effectively work together to transform their reality. Even if their actions are sometimes unsuccessful, students can gain new knowledge and perspectives to try another strategy.

One way to ground experience in concrete terms is through the use of pictures or photographs. Often visual representations are extremely powerful, and help to elicit dialogue. Showing a photo of workers cleaning beaches after the recent oil spill in Alaska is much more powerful than merely discussing the catastrophe in the abstract. Moriarty (1989) has used four criteria for the selection of photos or pictures, easily remembered through the acronym FIGS:

F - familiar, recognizable, a part of daily concerns
I - involving, something with which people can identify
G - generating questions rather than easy answers
S - social, with the cultural setting evident (p. 28)

These pictures should also contain a human being, someone with whom students and teacher can identify (Moriarty, 1989). They need to be carefully analyzed for possible concerns which might arise. Additionally, the dialogue which occurs in relation to the pictures should progress from the personal to the social.

Stories from the Field

As part of our research we developed an open-ended questionnaire (in appendix) for science teachers which might reveal characteristics of, questions about, or inclinations of a critical biology teacher. We used this questionnaire as we interviewed teachers who had been designated by students or other teachers as "good" teachers, who were described as student-centered in their approach, and who sought to build a democratic, liberatory classroom. The questionnaire asked teachers to define their philosophy as well as their practice, to define their major goals for teaching biology, how they implemented their goals, obstacles they encountered, science journals regularly read, etc. We interviewed both beginning and experienced teachers. The following is a representative summary of our interview results.

Jane: A Beginning Teacher in Conflict[1]

Jane teaches in an academically-oriented, white upper middle-class school district where major emphasis is placed on high SAT and advanced placement exam scores. Although Jane stated how she wanted to teach a creative, democratic, hands-on approach to popularized science, during the process of the interview she came to realize that what she had hoped to do and what she in fact was doing were in conflict. She told us how teachers had given her the district science curriculum framework

[1]All teachers' names which follow are pseudonyms.

to teach, told her when exams were to be given (all biology teachers at her school test on the same days), and suggested that she model their traditional, didactic teaching methods. This is a good example of how the system reproduces itself. Fortunately, Jane became aware of how far apart her theory and her practice were during the interview, and has decided to re-evaluate her practice to attempt to bring it more in line with her beliefs about teaching science.

John: A Success Story

John is a very popular teacher who has recently developed a course in ecology as an elective for non-college bound students. The course has become the most popular elective course in the school, rare for science electives. John, who sees himself as an advisor and a resource person rather than "just a teacher," believes that "you can't teach kids anything - they choose to learn and what you do is provide the opportunities for them to do so." At the beginning of the semester the students meet in groups to determine which issues they want to study. Each of the two classes then elects a governing board of five students per class, which represents student interests and concerns, and makes decisions about curriculum, field trips and other extracurricular activities, and class rules. These ten students meet once a week after school to determine which topics students requested will be studied, thus generating curricular ideas from students' current interests and concerns.

After students prioritize and vote on the issues they want to address in class during the year, they work together to gather information in the library and the community about these issues, present their findings to the class, and decide on what action to take to either increase awareness or help resolve a problem. This work has led to student-initiated and run trips to environmental organizations, peaceful protests against local polluters and arms manufacturers, fundraising to support work on environmental issues, active involvement in planning local and state-wide Earth Day events, and strong feelings of involvement and empowerment among the students. The student body of the school is informed of the various ecological causes in which these students are involved through the school newspaper and student word-of-mouth. There is a waiting list of students who want to enroll in this course; John hopes to add one or two more classes in ecology next year.

In order to purchase for the class a wide range of current science journals from which students glean research information, students raise money by providing beverages and snacks to the student body from their classroom for a donation. Money from these sales is also used for issues in the community which students want to address. Examples include donations to a homeless project, and to victims of the October 17, 1989 earthquake.

In our interviews with these students, we were struck by how excited and motivated these "low-achievers" were about their work in this course. One student stated, with the enthusiastic agreement of other members of the class, "We learn (in this class) that if we stand up for something, people will listen to us. We have the right to say what we want to, even though we're kids." Other comments included, "Learning matters if you can use what you learn to make a difference," and "Everybody can be a teacher - we all have something to share and learn from each other...(our teacher) learns from us and admits it, just as we learn from him. We're in this class together, teaching and learning together" (personal communication, February 23, 1990).

Marie: Hands-On and Minds-On Science

Marie believes that current events must be integrated into her biology curriculum, and so she searches through current newspapers and magazines for news related to biology that her students might find interesting or important. One newspaper article she brought to her class for discussion involved a controversy over a toxic dump located less than two miles from the school, which was listed by the Environmental Protection Agency as a hazardous site in need of immediate clean-up. But it was not on the list to be cleaned up, according to the local paper. When this information was brought to their attention, her students wanted to know more about the situation. So she helped them to generate the following questions: What is the problem? How can this problem be defined scientifically, historically, and politically? Whose interests are being served in maintaining this situation as it is? What can we do to help change this situation, in the interests of ourselves and our community? The students formed groups around these and other problems and questions, and launched their own investigations. Not only was science actively discovered by the students' researching, designing and conducting their own experiments, but the interaction of science, society, and political and ethical decision-making was forcefully driven home to them through their investigation of the issues surrounding the non-action by the EPA. Group decisions about what and how to investigate the problems were made consensually, with a conscious effort to incorporate reflection at each stage in the process of discovery. Through a process of letter-writing and phone-calling which included sending the results of their research to several EPA officials, the site was placed on the immediate clean-up list six months later. This is an excellent example of popularized science learning in action.

Rosa: Exploring Connections Between Politics and Science

Although we did not observe Rosa as she taught, we did hear about her teaching experiences, and we see her as an example of a teacher who seeks to connect science to the real world. At the beginning of the semester, students asked Rosa many questions about pesticides, particularly Agent Orange, because a relative of one of the students had returned from Vietnam disabled by the chemical during the war. Rosa brought several Vietnam veterans who had been disabled by Agent Orange to her classroom to talk with students. Their interest piqued, students then read the book My Father, My Son, by Admiral Zumwalt, whose son died after being sprayed with Agent Orange in Vietnam. Students actively participated in a discussion of the issues of the book and raised questions about the ethics of such actions and their consequences. The students then began to inquire about pesticide spraying in this country, wondering about similar dangers to themselves and their community. They sought to study dioxin, malathion, toxic chemicals in their water supplies, and pesticide sprays affecting farmworkers and their children in the agricultural fields of California. These generative themes arose from students' own interests and also addressed societal problems in the field of science. Rosa encouraged her students to think of problems in terms of action toward possible solutions; a "science for the people" which emphasized awareness and positive change.

Conclusion: Overcoming Obstacles

These examples clearly demonstrate how students can in fact generate their own curriculum, and become highly motivated to learn in the process. Teachers such as John, Marie, and Rosa, as advisors, resource persons, and co-researchers, are an integral part of this process. At the level of the classroom, such collaborative investigations can provide emancipation and empowerment for both the teachers and the students. At the level of the institution, the constraints on emancipation become stronger. The questions for critical teacher researcher/ practitioners to ask themselves are; "How, through collective action, can school ethos, structure and procedures promote rather than inhibit freedom, and how can the organization and evaluation of schooling enable teachers and students to gain greater control over their lives" (Gibson, 1986, p. 171)?

John Elliott, in Lawrence Stenhouse's Curriculum Research and Development in Action (1980), provided an example of teachers working collectively to change curriculum at the institutional level. The questions they began with were, "What kind of science is right for children?"; "What do we want them to achieve through learning about science?"; and "How can we best help them achieve it?" These are valuable questions for science teachers to ask, but need to be examined far more critically. For example; does "right" in the first sentence mean "relevant"? Which children are being discussed, and what are their backgrounds, previous experiences, class, race, and gender, and how do all of these affect their performance in science? A critical perspective would examine what is important for these children to know about science, what are the obstacles which prevent them from learning these things, and how these obstacles can be overcome. Asking these questions more critically empowers the students as well as the teachers to seek out concrete answers and solutions.

The structural level of schools, education, and our society is far less accessible to collective action. Just as we are 'born into language' (and so have little choice in what to speak), "so too we are born into history, society, ideology. Our beliefs, especially our 'common sense', are largely 'given' to us" (Gibson, 1986, p. 171). But these beliefs are not neutral, objective, universal, natural, or classless, nor are they immutable. Critical educational theorist/researcher/ practitioners are aware of this structural shaping of experience, and address it as part of the learning process. Through an emerging critical, collaborative dialectic among teachers and students that is action-based, significant structural change toward more participatory, democratic schools and thus a more democratic society becomes increasingly possible.

Of course, the road to a dialogical, student-centered, emancipatory biology curriculum is not easy. One of us, as a practicing biology teacher, has attempted to implement such a curriculum over a period of several years and has confronted numerous obstacles. These include: district curriculum guidelines; required standardized multiple-choice tests, antiquated laboratory facilities and supplies; large class sizes; colleague pressure to teach the same thing, the same way, on the same day; and student discomfort over being asked to become active participants in their learning and viewing the teacher as co-learner rather than as someone with all the answers. The obstacles that seem to interfere most with using generative themes in the biology classroom, and yet are most responsive to change by the individual teacher, are colleague and student resistance.

One way to overcome colleague resistance is to engage teachers in dialogue about the problems in science education, and what individual teachers can do to make a difference. We have found that nearly all biology teachers we have spoken with acknowledge that there are serious problems with the way biology is currently taught. Attempts to bring generative themes to the biology classroom can be presented as a way to address these problems. Although some teachers will remain resistant, some will be curious enough to experiment with new approaches. The key, we believe, is to engage colleagues in the same sort of problem-posing that works with students. Questions such as, "How can we interest more of our students in biology," and "What do the students really need to know" are questions all teachers should be able to answer.

Student resistance is considerably more difficult to overcome, particularly given the long pattern of passive apathy toward school most students have established by the time they are adolescents. But if students feel they have a stake in the classroom and in their learning, they are far more likely to be enthusiastic and active learners. What is necessary, then, is to actively involve students from the first day of class by asking their opinions, ideas, hopes, and fears about themselves and their world. A dialogue must be established in the critical first few weeks between students and teacher as well as among students, and then meaningfully incorporated into the curriculum for the course. It is not easy to combat long-established patterns of boredom and emotional distance students have learned, to protect themselves from the oppressive nature of most classrooms, nor is it always successful. But we have found that persistence pays off; most students will come to understand that meaningful and significant learning happens only when they are able to incorporate knowledge into their daily lives and act on that knowledge. The teacher's job is to facilitate this process.

Recommendations

We believe that science teachers who seek to teach from a problem-posing, critical perspective should consider the following things:

* Facilitate and cultivate the voices of students in determining a science curriculum so that they can become conscious of themselves as knowers and conscious of their own history, so that they can name their world in order to act on it. A student-centered, dialogical classroom provides a forum for the democratic exchange of ideas and action on those ideas.
* Engage students in critical reflection through dialogue and problem-posing, so that teacher and students can critically examine their own viewpoints and also come to consider other possibilities.
* Define issues, themes, concerns and problems with students, from their everyday life experiences. Think about possible solutions to problems of interest to them, and work to develop science curricula around such issues, problems, and solutions.
* Strive to sustain student interest and involvement, through creating a participatory, hands-on, minds-on, cooperative

environment in the classroom. In addition, strive to incorporate action in the community as an important part of the curriculum. Empowered knowers experience a sense of agency and possibility. This undermines the fatalism, resistance, and passivity which permeates schools and society at large.

We believe that an approach to science teaching which is critical and emancipatory will draw students into the world of science in a powerful and meaningful way. A transformative, critical science education not only empowers students to learn about science issues which affect their lives, but also enables them to act on that knowledge to better themselves and their world.

References

Connolly, R. (1981). "Freire, praxis and education," in R. Mackie (ed.), Literacy and Revolution: The Pedagogy of Paulo Freire. New York: Continuum.

Elliot, J. (1980). "Science 5-13," in L. Stenhouse (ed.) Curriculum Research and Development in Action. London: Heinemann Educational Books.

Freire, P. (1981). "The people speak their word: Learning to read and write in Sao Tome and Principe," Harvard Educational Review 51, 27-30.

Freire, P. (1970). Pedagogy of the Oppressed. New York: Seabury Press.

Gibson, R. (1986). Critical Theory and Education. London: Hodder and Stoughton.

Hurd, P. (1986). "Perspectives for the reform of science education." Phi Delta Kappan 67:5, 353-358.

Knapp. M. et al. (1987). Opportunities for Strategic Investment in K-12 Science Education: Options for the National Science Foundation. SRI International.

Moriarty, P. (1989). "A Freirean approach to peacemaking." Convergence 22:1, 25-36.

Mullis, I. & Jenkins, L. (1988). The Science Report Card: Elements of Risk and Recovery. Report based on the 1986 National Assessment of Educational Progress. Princeton, New Jersey: Educational Testing Service.

Sharan, S. (1980). "Cooperative learning in small groups: Recent Methods and Effects on Achievement, Attitudes, and

Ethnic Relations," Review of Educational Research 50:2, 241-271.

Shor, I. (1980). Critical Teaching and Everyday Life. Chicago: University of Chicago Press.

Shor, I. and Freire, P. (1987). A Pedagogy for Liberation. South Hadley, MA: Bergin & Garvey Publishers.

The Task Force on Women, Minorities, and the Handicapped in Science and Technology (1989). Changing America: The New Face of Science and Engineering. Final report, December 1989. Washington, DC: National Science Foundation.

Wallerstein, N. (1987). "Problem-posing education: Freire's method for transformation," in I. Shor (ed.) Freire for the Classroom. Portsmouth, New Hampshire: Boynton/Cook Publishers.

Appendix

Questionnaire

Interview Questions
Generative Themes in Biology Teaching

Name ______________

Demographic Information: Number of years teaching ____; Number of years teaching biology ____; Student Composition (gender, race, class, age):

Type of class (remedial, AP, etc.) ______________; School demographics/setting:

School/collegial support:

Names of science journals regularly read:

1. How do you accommodate cultural differences in your teaching?

2. General questions of philosophy, in the context of biology teaching: Why teach what you teach? Why teach how you teach?

3. What are your goals as a biology teacher?

4. How do you attempt to reach these goals?

5. What role do students play in your classroom? In their learning?

6. What do you consider to be the most important problems in the world today that relate to biology?

7. How do you address these problems in your biology classes?

8. In what ways do you motivate students through these problems?

9. In what ways do you attempt to relate biology to students' everyday lives?

10. According to you, what are the problems with the traditional approach to teaching biology?

11. How do you attempt to overcome these problems?

12. How do you encourage a "hands-on" approach to learning biology?

13. How do you put together your biology curriculum? What resources do you use? Please give examples.

14. What are the major obstacles that prevent you from doing the best job you can as a biology teacher?

15. How do you think it would be possible to overcome these obstacles?