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Constructivist teaching practices used by five teacher leaders for the Iowa chautauqua professional development program

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There has been a wealth of research examining learning environments as one of the variables that contributes to academic success for students studying science. A constructivist learning environment has been explored as one way to assist students in achieving greater success with science learning. There is a lack of research concerning how and if successful teachers continue to change over time. This study was designed to address such research gaps. The teacher leaders involved served as staff members for Iowa Chautauqua and continue to develop and improve in their use of constructivist practices. There has been a lack of evidence focusing specifically on how participation in the Iowa Chautauqua Professional Development Program actually increases use of constructivist teaching practices. Results of the research indicate that the teacher leaders continue to develop further in their use of constructivist practices over time. The Constructivist Learning Environment Survey (CLES) scores were used to indicate improvement. There are implications for planning and improving classroom learning environments for enrollees in new efforts that were suggested by teacher leaders.

Key Words: constructivist learning; professional development, factors indicating, constructivist practices

Introduction

Research has consistently shown that constructivist classroom environments have a positive impact with respect to a variety of student learning outcomes (McRobbie & Fraser, 1993; Nix, Fraser, & Ledbetter, 2005). Unfortunately, few differences in teaching and its effects on student learning have been reported by teachers in typical science and mathematics classrooms (Dorman, Fraser, & McRobbie, 1994). Other research has also indicated that students tend to succeed to a greater degree when both student learning styles and the learning environment provided by teachers are consistent (Nix et al., 2005).

In the last twenty-five years, there have been major efforts in education to improve science education in the U.S. and across the world. With regard to reform science teaching, research has focused primarily on developing constructivist learning environments which have been major factors affecting student learning positively (Ogbuehi & Fraser, 2007). A constructivist

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epistemology focuses on the construction of reality through the senses (Kim, Fisher, & Fraser, 1999; Wheatley, 1991). Constructivist theory presupposes that there is not an objective reality that can be determined, but rather that all reality is created by individuals. In the context of a classroom setting, this translates into a need for including students in developing and maintaining their own positive learning environments (Kim et al., 1999, Pedersen, Yager, & Yager, 2011). Such a philosophy focuses on allowing students to be active participants rather than passive recipients receiving science information and explanations from teachers and/or textbooks. Research also suggests that it is only through active engagement of students that the desired learning outcomes can be achieved (Wheatley, 1991). Constructivist theory suggests that individuals gain real knowledge through the use of their senses. In terms of student learning, constructivist theory asserts that for real learning students must be permitted to interact with their learning environments. If this interaction does not occur, student learning in not maximized (Otting & Zwaal, 2003, 2007). Apparently teachers must challenge learners to learn. They must encourage them to use their own experiences as they make new ideas applicable to the world in which they currently live (Bukova-Guzel, 2007).

The CLES Instrument

The Constructivist Learning Environment Survey (CLES) is an instrument that has been frequently used in learning environment research. It has been particularly helpful in assessing teaching and student success in science education (Taylor, Fraser, & Fisher, 1997, Taylor, Fraser, & White, 1994). It has been shown to be an effective measure for teachers, students, and researchers to ascertain how and to what end constructivist approaches are modeled in science classrooms (Taylor et al., 1997, 1994). The CLES has helped determine the effectiveness of specific actions by individuals as well as cohort teachers, samples of their students, and by outside observers via use of videotapes of actual classrooms. CLES has been cross-validated and used in other countries with demonstrated successes (Binadja & Yager, 2012; Oh, 2003; Rannikmae, 2008; Yutakom, 1997). However, research with constructivist theory has not been studied concerning its effects over time (Lucas & Roth, 1996; Watters & Ginns, 1994). There is a need to determine more conclusively whether implementation of constructivist learning principles in science classrooms actually help to improve student learning.

Theoretical Basis for the CLES

The CLES was originally developed by Taylor and Fraser in1991 and underwent revisions in 1994 and 1995 (Taylor et al., 1994). The researchers involved with this report used the 1994 version of the CLES instrument over the 1997-2004 years. The 1994 CLES instrument was developed from the perspective of critical constructivism which is based on the premise that pupils' cognitive construction of knowledge occurs in, and is influenced by, socio-cultural contexts (Taylor, Dawson, & Fraser, 1995).

Taylor et al. (1995) have pointed out that constructivism stresses individual knowledge construction, while also recognizing the processes of negotiation with others as a way of assessing the viability of knowledge. Critical theory is founded on the ideas that knowledge is legitimized through socio-cultural means. It encourages individual freedom from the repressive conditions which frequently exist within the social context found in typical school science. Negotiation takes place in classrooms among students as well as students and teachers. Constructivist theory indicates the processes by which individual learners construct understanding in science. This learning is in conjunction with the prior knowledge of students. Critical

theory indicates that the science classroom provides a socio-cultural setting. This setting ultimately impacts important aspects of the whole social learning environment.

Format and Scoring of CLES

The CLES is purported to be a tool that provides teachers, students, and researchers with opportunities to indicate the degree to which constructivist teaching practices are in use. The CLES was used by Iowa teachers to assess the judgments of students concerning the use of observable constructivist practices. It was also used to indicate the degree to which classrooms were seen as "constructivist" by students as well as by the evaluations of varying research teams. For this study, a team of three PhD students viewed videotaped class sessions to note the utilization constructivist learning practices and to compare these with student and teacher assessments. Often there has been a lack of longitudinal research on this important topic (Lucas & Roth, 1996; Watters & Ginns, 1994).

The 1994 version of the CLES instrument exists in two forms: a teacher form and a student form. The Chautauqua teacher leaders and research associates decided to use both student and teacher versions of the CLES but only the perceptions of teacher leaders are used in the data reported in this study since no major differences were found. Teacher leaders have served as critical mentors of the Chautauqua staff for over a ten year period. The major question is: do they continue to improve? The student perceptions were analyzed and supplement the data collection obtained from videotapes of actual teaching. These analyses were collected and related to student perceptions by the three research assistants concerning their observations of classrooms of the five teacher leaders involved. Only one class section of students for each of the five teacher leaders was surveyed regarding the same features. The CLES was used to ascertain information concerning the teacher and student perceptions of the type of instruction used and experienced. But, it is important to note that classrooms were observed by researchers via multiple videotapes of the five teacher leaders (Wayne, Laura, James, Ann, and Lowell) are the major outcomes of the study.

All of the CLES items consisted of five scales each with forty-two items. Each item was evaluated with a Likert scale having five choices: *Almost Always, Often, Sometimes, Seldom, and Almost Never*. The items for each scale appeared in a cyclical fashion; some included negatively worded items and used as a measure of response consistency. The responses of subjects were scored as follows: Almost Always choice was given a score of five and the Almost Never choice a one for the positively worded items. A reversed scoring procedure was used for the negatively worded items. The five features on the 1994 CLES instrument are designed to obtain a measure of the student perceptions about the important dimensions of a constructivist learning environment. Sample items from the student version of the CLES instrument illustrate how evidence is (and can be) used to illustrate constructivist teaching.

Examples of the items on the CLES Scale cited indicate what they were designed to accomplish:

1. **Personal Relevance (PR):** relevance of learning to students' lives.
2. **Scientific Uncertainty (SU):** tentative status of scientific knowledge.
3. **Critical Voice (CV):** legitimacy of expressing a critical opinion.
4. **Shared Control (SC):** student participation in planning, conduct, and assessment of learning.

5. **Student Negotiation (SN):** involvement with other students in assessing viability of new ideas.

Professional Development Efforts Recommended by the National Standards

In 1996 the National Research Council (NRC) released the National Science Education Standards (NSES) after four years of intense debate and preparation of many drafts in attempts to reach consensus. Professional Development Standards were added almost at the end of the debates prior to the final publication of the NSES in 1996 (NRC, 1996). The standards indicate that there are fourteen changes that need to be made with regard to helping with the continued growth and development of in-service science teachers. These changes identified areas which teachers should "emphasize less" and areas needing "more emphasis" (NRC, 1996, p. 72). Chautauqua science teachers were urged to move their practices to match the NRC recommendations for change. The list indicates the needed changes for improving constructivist practices used by Chautauqua staff. The analyses were used by the Chautauqua staff to help finalize the changes needed to meet the conditions for maximum success with science teaching used across the U.S. The Less Emphasis situations (in the left column) are what typical teachers do while the Iowa teachers are urged to use the corresponding More Emphasis teaching (in the right column) to indicate constructivist actions. They are:

Less:	***More:***
Transmission of teaching knowledge and skills by lectures	Inquiry into teaching and learning
Learning science by lecture and reading	Learning science through investigation and inquiry
Separation of science and teaching knowledge	Integration of science and teaching knowledge
Separation of theory and practice	Integration of theory and practice in school settings
Individual learning	Collegial and collaborative learning
Fragmented, one-shot sessions	Long-term coherent plans
Courses and workshops	A variety of continuing professional development activities
Reliance on external expertise	Mix of internal and external expertise
Staff developers as educators	Staff developers as facilitators, consultants, and planners
Teacher as technician	Teacher as intellectual, reflective practitioner
Teacher as consumer of knowledge about teaching	Teacher as producer of knowledge about teaching
Teacher as follower	Teacher as leader
Teacher as an individual based in a classroom	Teacher as a member of a collegial professional community
Teacher defines target for change	Teacher as source and facilitator of change

NRC, 1996, p. 72

For this study, the More Emphasis conditions are defined as "constructivist" practices. The Iowa Chautauqua Development efforts used the work of Brooks and Brooks (1993) for un-

derstanding and use of constructivist practices prior to the reforms of the NRC Standards. They described constructivist teaching and indicated how typical students are taught and what they miss in traditional science classrooms. Their analyses indicate that typical science teaching consists of: 1) strict adherence to a fixed curriculum, 2) curricular activities which rely heavily on textbooks and workbooks, 3) students viewed as "blank slates" onto which information is etched by the teacher, 4) teachers generally behave in a didactic manner as they disseminate information to students, 5) teachers expect students to recite correct answers, 6) student learning is assessed via performances on formal testing, and 7) students mostly work alone. "These conditions eliminate student motivation and logically seem to be responsible for the increasingly negative attitudes toward science which remains and increases as student advance across grade levels" (Ali, Yager, Hacieminoglu, & Caliskan, 2010). Such an analysis was useful in encouraging changes.

Brooks and Brooks (1993) claimed that the typical features of teaching exist in over 90% of typical K-12 science classrooms. They forcible argued that use of constructivist practices teaching must occur routinely. The Constructivist practices urged by Brooks and Brooks (1993) used teachers to: 1) pose problems of emerging relevance to learners; 2) structure learning around "big ideas" or primary concepts; 3) seek and value students' points of view; 4) adapte curriculum to address students' suppositions; and 5) assess student learning in the context of teaching. They suggested ways that constructivist teachers should respond to student questions and ideas including: 1) responding to student questions with additional questions; 2) responding to student assertions with plausible contradictions; 3) responding to student requests for assistance with requests for explanations of their thinking to date; and 4) responding to student arguments with responses that place the responsibility on students for assessing the efficacy of their own efforts. Similarly, Von Glaserfeld (1989) has argued that constructivist teachers should be able to use information regarding the state of student current thinking regarding the use of teaching methodologies that provide students opportunities for students to construct desired conceptions. This thinking and such actions contributed much to the Iowa Chautauqua efforts.

Purpose of this Study

This study is designed to report on empirical investigations designed to examine the ways in which the constructivist learning environments change over time as viewed by students, experienced teachers, and outside observers (via videotapes). The study is an attempt to examine whether the implementation of a particular model which focuses on constructivist teaching principles is successful. It can assist teachers in modeling constructivist learning theories in their classrooms. It is a report of how students in one class session taught by the teacher leaders respond concerning the effectiveness and use of constructivist actions. The Iowa Chautauqua focuses on use of constructivist learning theory as a part of a typical three year-long effort which includes a four week summer workshop for new teachers and associated short courses during the following academic year (usually 3 days in October and 3 days in April). The study is concerned with how teacher leaders are seen to change over time. It also considered changes reported by students of the most successful leaders and the changes (improvement?) over time.

Iowa Chautauqua Professional Development Model

The Iowa Chautauqua effort has been developed over a 30 year time period beginning in 1981(see outline in Appendix 1). Throughout its development there has been a focus on the involvement of the most successful teachers who changed from traditional to constructivist teaching (the differences Brooks and Brooks suggest). Of interest for this study is how (and if) such

teacher leaders continue to improve in terms of creating situations where teaching continues to improve and where teachers exhibit even more (in terms of total numbers as well as new ways!) constructivist practices!

Education reformers have noted that there are changes that are also needed in assessment practices which match constructivist practices. The NSES argue that schools have relied too much on traditional testing as the primary tool for assessment and that alternative forms of assessment should be considered in regarding student performances and their acquisition of real (and useful) understandings. The NSES stress the need to place more emphasis on "assessing what is most highly valued, having students engaged in ongoing assessments of their own work and that of others, and focusing on assessing what students can do to illustrate their understanding" (NRC, 1996, p. 100). This leads to a decrease in a focus on the traditional ways in which assessments have been used, i.e. almost solely on assessing student achievement regarding major science concepts and relying on standardized tests as a means assuming science information has been learned and can be demonstrated. It is more difficult to use assessments in ways that they are used in science itself. When teachers use students as partners in assessments, the processes themselves and the results with students change dramatically (Wiggins & McTighe, 1998).

The Iowa Chautauqua Program is a model first developed for improving science in elementary schools. It was designed specifically to prepare teachers to use new contexts (situations) leading to a need for basic science concepts and specific process skills used by scientists. This was done to learn more about the objects and events that all people encounter in the natural world. The NSES suggest changes in ways in which students should be taught science and evaluated using varying assessment practices.

Chautauqua is comprised of an intense two week long leadership conference identifying and preparing teacher leaders as vital staff partners who are intimately involved in each of the 1-3 year efforts with new groups of teachers at sites across the state. The leadership conference is followed by summer workshops at multiple sites across the State for developing new constructivist teachers, especially as new ideas are explored and used with students prior to the three day short courses in early fall and again in the spring. The leadership conference focuses on how to prepare new teachers for shifting to the kind of teaching indicated in the NSES in their own classrooms while including as many as possible as the features characterizing constructivist teaching. It is a highly personal program designed to assist teachers in implementing constructivist learning theories in their science classrooms over a full year. A given Chautauqua site is often active for three years at a specific site. All five of the teacher leaders in the current study participated in the Iowa Chautauqua Program prior to the 1997-2004 interim used for data collection times for this study. Most had been teacher leaders in five or more Chautauqua workshops at multiple sites across Iowa.

The Iowa Chautauqua Program was first developed in 1981 with National Science Foundation (NSF) support designed to reform K-12 science education. One of the multiple efforts involved schools from six geographical areas across the U.S. who were involved in a national effort coordinated by the National Science Teachers Association (NSTA). The focus was on new teaching approaches and materials for implementing new strategies for teaching science. Thirty teachers were involved with the Iowa program, but, this was increased to as many as 230 new teachers each year throughout the state over the three decades. To date, over 15,000 teachers have been involved -- often for three or more years. The best way for preparing students for dealing with current societal issues and attempts at their resolution focus on current and future citizenship roles designed to meet Goals 2 and 3 of the NSES (NRC, 1996, p. 13). These two goals from the total of four call for preparing students who can: 1) use appropriate scientific

processes and principles in making personal decisions; and 2) engage intelligently in public discourse and debate about matters of scientific and technological concern.

This study is a report on one investigation which examines the ways in which the constructivist learning environments that were developed by five of the most successful teacher leaders in the Iowa Chautauqua Professional Development program. All were Chautauqua teachers prior to 1997 when this study was conceived and planned by the five teachers. In addition, the study is designed to determine whether the implementation of a professional development model focusing on constructivist teaching principles is successful in assisting teachers to continue developing even more constructivist learning features in their own classrooms. The teacher leaders completed the CLES at various time points from 1997 to 2004. A record of their perceptions as well as their student experiences in classrooms which illustrated the constructivist learning environments defined by the NRC Standards and the features offered by Brooks and Brooks (1993). Use of CLES also makes it possible to identify whether or not teacher and/or student perceptions change over time. It also provides a way to assess the impact of the Chautauqua Model, which focuses on teacher implementation of constructivist learning theory.

The Research Questions

The study is organized by the following research questions:

1) How do five teacher leaders (Wayne, Laura, James, Ann, and Lowell) compare in terms of where they start and were they are at the end of the 1997-2004 data collection points?
2) What constructivist features are most in evidence? Which change the least?
3) How do the student perceptions compare with those of other students being taught by each of the teacher leaders? How do both compare with the reports of observations provided by three research assistants?

Constructivist practices are included in the five features that comprise the CLES. Again, these are: 1) Personal Relevance (PR); 2) Scientific Uncertainty (SU); 3) Critical Voice (CV); 4) Shared Control (SC); and 5) Student Negotiation (SN).

Responses to Research Questions

This study focuses on five teacher leaders who all participated in the Chautauqua Program from the years 1997 to 2004. They were important staff members in efforts with new teachers at various sites across Iowa where there was interest in changes characterizing the changes in teaching advocated in the NSES. Each year, the five teachers submitted videotapes of three consecutive days of their own classrooms at mid-point of the second semester. These were meant to relate to items included in the CLES. It was the first effort to assess their understanding and use of constructivist teaching practices in their classrooms as a result of their continued participation in the Chautauqua program. The efforts they used were shared with the new Chautauqua Leaders at three grade levels for instruction and sampling, namely elementary, middle and high school. The teacher leaders all asked students in one class to complete the student version of CLES at the beginning of the academic year in October and again at the exit of the school academic year (April). For this report, the student scores by the teacher leaders were used each year as they sought new ways of developing even better constructivist classrooms. Of course, the students involved varied each year of this study. It was obviously not possible for students to ask or debate what the CLES sought to validate. The completed student scores on the

CLES were submitted without names and provided the main data collected at two year intervals. Again, the only teacher actions for this study were those which were reported by the five teacher leaders. The scores of the new teachers each year are not included nor are scores reported from the PhD students who observed (from videotapes) several sections taught by teachers leaders.
One of the difficulties in conducting longitudinal research in educational settings is achieving a group like the five teacher leaders involved with this study who continue to teach and continue as important "teacher leaders" helping new teachers and teachers in other schools to move to more constructivist teaching practices. Several such teacher leaders retired or moved to full time professional development positions. Such efforts invite collaborative-learning from each other. It is nearly impossible to track the same teachers and a single class of their students over an extended period of time.

Overall, the results of this study demonstrate that of teacher leaders who have experienced the Iowa Chautauqua Model continue to develop in terms of even greater increases in use of constructivist learning principles in their classrooms over time. With the advent of technology and the increasing digitized world, unique challenges are presented for teachers who were not involved years ago. In addition, teachers are challenged to develop ways to implement their visions of teaching while accommodating the many different types of learners likely to comprise classrooms.

The Five Teacher Leaders and Their Efforts Resulting from Iowa Chautauqua:

This study was conceived and carried out by five teacher leaders (among the 20+ who were invited each year for annual conference for teacher leaders (1997-2004). Information about the five teachers follows:

Introduction of Teacher Leader Wayne:

- Chautauqua Teacher Leader for 12 years;
- Taught in upper elementary grades; aspired to being a teacher, especially in elementary and middle school grades in the district where he had been a student; he worked with two of his high school teachers who were definitely not interested initially in any of the constructivist efforts.
- Worked closely with the Regional Education Agencies and with the teaching in one of the largest districts in Iowa (Des Moines).
- With the help of his students, he located local problems/issues in partnership with his students – using their parents, principals, and local community leaders.
- Active in professional organizations in Iowa and nationally; actively involved his students and their projects in community improvement efforts; was instrumental in getting parents to help beyond the actual projects for their own students.
- Very humble, always feeling other teachers were better; he was amazing in building collaborative teams; at times other teacher leaders were in awe at what his students did and how they were partners in making science central to the whole curriculum.

Introduction of Teacher Leader Laura:

- Laura was a teacher leader in several programs in Northeast Iowa; she worked with Chautauqua workshops for ten years – sometimes at two sites the same year.
- Laura was respected (and envied!) by all teachers in the district; she promoted collaboration and the idea that sharing ideas of specific ways which worked in getting other teachers working with their students – often as co-workers.
- Laura was active in professional organizations and encouraged her middle school students to participate in science fairs; she constantly looked for new ideas that worked best in schools that were suggested by students.
- She worked better with elementary and middle school groups at various other sites – always sharing ideas; she was involved with assisting with gaining community involvement and administrative support.
- Laura was viewed most favorably by the principal; she helped other teachers to get their principals more involved. She was effective in helping high school teachers to alter their study of traditional science content as they tended to teach and instead to build on what students experienced in middle schools.
- Laura worked beyond her own school to help other teachers at other sites; she was in constant search for new ideas; for more involvement in as many as 10 action research projects. She "led by doing" – but always with "open doors" and pointed out the successes of others.

Introduction of Teacher Leader James:

- James was a well-known and extremely active science teacher in Eastern Iowa for over 20 years; he is now retired – but still active in the Iowa Science Teachers Section of the Academy of Science. He was looked upon as "Mr. Science" – in his school district.
- James was licensed as a high school teacher, but was known as a middle school teacher where he involved his students with local issues that included them and others which involved local citizens and often parents.
- James often found problems with his principal regarding schedules, and instructional needs. But, he found ways to get approval and to get student ideas and projects underway and to function ideally. He praised student efforts but rarely took personal credits!
- James became known across the State and beyond. His research often was related to activities in which his students were also involved and given credit – involvement and enthusiasm concerning the results of projects – especially those which involved other students and the impact of school and community improvements.
- James worked with student collaborators and was well known from Kansas, Indiana, and across Iowa: North and South as well as East and West in the State.
- James remains active and assists new teachers in trying new ideas; he is a model teacher by his actions. He encourages action and expects student contributions to be positive. He was not actually involved in at least one of the academic years when data were collected and reported for this study.

Introduction of Teacher Leader Ann:

- Ann worked in one of the larger school districts in Western Iowa. She was active in one of the important Chautauqua efforts. She was involved with contributions for over eight years.
- Ann was a high school chemistry teacher – but, she also served unofficially as the science coordinator to the entire school. She worked with teams of elementary teachers and students in assessing how they could/should experience really big successes. She was respected by building principals and by the school superintendent – who later became the Director of Education for the entire State. She was responsible for sharing what can be done with administrative support and involvement. She supported other specific education teacher involvement. Her superintendent often proclaimed that "until teachers stop acting as the factory workers, there could be no real reform"!
- Ann was not the typical teacher with teaching plans or those which matched the prescribed curriculum; she was an explorer, an advisor, and a "practicing" scientist as well as an educator! She always had ideas that exceeded what most never considered. She was self-centered concerning her own teaching – usually expecting and engaging others in terms of teaching performances; she encouraged other teachers to analyze their own teaching!
- Ann was active in developing the National Science Education Standards; she urged all students aspiring to teach to share their class experiences as well as the actual successes of her students. She shared her ideas for how science teaching should occur. She always looked for student input without losing control as a co-leader. She was associated with the American Chemical Society and their leadership and with teaching changes the organization suggested.
- Ann was a willing collaborator involved with over 30 Action Research efforts with new Chautauqua teachers – she was outstanding in always asking students to try, to analyze, and to be ready to evaluate evidence which was included as a major part of science teaching too.

Introduction of Teacher Leader Lowell:

- Lowell has been involved with Chautauqua for nearly 30 years. He was/is one of the most successful teacher leaders in working with all students on a variety of projects – sometimes for a whole nine week effort. He teaches in a small town where there is great pride in their school and how the community can work as one.
- Lowell was enthusiastic in trying to change standardized testing. He was working with a testing organization which meant leaving Iowa and his teaching for a whole year. He did work with typical high school students as well – moving even further than what he did with them in the middle school.
- Lowell was a popular part of nearly all teacher leader conferences, especially with others previously involving the best new teachers completing their program work for two years at a given Chautauqua center. He constantly looked for projects to extend the learning and those that led to new possibilities, especially those generated by students. He was not interested in the typical science disciplines – but looked for more problems/issues which needed more information – whether it came from biology, chemistry, physics, or earth science.

- Lowell sometimes encouraged his students to work on their own personal projects -- problems that were personal, local, and current. He expected student involvement, not only with personal projects, but with others where they were part of a group. In all instances he encouraged each student with the task of including many other students in each class to increase their interest as his/her peer students did. He took on the task of introducing other students in the class or school about the expectations of their science efforts.
- Lowell did not work to make science found into a daily class period; he wanted to include whole schools and communities – and even beyond! He encouraged all students to develop one project resulting from issues in local newspapers.
- Lowell always pushed for changes, improvements, and extensions. His work certainly inspired many efforts of other science teachers across the State and beyond.

Results

The results of this study are included and summarized in Table 1. The results indicate the data collected over a six year period, but with complete sets collected only recorded for study at two year intervals staring in October 1997 through April 2004. The data included in the table indicate perceptions of teacher leaders regarding each of the five CLES sub-scales. Students in one section were also provided assessments of their view of the constructivist practices experienced. This was routinely done, especially since it also involved new teachers who were not initially "aware" of constructivist ideas. The four week summer conferences regularly included new teachers who were enrolled in Iowa Chautauqua for at least one full year. However, the differences between student and teacher assessments were minimal and without observed differences. This was also true for the students in the sample classes; evaluations of videotapes of their classes were also completed by the research team of three graduate students. In fact, the only differences among new teachers, students with their PhD studies (was an indication of the success of Chautauqua ideas and the problem with direct instruction). The CLES features which included Shared Control (SC) where frequently the students scored it higher than did several of the teacher leaders themselves. It was the only one of the five CLES features where there were observable differences in the evaluation of students in one class, the team of five teacher leaders, and the analyses of videotapes by the three member research team.

It is interesting to note as well that there were several instances where the student assessments were higher than some of the teachers' own assessments. But, the differences over time are reflected while noting the data provided in Table 1. Great interest in the steady improvement in the use of the constructivist practices were also noted by the students taught by the five teacher leaders. The improvements over the six years interim are interesting and illustrate the continued growth concerning constructivist practices over time for the five teacher leaders.

The data provided for evaluation by a three person research team who examined the results for each CLES factor was done without their knowing the teachers and/or the self-evaluations of the five teacher leaders. Even so, the results were similar. The same changes – with teachers becoming more constructivist – were reported in student assessments. Such evaluations were also found to be the case with the independent assessments provided by the three member research team. As with the teacher self-evaluations, the research team tended to be more positive about the display of constructivist practices than did those reported by the teacher leaders themselves.

For these reasons, the only data reported in this study (Table 1) came from the results of teacher leaders in one class section for each of the years chosen for data collection and analysis.

Table 1. Continued Use of Constructivist Teaching Taught by Each of Five Teacher Leaders Over a Six Year Interim

Five Teacher Leaders	Class Size	Five CLES Features: Personal Relevance		Scientific Uncertainty		Critical Voice		Shared Control		Student Negotiation	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Wayne											
1	26	1.5	0.6	2.4	0.7	2.5	0.8	2.4	0.4	2.8	0.7
2	24	3.6	0.3	3.3	0.4	3.5	0.2	3.1	0.7	3.5	0.4
3	23	3.6	0.4	3.4	0.2	2.8	0.6	3.5	0.6	3.6	0.7
4	24	4.2	0.6	4.3	0.2	4.3	0.6	3.5	0.7	3.7	0.5
Laura											
1	17	2.6	0.3	2.8	0.2	2.4	0.2	2.6	0.6	3.2	0.4
2	18	3.4	0.6	3.3	0.6	3.8	0.3	3.4	0.2	3.6	0.2
3	19	4.0	0.7	3.3	0.7	3.7	0.4	4.6	0.4	4.6	0.6
4	21	4.5	0.4	4.5	0.7	4.6	0.5	3.7	0.6	4.6	0.3
James											
1	24	2.4	0.9	2.6	0.2	3.3	0.4	1.8	0.4	3.1	0.4
2	26	4.2	0.2	4.0	0.3	3.3	0.6	3.3	0.4	3.7	0.6
3	28	3.6	0.1	3.6	0.3	4.0	0.1	3.2	0.2	3.9	0.6
4	31	4.6	0.1	4.6	0.5	4.7	0.3	3.9	0.5	4.5	0.4
Ann											
1	20	3.1	0.8	3.5	0.4	3.2	0.7	2.3	0.5	3.5	0.6
2	14	3.7	0.7	2.7	0.1	2.9	0.3	2.4	0.4	3.6	0.3
3	24	4.0	0.7	3.2	0.6	4.2	0.2	4.3	0.7	4.5	0.2
4	19	4.7	0.3	4.5	0.2	3.7	0.4	4.2	0.4	4.2	0.6
Lowell											
1	18	2.6	0.1	2.2	0.3	3.4	0.8	2.4	0.7	2.3	0.4
2	29	3.4	0.4	3.0	0.5	3.0	0.4	3.2	0.3	3.7	0.2
3	21	3.8	0.5	4.1	0.2	3.7	0.4	4.3	0.3	3.9	0.4
4	17	4.3	0.4	4.0	0.0	3.9	0.1	3.3	0.3	4.5	0.2

Collection Points:
1. Testing Spring (April) 1998
2. Testing Spring (April) 2000
3. Testing Spring (April) 2002
4. Testing Spring (April) 2004

The teacher leaders were experienced with the teacher version of CLES. They used it with their involvement in working with new teachers who enrolled in each year-long Chautauqua series. They usually used the CLES with each new group by indicating their own growth and other changes that had occurred over time. Two or three potential teacher leaders at the April short course were invited each year to the two week Leadership Conference each year from each of the sites for possible involvement as new teacher leaders the following year. It is interesting to note that many of the teacher leaders refrained from boasting of their own level of constructivist teaching. There is always a desire “to improve more”. It may be this desire to be a better teacher in helping students learn that is most successful with moves to constructivist practices.

The use of three PhD research assistants helped the group to promote their own major understandings of their experiences with research and Constructivist teaching! This was not often experienced in their own college science classrooms as they prepared for a teaching career. These results regarding research questions two and three are important. However, the results with use of the CLES instrument substantiated the results with students of the five teacher leaders. But, they added little to the results as those reported in Table 1. In fact the results were duplicated. Several teacher leaders used the procedures in sections of students in all the classes they taught for a given year.

Conclusions

The results indicate that teacher leaders who participate in the Iowa Chautauqua program over a period of years continue their professional development. They actually increase in their abilities to create constructivist learning environments. Evidence of significant positive changes regarding all five CLES sub-scores was found over time. The teacher leaders were great models for encouraging the same changes in their students as well as in new teachers. The major activities with the Chautauqua projects are working with new groups of teachers each year at three to five new sites across Iowa.

Table 1 indicates the findings reported directly pertaining to research question one. Although there are some indications that the perceptions are similar or at times indicating a slight decline, most clearly indicate that the teachers (and their students) see their teaching to be more constructivist at each data collection point.

The student scores matched very well with the ratings which the five teacher leaders gave themselves. This is not too surprising since the teachers are staff members who were selected to be leaders designated primarily for moving enrolled teachers to more constructivist practices. Nor is it surprising that the three researchers who were involved with research undertaken in this study to get more teachers to move from teacher control practices to those which could be described as Student-Centered. The researchers were quick to contact teachers regarding specific student statements and actions coming from the video analyses of class sessions.

Other variables such as teaching styles emphasized in the various schools may have contributed to the positive results that were observed. Future research may be needed to consider evaluating varying teaching styles in addition to the greater variation among student groups who reported scores regarding the five CLES factors.

Other researchers may want to consider other variables separately or in relation to each other. Another difficulty in conducting longitudinal research in educational settings is achieving a group like the five teacher leaders involved in their study who continue to teach and continue as important teacher leaders who help new teachers and teachers in other schools to move to more constructivist teaching. Such efforts as Chautauqua invite leaders to learning “collaboratively” from each other. It is nearly impossible to track the similar students working with given teachers over an extended period of time. Overall, the results of this study demonstrate that students of teachers experiencing the Iowa Chautauqua Model continue to develop in terms of even more increase in their use of constructivist learning principles in their classrooms over time.

The results of the study indicate the power and influence of exceptional teachers in working with other teachers. They suggest that science teaching can be like science itself – encouraging ideas for changes and improvements, devising Action Research Projects to collect evidence of successes (and failures), and reporting on positive results as recognition of real success over time. It is a way of informing and encouraging such changes on the part of other teachers. There is a need to continue demonstrating whether learning is enhanced regarding all constructivist features in typical science classrooms. Teachers new to constructivist ideas vary in

terms of growth and change. Teacher leaders in this research were involved as major players and staff members in the Iowa Chautauqua Professional Development programs for an extended period of time.

The CLES instrument was developed with the view that a classroom learning environment is influenced by both practical and distinct interests; therefore, a major focus must be placed on the facilitation of student involvement in negotiating actively with teachers and with peers and others outside the school itself. The goal of this negotiation aims to make learning relevant to the lives of pupils outside of school, to encourage students to assume control of their personal learning, and to foster an awareness of potentially negative cultural values and beliefs that can diminish the opportunities for meaningful learning.

Implications

Other variables such as teaching styles emphasized in the various schools may have contributed to the positive results that were found. Future research may be needed to consider evaluating varying teaching styles in addition to the greater variation among student groups for reporting scores regarding the five CLES sub-scales. Other researchers may want to consider other variables separately or in relation to each other.

The results have important implications with regard to the use of constructivist teaching styles employed in K-12science classrooms. There has been an abundance of research that has focused on teaching styles and its relationship to learning environments (Seidel & Prenzel, 2006). A teaching style is defined as a teacher's specific approach to teaching (Evans, 2004). Others have defined a teaching style as "personal behaviors used to identify and use such strategies with the learners" (Kaplan & Kies, 1995, p. 29). This progression of teaching style went from being fairly teacher-centered (i.e., assertive and suggestive) to being learner-centered (i.e., collaborative and facilitative). The teaching style that is most closely associated with a constructivist learning environment is defined by a facilitative style (Seidel & Prenzel, 2006). The research findings reported in this study agree with the results found in the other studies but include results from classrooms over a decade taught by the teacher leaders and their ever improving teaching. Several teacher leaders who were involved with the Chautauqua Program before 1997 experienced growth in all CLES categories. Such observations and analyses were useful in encouraging more constructivist classrooms the next year in the schools involved.

The facilitative teaching style is one which is highly learner-centered (Rosenfield & Rosenfield, 2006). It is grounded in the belief that each student should be responsible for his/her own learning. The greatest role of the teacher is to provide an environment that is most conducive to this occurring. As the name implies, the primary role for the most effective teacher relates to facilitation rather than one described as teacher-controller – sometimes designated with the adjective "guided" to inquiry. More traditional styles such as lecturing and note-taking are not conducive to encouraging nor cultivating a constructivist environment (Rosenfield & Rosenfield, 2006). The facilitative teaching style appears to be the most closely aligned with the development of a constructivist learning environment which is central to the Iowa Chautauqua Model. This certainly was the case in using the CLES over the 1997-2004 interim which provided the data reported in this study. By gaining awareness of their own teaching styles as perceived by their students, teachers are better able to identify whether or not their styles are conducive to producing and maintaining constructivist learning environments. Perhaps that is what leadership is all about – teachers who continue to learn. They are great models for encouraging the same changes in students as well in new teachers. The major activity for Chautauqua is working with new groups of teachers each year for three to five new sites across Iowa.

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Appendix 1. The Iowa Chautauqua Model: A Professional Development Model Approved by the National Diffusion Network

LEADERSHIP CONFERENCE

A Two Week Conference Designed To Prepare Teacher Leaders

1. Organizing staff team for conducting a workshop series for 30 new teachers consisting of:
   a) One Teacher Leader per ten new teachers
   b) Scientists from a variety of disciplines
   c) Scientists from industry
   d) School administrators
   e) Science Coordinators as chair of staff teams
2. Organization and scheduling for each workshop
3. Materials for publicity and recruitment
4. Examples of specific assessment strategies:
   a) Six domains for teaching and assessment foci
   b) Use of reports and other written material from past years
   c) New research plans for Teacher Leaders
   d) Focus on how students use concepts and process skills in new contexts
   e) Use of videotapes of actual classrooms in action

FOUR WEEK SUMMER WORKSHOP

Experiences that Characterize the Iowa Chautauqua Professional Development Model

1. Including special activities and field experiences that relate specific content within the disciplines of biology, chemistry, earth science, and physics.
2. Making connections between science, technology, society within the context of real world issues.
3. Examination of societal issues such as air quality, water quality, land use/management that can be used as the context for concept mastery and process skill development
4. Use of personal problems for individual projects (related to health, natural hazards, population growth)
5. Every staff member and every teacher participant selects at least one issue/problem and completes at least one Action Research Project regarding it.
6. Plans for continuing Action Research in the classroom over the next academic year.
7. Completion of several videotapes of teaching experiences with both self and group analyses.
8. Organize 3 grade level groups, e.g., K-5, 6-8, & 9-12 (with up to 10 in each group) for continuing collaboration

ACADEMIC YEAR SHORT COURSE SERIES

Fall Short Course → Interim Projects → Spring Short Course

(3 days)				(3 days)
Awareness Workshop		Three Month Interim Project		Final Workshop
20 hr Instructional Block (Thursday pm. Friday, & Saturday)		**Plan for 3-5 Week Module**		**20 hr Instructional Block** (Thursday pm. Friday, & Saturday)
Activities Include: 1. Review problems with traditional views of science and science teaching 2. Outline specific features of the More Emphasis features from		Activities Include: 1. Developing a precise instructional plan for minimum of twenty day module 2. Administer pretests in six domains		Activities Include: 1. Report on experiences 2. Report on assessment efforts 3. Interact on new information concerning group and individual projects and new teaching

the NSES in a science context in terms as grade level, curriculum frameworks, and the school community 3. Define techniques for developing 3-4 week modules and assessing their effectiveness in teaching 4. Select tentative module topics 5. Practice with specific assessment tools in each of the six Domains. 6. Use "Lesson Study" designs 7. Analyze one videotape involving a teacher volunteer with each grade level group to be shared		3. Teach module development to illustrate the reforms featured in the NSES 4. Collect posttest information 5. Communicate with regional staff, other Teacher Leaders, and central Chautauqua staff 6. Complete and analyze one class videotape with colleagues from given sites 7. Plan at least one Action Research Project for all in the grade level group(s)		strategies 4. Show one videotape of teaching in one class for each grade level 5. Analyze changes from summer, fall, and spring 6. Plan for involvement in professional meetings over the summer and following fall 7. Plan for next-step initiatives, including complete reorganizing of existing courses

Iowa Chautauqua Profesyonel Gelişim Programı için Beş Öğretmen Lideri Kullanarak Yapılan Yapılandırmacı Öğretim Pratikleri

Fen çalışan öğrencilerin akademik başarılarına katkıda bulunan bir değişken olarak öğrenme ortamlarının çalışıldığı yığınla araştırma bulunmaktadır. Yapılandırmacı bir öğrenme ortamı öğrencilerin fendeki daha yüksek başarılarını destekleyen bir yol olarak araştırılmıştır. Başarılı öğretmelerin zaman içerisinde değişime nasıl devam ettiğine dair çalışmalar eksiktir. Bu çalışma bu boşluğu doldurmayı amaçlamıştır. Lider öğretmenler Iowa Chautauqua için üye olarak hizmet vermişlerdir ve kendilerinin kullandıkları yapılandırmacı pratiklerinin geliştirilmesine devam etmişlerdir. Iowa Chautauqua Profesyonel Gelişim Programına katılım yapılandırıcı öğretim pratiklerinin kullanılmasını nasıl attırdığına dair delillere ilişkin olarak bir boşluk vardır. Araştırma sonuçları lider öğretmenlerin süreç içerisinde yapılandırmacı pratik uygulamalarını geliştirdiklerini göstermektedir. Yapılandırıcı Öğrenme Ortamı Araştırması puanları bu gelişmeyi belirlemek amacı ile kullanılmıştır. Lider öğretmenler tarafından sınıf öğrenme ortamını planlama ve gelişmesi için önerilen yeni çabaların etkileri vardır.

Anahtar kelimeler: Yapılandırıcı öğrenme; Profesyonel Gelişim, Yapılandırıcı Pratikleri Gösteren Faktörler