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ABSTRACT

This study examined approaches to action research held by science, education, and mathematics faculty and how they convert ideas to action research proposals and plan to gather and analyze their research data. The study also described some of the research outcomes of successful action research projects. Rubrics were used on a diverse set of products and processes involved in the action research project by faculty teams at 53 universities. These teams were participating in NASA Opportunities for Visionary Academics (NOVA), a project aimed at improving science education at U.S. universities. The development of the rubric allowed quantification of approaches across research proposals. Further documentary analysis was conducted on course change proposals by developing a matrix that noted: (1) the conception of action research articulated; (2) research questions or research focus; (3) research design; (4) proposed data collection methods; (5) proposed data sources; (6) proposed instrumentation; and (7) proposed data analysis. Final outcome reports and conference presentations of 16 action research projects were also analyzed. Data obtained from site visits to 20 of the institutions were used to triangulate the findings. It was found that action research projects have produced a wealth of information about successful innovation in undergraduate courses, although many faculty are still novices in the implementation of action research projects. The majority used quantitative approaches over quality designs. The outcome of these action research efforts has shown significant gains in student learning, as well as in faculty professional development, although the latter was less of a focus in the cases analyzed. Observational data undertaken during site evaluation visits support the idea that faculty shifted their practices away from traditional didactic lessons, and that action research facilitated this process. An appendix contains a sample scoring rubric. (Contains 37 references.) (SLD)

Running Head: ACTION RESEARCH IN THE NOVA PROGRAM



# Faculty conceptions and practices of action research in the NOVA program

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**Abstract**

This paper examines (a) approaches to action research held by science, mathematics and education faculty, (b) how they convert ideas into action research proposals, (c) how they plan to gather and analyze their research data, and (d) describes some of the research outcomes from successful action research projects.

Rubrics were used on a diversity of products and processes involved in the action research process by faculty teams at 53 colleges and universities. The development of the rubric allowed quantification of approaches across research proposals. Further documentary analysis was conducted on course change proposals by developing a matrix that noted (a) the conception of action research articulated, (b) research questions or research focus, (c) research design (d) proposed data collection methods, (e) proposed data sources, (f) proposed instrumentation, (g) proposed data analysis. Final outcome reports and conference presentations of 16 action research projects were also analyzed. Data obtained from site visits to 20 of the institutions data were used to triangulate the findings from the analysis of action research projects.

It was found that action research projects have produced a wealth of information about successful innovation in undergraduate courses, although many faculty are still novices in the implementation of action research projects. The majority used quantitative approaches, over qualitative designs. The outcome of these action research efforts has shown significant gains in student learning, as well as in faculty professional development, although the latter was less of a focus in the cases analyzed. Observational data undertaken during site evaluation visits support the idea that faculty shifted their practices away from traditional didactic lessons and that action research facilitated this process.

## Introduction

NASA Opportunities for Visionary Academics (NOVA) is a NASA-funded project aimed at improving science education at Universities across the USA by introducing innovative science and mathematics classes for pre-service teachers. New courses that are developed utilize the NASA enterprises or themes as a major focus and adopt an inquiry approach to teaching science and mathematics. The national network consists of more than 76 Universities in 37 States. Courses are housed in a number of different academic units, 61% in science departments, 9% in mathematics departments, 22% in science education or education departments, 1% in engineering units, 1 % in technology units, 1% cross listed (interdisciplinary) and 5% unspecified.

To become involved in NOVA activities, a team of three faculty members (one from education, one from science or mathematics, and an administrator) attends an initial training workshop. Thereafter they develop a grant proposal, which is submitted to NOVA for funding consideration. Beginning in 1998, as a regular part of the NOVA Phase I workshops, action research formed one component of the professional development process. All proposals to NOVA included an action research component. The education faculty member on the NOVA team usually took on the role of assisting science and mathematics faculty members in the development and use of action research plans in improving teaching, student learning, and course design.

Once funded, the team implemented the new science or math course, gathered action research data, and submitted a final report that included the results of the research. Each year, follow-up leadership development conferences are held for ongoing faculty development, additional project opportunities and the presentation of action research projects to the NOVA network. This context provides an ideal situation for research into issues relating to change and innovation in higher education because of the database of materials that has been accumulated and housed at the Science Teaching and Learning Center at the University of Alabama and the range of institutions and faculty members involved in the initiative.

**Background and significance**

Action research is an iterative process involving successive cycles of question generation, planning, action, observation, and reflection, with the latter being termed the four moments of action research (Zuber-Skerritt, 1992; Hopkins, 1993). The difference between this approach and traditional research is that it does not end with data analysis, but leads to the generation of new questions and new action (Cross, 1998). Action research is concerned with results that are relevant to immediate practice.

Previous published research with university faculty (Kember, 1998, 2000) as with K-12 teachers (Cochran-Smith & Lytle, 1992, 1999; Arhar, Holly & Kasten, 2001), has validated the effectiveness of action research on the development of expertise in teaching and for enhancing student learning and achievement. Action research is a powerful form of professional development.

In the US, classroom research has been advocated for many years as a mechanism for contributing to the scholarship of teaching in higher education (Cross & Angelo, 1989; Cross, 1998; Paulsen, 1999, 2001). Classroom research is essentially equivalent to action research (Bondy & Ross, 1998), with the purpose being to improve teaching and learning, which means that the cycle from question formulation to changing practice must be completed (Cross, 1998). Neither action research nor classroom research have been widely applied in higher education in the US, except for in some teacher education programs (Ross and Bondy, 1996; Bondy and Ross, 1998). In part this is because, historically, teaching scholarship has been synonymous with research publications and quantitative research (Kreber, 2000), and there has not been a focus on improved teaching practice for tenure and promotion review (Boyer, 1990).

One of the main purposes of the NOVA project is to encourage faculty to adopt new approaches to teaching and assessment, and to the evaluation of their work. NOVA promotes a cognitive apprenticeship approach, which involves people changing roles from teacher to learner within an action research model, involving cycles of planning, action, observation and shared reflection (Sunal, Hodges, Sunal, Whitaker, Freeman, & Edwards, 2001). This allows the teacher-learner to review the adequacy of traditional approaches and to make changes. Ownership of change is a central concept. Thus, the NOVA project has attempted to provide an alternative research framework to the dominant paradigm, and

to bridge the gap between research and practice by promoting research on classroom action.

After Habermas, Carr and Kemmis (1986) categorized action research projects as serving one of three knowledge-constitutive interests, (a) technical, (b) practical, and (c) emancipatory, with each interest serving a particular purpose. These interests can be related to differing approaches to research, where different researchers emphasize different aspects of practice in their investigations and rely on different research methods and techniques that seem appropriate in the study of practice viewed from the particular perspective they adopt. Most faculty approach their research from their particular discipline and the accompanying paradigm (Huber, 1999). That is, different methodological perspectives in research on practice are related to different epistemological perspectives on the nature of practice (Kemmis and McTaggart, 2000).

Keller (1998) noted that the research on and in American institutions of higher education has been dominated by "methodological monism" (p. 267) where the scientific method has predominated over other approaches. He argued for more research in higher education using other methods of enquiry, particularly pluralistic approaches. Kezar (2000) added that much of the critique of research in higher education points at the need to bridge the gap between research and practice, and suggests that action research provides one way to achieve this.

Kember and McKay (1996) added that action research is "the mode of research associated with critical theory" (p. 231) and that it necessarily is concerned with social practice, is participatory, allows participants to decide topics, aims toward improvement, is cyclical, reflective and involves systematic inquiry. These reflect the intentions of the NOVA program in promoting action research amongst teams of interdisciplinary faculty members. The analysis of approaches to action research adopted by faculty in education, mathematics and science education at a variety on university campuses across the US provides an opportunity to examine the extent to which action research has contributed to shifts in teaching and research practices.

## Research Purpose

The purpose of this paper is (a) to examine the approaches to action research used by education, science and mathematics faculty teaching content courses to education majors, (b) to consider how faculty converted ideas into action research proposals, (c) to analyze how they plan, gather and analyze their research data, and (d) to describe some of the research outcomes from successful action research projects.

## Method

Rubrics as a form of alternative assessment are common practice in educational settings and have been used to assess a diversity of products and processes including reading, writing, portfolios, research projects, as well as knowledge and skills in content disciplines (Taggart, Phifer, Nixon and Wood, 2001). They are useful tools for assessing restricted as well as extended performance tasks (Burke, 1999). Rubrics can be classified as holistic or as analytic, with holistic rubrics being used to rate a few skills without in-depth analysis (Wilson and Onwuegbuzie, 1999). In contrast, analytic rubrics are typically used with extended performance tasks because there are several criteria for assessing performance. Thus, when constructing an analytical rubric it is necessary to break the task down into smaller components and to rate item each on a scale.

Wilson and Onwuegbuzie (1999) created analytical rubrics for assessing graduate student performance in developing and presenting research proposals. Their rubrics were used as the basis for developing a four-point rubric for scoring action research proposals, where 1 = novice; 2 = apprentice; 3 = proficient, and 4 = distinguished. This rubric was used to rate the action research proposals of 53 institutions in the NOVA program. The rubric is an analytical rubric containing 14 items, with a total possible score of 56, which would assume a score of 4 on all 14 items. This allowed quantification of approaches across proposals. Each institution received a total score and was categorized as (a) novice-apprentice (score of 14 – 27), (b) apprentice-proficient (score of 28 – 41), or proficient–distinguished (score of 42 – 56) (see appendix 1).

Documentary analysis (Merriam, 1998) was conducted on all 53 proposals by developing a matrix that noted (a) the conception of action research articulated, (b) research questions or research focus, (c) research design (d) proposed data collection methods, (e) proposed data sources, (f) proposed instrumentation, (g) proposed data

analysis. Documentary analysis was also undertaken on the abstracts of papers presented at the 2001 and 2002 NOVA Leadership Development Conferences.

Site visits were made to 20 of the participating institutions and included interviews with all NOVA team members, interviews with students, as well as an observation of a lesson. Classroom notes field notes were written and sessions rated using the ESTEEM instrument (Burry-Stock & Oxford, 1994). Data obtained from site visits was used to triangulate the findings from the analysis of action research projects.

## Findings

A total of 53 action research proposals were analyzed using a four point scoring rubric. The mean score was 36.07, with a S.D. of 8.21. Eight institutions (15%) were categorized in the novice – apprenticeship range; 32 (60%) in the apprentice to proficient range; and 13 (25%) in the proficient to distinguished range. So, in the first stage of proposal development, most institutions were still in the initial stages of developing action research plans because the majority of proposals were categorized within the apprentice-proficient range. A quarter of the institutions had clear and well-developed action research proposals that provided a comprehensive framework for meaningful data collection and analysis.

All 53 action research proposals reviewed reflect the desire to move away from traditional lecture approaches to more interactive methods to enhance student learning. Action research conceptions were well articulated in 31 of these proposals and the cyclical nature of change is clearly reflected. Some explanations given include 'developing a best practice model', 'analysis and improvement on an ongoing basis', 'developing a plan for severe problems' and 'authentic feedback to determine student strengths and weaknesses, for future improvements for improved student learning'. This is consistent with an inquiry approach to teaching where faculty are concerned to find better ways to enhance student learning. The purposes elaborated for research were to enhance (a) student content knowledge, (b) student process skills, (c) student attitudes and/or (d) student teaching outcomes. These were specifically stated in 50 proposals, showing explicit concern for enhancing student learning.

The documentary analysis of the 53 proposals reveals that most were weak on the data analysis component, with 39 proposals (74%) making no mention about data analysis

or simply stating that data would 'be analyzed' or 'compared' to other groups. Forty-one percent of institutions did not devise actual research questions or hypotheses, although in almost all cases these could be inferred. Many institutions (57%) did not specify the type of instruments that would be used to collect data, making broad statements about methods of data collection, such as by survey or questionnaire.

Quantitative approaches were represented in most of the proposals, with the pre-test, post-test design being the most common. Twenty-eight institutions (53%) suggested this approach. Another quantitative approach commonly advocated was that of experimental and control groups (30% of institutions), in some cases in a true quasi-experimental design or combined with a pretest post-test design. In these instances the NOVA course was to be compared to a comparable class that was not being taught in the new way. Fourteen institutions (26%) made no mention of their design, while a few planned qualitative designs, such as case study, ethnography, or ongoing processes of data collection. Strong proposals, rated proficient-distinguished, included both quantitative and qualitative approaches, indicating that sound proposals could be either qualitative or quantitative.

The quantitative approaches were usually to be combined with additional qualitative techniques and were designed to elicit more in-depth data, to provide a deeper understanding about teaching and learning. Sixty-two percent of institutions mentioned methods other than surveys to assess student outcomes. The range of techniques suggested for student assessment was wide and includes journals, on-line tasks, performance tasks, rubrics, observation, interview, concept maps, quick writes, journals, portfolios, discussion groups, self evaluation, peer review, and logs of class activities. This is an impressive array of qualitative techniques, which professors in science and mathematics disciplines have embraced. These alternative approaches provide valuable ways to assess student's content and conceptual knowledge, skills and attitudes, but as already noted, there was insufficient discussion on how these would be used to gather data, and how that data would be analyzed.

An interesting, simple and yet effective approach was suggested by SUNY at Oswego, where they planned to have student write anonymous 'quick writes' (Cross & Steadman, 1996) where students would address key questions like "What have you learned

this week?" "Are you having difficulty with a particular concept?" and "How can your instructor enhance your learning?" These were then collated each time by a different group of students who would collect, review and summarize the answers. These results formed the basis of a discussion on the progress of the course. Many other innovative examples could be cited, including the use of concept maps by SFU and multiple assessment strategies used by Morehead SU for each unit, where each unit was assessed in a different way, giving students exposure to different methods and instructors multiple ways of assessing students.

It is important to note that most institutions saw the students as the primary sources of data. There were only eight institutions that mentioned faculty as a source of data, indicating that there is a strong focus on the students as the unit of analysis, rather than on the faculty member, teaching strategies, student-teacher interactions, or assessment methods. To this end, the bulk of the research questions focused on (a) student content knowledge, (b) student science/mathematic skills, (c) student attitudes to science/ mathematics, (d) student ability to integrate knowledge, (e) problem solving, and/or (f) teaching efficacy. Only 10 institutions had a research question or a suggested focus that pertained to faculty and their teaching, and mostly these were not actualized in the methodology for data collection and analysis. In three cases action research was conceptualized as something for 'future teachers' (not college professors) and was suggested as a component for students during their practicum or student teaching experiences.

The action research project being conducted at Cleveland State University is one example of an action research approach in which the instructors are focusing on their own teaching. The two instructors (one from education and one from science) have co-constructed a 'teaching portfolio' that includes personal reflections, teaching philosophies, methods and activities, student surveys and suggested improvements for teaching. This is a potentially powerful tool that can lead to constructive reflection, course redesign and changes in teaching. California State University at Northridge focused on the role of scaffolding, the process whereby the instructor provides structured support to achieve student learning outcomes, as a vehicle for dealing with student misconceptions. The research was to include video and audiotape of classrooms, transcriptions of the lessons

and discourse analysis. Here the research focus was clearly on faculty, their classroom dynamics and selected teaching strategies.

**Outcome of action research projects**

Faculty who have engaged in quality action research projects have made presentations at recent NOVA Leadership Development Conferences (LDCs). At the 2002 LDC 10 action research papers were presented by different Universities. One presentation by Cleveland State University (described above) focused on investigating effective ways to teach science for improved student learning, highlighting the way in which faculty from different disciplines can work together productively. Another paper by Stephen F Austin University highlighted the need for instructors to create a 'friendly learning environment' for students with poor attitudes because attitudes to science are related to the desire to learn conceptually. All of the other eight papers reported positive quantitative and qualitative gains in student conceptual knowledge, attitudes to science and/or science teaching efficacy as a result of the new teaching methodologies.

At the 2001 LDC six action research papers were presented, including papers describing student outcomes as well as those discussing new approaches to teaching and processes for faculty change. Four of these highlighted improvements in student attitudes, content knowledge, process skills and teaching efficacy, and one institution discussed approaches to problem solving. Fox University presented a unique project called Science Outreach, where education and science majors work together for eight weeks during the summer with students who have been home schooled. Students are responsible for planning and implementing instruction. They report that many of the science majors subsequently shifted their career goals to education. Kansas State University described a valuable action research model for education and science faculty to work together. This model called 'peer consultation' involves cycles of pre-observation discussions, written critique of observations (by the education faculty member), and written interactive reflections and follow-up between the two professors. This provides valuable data for later analysis of action.

Of the 16 action research papers presented at the LDCs, 13 describe improvement in science or math content knowledge, attitudes to the subject, process skills and teaching efficacy. The other papers dealt specifically with instructor issues such as the classroom

environment and teaching strategies. The studies of student outcomes mostly used a pretest – posttest design, and some made comparisons to traditional classes. These quantitative and qualitative projects clearly show improved student outcomes as a result of the new courses. Clearly the action research projects have produced a valuable set of information about successful courses and improved student learning.

The outcome of these research efforts show significant gains in student learning, as well as in faculty professional development. Observation data undertaken during site visits indicate that faculty have shifted their teaching practices because only one lesson observed (5%) was a completely traditional didactic lesson. During faculty interviews many claimed that the new approaches are also being integrated into the other classes they teach, and into the classes of other faculty members who have observed their new strategies. Faculty also repeatedly stated that interaction between departments or disciplines was a valuable form of professional development. Faculty from education tended to be used as 'consultants' providing 'new' ideas on how to teach and assess student learning. For people who had only previously taught in a traditional format these were exciting opportunities for them to review their own teaching processes.

**Classroom observations**

Site visit data of classroom observations of NOVA courses being taught shows that 69% were using inquiry based lessons in which students were actively engaged in learning. These lessons were described by the observers as "an excellent learning cycle class involving an engagement activity, student discussion, mini-lecture, and a follow-up activity for application", or "the NOVA model was fully implemented", or "a fully developed lesson using innovative strategies and well integrated with the NASA enterprises". In all of these cases the interview data shows active teams involved in design, planning and implementation, with faculty noting that the initial NOVA workshops had consolidated the teams and that NOVA had brought together different disciplines. Good collaboration has helped shift faculty from teacher-centered teaching to student-centered approaches.

In the remaining 32% of classes, one course was an on-line course and so the lesson was Internet based, with little opportunity for student interaction, although the instructor did answer questions from students. In four of the classes (19%) there were

elements of student participation through the presentation of class projects, the construction of models, or the use of graphing calculators. A large portion of these sessions was dedicated to direct instruction without any student participation or interaction, indicating that some elements of student-centered approaches have been adopted, but that faculty were still experimenting with new approaches and shifting their views. At one of these institutions two of the team members were new and had never attended a NOVA session. They had only had tentative discussion with the education faculty member who was the only original NOVA team member. At another school, only one member had attended the NOVA workshop and had returned to promote this to other faculty and felt he was making progress. In both cases, the faculty had under-developed conceptions of action research. So, the absence of consolidated teams in these cases has hindered progress to using new approaches and in implementing action research projects.

In only one instance (5%) was the observed lesson completely didactic, with the instructor reviewing homework, with some question and answer participation. This instructor had an excellent understanding of the many ways in which children solve mathematical problems and wanted future teachers to be aware of these and insisted they learn how to solve problems in alternative, but very rigid, ways. Thus, the essence of constructivism in which people solve problems in personal ways was reduced to new forms of algorithms.

Overall this data shows that the majority of faculty have shifted their practice to more student-centered approaches and that others are in transition. Only one person adopted a teacher-centered approach even though in the interview she stated she did otherwise. The contradiction between espoused philosophy and actual practice needs further exploration. The data from classroom observations supports the notion that action research projects, together with the professional development provided by NOVA, and well functioning teams at institutions are requirements for effective implementation of new models of teaching and learning in higher education. Further analysis of the data is needed to examine the relationship between effective action research proposals, teaching efficacy and the implementation of inquiry-based lessons.

## Discussion

Approximately two thirds of the proposals presented articulate statements about the role and purpose of action research. But, given that only a quarter of the proposals were scored in the distinguished to proficient range, it is clear that additional work is needed to support faculty in developing (and implementing) comprehensive action research proposals. There is a need to provide more input on instrumentation for data gathering and on data analysis, particularly with respect to qualitative techniques. In general faculty are comfortable with quantitative approaches, but less familiar with techniques for gathering and analyzing qualitative data. For instance, Kember and McKay (1997) noted that the use of control groups is unusual in action research groups, but this was the dominant conception of research design in the NOVA action research projects. That faculty are more prone to using quantitative techniques suggests that it may be difficult to move faculty in science and mathematics disciplines out to the research paradigm with which they are most familiar and comfortable.

The use of a broader range of methodological approaches, as promoted by Keller (1998) is likely to provide a richer and more in depth platform for examining teaching and learning. Evidence in the research proposals and exemplary cases described shows that there is a move towards this in more than half of the cases, where a range of strategies have been used by science and mathematics professors to assess student attitudes, perceptions and conceptual knowledge. Evidence presented also shows that successful implementation of an inquiry approach to teaching was dependent on the successful functioning of interdisciplinary teams. The inclusion of education faculty, who are likely to be more sympathetic to qualitative techniques, has aided in this emergence of alternative assessment strategies in science classes. Despite this positive move toward innovative ways of assessing students, there is less evidence on the extent to which alternative methods have been used to examine the effectiveness of particular approaches to teaching, to reflect on classroom relationships, to consider issues relating to classroom climate, to examine personal constructs and their impact on teaching, or even the impact of different assessment techniques. Research is primarily reserved for examining the impact on student learning and it might be argued that this has been done to justify the introduction

of a new course and to counter any negative perceptions about innovation from other faculty or administrators.

There is a substantial body of research on the reciprocal relationship between students' prior experiences, their approaches to learning, their perceptions of the learning situation, and their learning outcomes (e.g. Prosser & Trigwell, 1999). For instance, students tend to adopt a 'surface approach' to learning by memorizing facts if they perceive that the environment requires it. In contrast they will adopt a 'deep approach' to learning if the teaching context demands that they make conceptual connections and that they strive for understanding. Prosser & Trigwell (1999) added that there is far less research into university teacher's conceptions of teaching, and "even less into their perceptions of the teaching context, their approaches to teaching, outcomes of teaching and relations between these aspects of the experience of teaching" (p. 21). However, it may be difficult to persuade faculty to engage in this kind of research because it is outside of their realm of familiarity. Schon (1995) described the paradoxical case of a professor at MIT who had the opportunity to research the impact of computer aided instruction on student learning, but who was not able to develop a suitable research question. He concluded that introducing and legitimizing action research may prove equally difficult with other scholars who would be undertaking the research. More work is needed in the NOVA project to encourage faculty to move towards examining their own teaching practices within an action research mode that utilizes the pluralistic research methods suggested by Keller (1998).

Action research involves cycles of planning, acting, observing and reflecting (Hopkins, 1993). The exemplary projects illustrate how faculty have been through these stages once, but there is little evidence of the continuation into additional cycles. Reflection necessitates the origination of new hypotheses and research questions for ongoing planning, action, observation and reflection. Action research is an iterative process. One case at Brescia University shows how one instructor modified instruction in the next course offering to account for any negative student perceptions and poor conceptual understanding in certain areas of the content, but other than this there is little evidence of the cyclical change implied in action research. Further data needs to be gathered to establish the extent to which ongoing cycles are being implemented and

NOVA faculty should be encouraged to see change as an ongoing process of seeking improvement in teaching and learning.

That professors appear to be less able or willing to use alternative methods for personal evaluation and self-reflection supports the analysis that there is a gap in higher education between research and practice (Kezar, 2000). It is possible that faculty go through different stages as they grapple with how to conduct action research. Initially they may find it easier to focus outside of themselves and on students. They may need far more support and input, such as through the involvement of a 'critical friend' (Kember, 1998) or participant observer, to assist them in moving towards research, reflection and analysis on their own practice. Kember (1998) described the role of the critical friend in the Action Learning Project, an inter-institutional project involving eight institutions in Hong Kong. Within the project there were a number of coordinators who worked with ten to twelve teams (and there were over 50 teams) in the role of 'critical friend'. Their role included that of (a) 'rapport builder', (b) 'coffee maker' (ongoing facilitator`), (c) 'mirror', (d) teaching consultant (e) evaluation and research advisor, (f) writing consultant and (g) match maker (putting people in touch with others). NOVA does not have any full time staff and it will be a challenge to find ways to promote this notion.

Professional development is not a one-off event and involves (a) a clear focus on learning and learners, (b) an emphasis on the individual and organizational change, (c) small changes guided by a grand vision, and (d) ongoing professional development that is procedurally embedded (Guskey, 2000). Action research is one way to achieve this and this research shows that most faculty in the program have a clear focus on learners and learning and have embarked upon change processes at the personal and institutional level by implementing these new courses and action research projects. The action research has enabled faculty to engage in thinking about student learning and to reflect upon their own teaching styles. All proposals espouse the desire to move towards inquiry approaches in science and mathematics teaching in higher education and this was observed more then two thirds of the classroom observations. Thus, the action research projects have contributed to faculty development.

The Carnegie Foundation for the Advancement of Teaching suggests three criteria for defining the scholarship of teaching and learning, (a) that teaching is teaching is deeply

embedded in the discipline, (b) that it is an aspect of practice, and (c) that it is characterized by a transformational agenda (Hutchings, 2000). The majority of the project proposals, cases and exemplars described in this article meet the first two criteria, although different action research projects are clearly in different stages of development and implementation. First, the action research designs proposed and used for inquiry are rooted in the scientific method as evidenced by the large number of proposals that adopted a pre-test post-test design, together with control and experimental groups in some instances. Therefore, their inquiry is rooted in the particular tools of their discipline. Second, all of the cases involve faculty using new approaches to teaching and grappling to understand the impact on student learning, that is, the faculty are considering aspects of their teaching practice.

In considering the third criterion, it is important to consider the purpose of the research proposals. Within emancipatory action research practitioners work together as a group and collectively identify problems and possible solutions (Carr & Kemmis, 1986). There is a concern for political change, consciousness raising and the generation of new theories, as much as for practical improvements. Most of the action research proposals in the NOVA program are concerned with practical issues, like how to improve student attitudes and concepts. These are not transformational agendas and so more research is needed particularly on the exemplary action research projects that have produced results, to establish the extent to which action research projects have transformed personal and institutional practices. There is evidence from interviews with administrators in universities with NOVA courses that this has happened, but these have not been the focus of action research agendas. So, action research projects may still be in transition towards transformational agendas. Despite this, the NOVA program can be considered to be making a substantive contribution to the scholarship of teaching and learning.

Appendix 1

Scoring rubric

| Score | Explanation |
|---|---|
| 1 - novice | The item is not included. |
| 2 - apprentice | The item can be inferred from the text or there is evidence of intent that is not elaborated. |
| 3 - proficient | The item is stated in the text but is not elaborated or is explained in part. |
| 4 - distinguished | The item is fully elaborated in the text. |

Scoring dimensions

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Action research proposal | | | | |
| | | | | |
| 1. The rationale of the study is clearly presented | | | | |
| 2. The purpose of the study is provided adequately | | | | |
| 3. The action research cycle (PAOR) is evident | | | | |
| 4. There are clear research questions or hypotheses | | | | |
| 5. The research methods are clearly stated | | | | |
| 6. Research methods are appropriate to the questions | | | | |
| 7. Instrumentation is described | | | | |
| 8. States who the program participants are | | | | |
| 9. Data sources are identified | | | | |
| 10. Potential sample sizes are noted | | | | |
| 11. Triangulation of data is proposed | | | | |
| 12. States who will collect the data | | | | |
| 13. Methods of data analysis are proposed | | | | |
| 14. Methods of data analysis are appropriate | | | | |

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