Bettye B. Burkhalter, James E. McLean, Melaney A. Jones

Recipients' Views of the Role of Christa McAuliffe Fellowships in Science Education[1]

Results are presented that identify the dimensions of the perceptions of Christa McAuliffe Fellows regarding the impact of their participation on their classroom teaching and the relationship of these dimensions to selected demographic variables.

The world continues to be reshaped by change and technology. Space exploration is central to these changes by providing unlimited opportunities for expanding mankind's understanding of the universe through scientific research. One such far-reaching opportunity lies in education's role in the space program. The importance of education in America's space program was clearly defined in 1965 by NASA's first administrator, James E. Webb: "NASA's educational programs and services are generally aimed at college or university levels, but also include space-science material, for elementary and secondary schools to assist in updating classroom instruction and student participation." (Levy, 1965). NASA's Space Education Centers provide motivational materials that are an asset to any teacher's curriculum. Classroom teacher Christa McAuliffe was no exception. She took advantage of these space-science materials as well as her own ideas as a master teacher. She was a visionary teacher who had the capacity to reach out into the future and inspire her students to think critically about the world around them: the world in which they would live and work in the near future.

In addition to being a master teacher, she also wanted to be the first teacher to travel and teach in space. In July 1985, NASA selected Christa McAuliffe to become the first teacher in space (Wilford, 1986). Her dream and mission was intended to reawaken the pioneer spirit in Americans, especially students and teachers, and to demonstrate to the world that the space program was accessible to everyone (Richman, 1986). In effect, this mission was to open space flight to the public and humanize the experience. Unfortunately, this dream never became a reality for Christa because the mission failed. On January 28, 1986, the world watched the Challenger launch at 11:38.03 a.m. with excitement, admiration, and high expectations. However, within two minutes, America's first classroom teacher in space vanished when the Challenger exploded at 11:39.14 a.m. Although Americans were stunned and mourned the loss of Christa McAuliffe and the other six astronauts, America's space program was destined for even bolder ventures. Out of Challenger's ashes, grief, and remorse came a renewed entrepreneurial determination to move full speed ahead and to not disappoint the seven men and women who gave their lives daring to break the bonds of Earth (Reagan, 1986). As a national recognition to America's first teacher in space, the *U.S. Congress enacted the Christa McAuliffe Fellowship Program* in 1986 (Public Law 99-498, 1986). This Program awards a one-year sabbatical to one classroom teacher in each of the 50 states and U.S. territories for study, research, or academic improvement. Upon completion of the

… the use of space to motivate science education is at an all-time high.

[1]Note. A preliminary version of this paper was presented at the 49th International Astronautical Congress, Melbourne, Australia.

Fellowship, the teacher is required to return to the classroom for two years to share the Fellowship experience with other teachers, students, and the educational community at large. It is interesting that NASA announced that the Teacher in Space Program would be resumed (NASA, 2002) less than two months prior to the space shuttle Columbia disintegrating upon re-entry, again postponing a teacher going into space. However, the use of space to motivate science education is at an all-time high.

Need to Teach Critical Thinking Skills

The chief executive officer of Xerox Corporation reported that only a small percentage of young Americans sampled in the "National Assessment of Educational Progress" could reason effectively about what they read and write (Applebee, 1987). These data are alarming because they suggest that the majority of our youth do not have the critical thinking skills needed in an economy that is now based on information and knowledge. Today the office, not the factory, is the center of working Americans. In order to provide a critically thinking workforce that has the ability to interpret, infer, evaluate arguments, recognize assumptions, and understand deduction, it is essential that educators consistently explore and search for ways to teach critical thinking skills at every level.

While most educators agree there is a need to teach students how to engage in critical thinking, the lack of consensus as to what is meant by critical thinking has led to inadequate teaching of these skills. This inadequacy can be divided into two categories: what thinking skills we choose to teach and how we choose to teach them. Controversy exists as to which thinking skills to teach, and educators either do not understand or cannot precisely define these skills. With regard to the implementation of these skills, many educators fail to provide the instruction that promotes critical thinking; focus on too many skills without giving the students adequate time to master these skills; and utilize achievement tests that may inhibit the development of critical thinking skills (Beyer, 1984). Nothing is more important in the education of our students than for educators to help students to think critically about their world (Hugenberg, 1995).

While most educators agree there is a need to teach students how to engage in critical thinking, the lack of consensus as to what is meant by critical thinking has led to inadequate teaching of these skills.

As early as 1923, Jean Piaget challenged teachers to reevaluate their goals for students and to promote critical thinking rather than conformity. Piaget described two important educational goals. The first "principal goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done—men who are creative, inventive, and discoverers. The second goal of education is to form minds which can be critical, can verify, and not accept everything they are offered." (Ginsburg, 1969). As we move toward a global and information technology-based society, it is important that our students understand international and cultural diversity and become sensitive to different points of view. The key to this understanding and increased sensitivity is critical thinking: identifying and challenging assumptions and exploring and imagining alternatives (Brookfield, 1987). In essence, critical thinking means a student takes a holistic approach to solving a problem and assuring all dimensions of the problem have been examined. Based on these issues, the purpose of this study was to identify the perceptions of classroom teachers awarded the Christa McAuliffe Fellowship and the impact the Program had on their classroom teaching and on the need of teaching critical thinking skills.

Procedures

The study employed a survey. The survey instrument was comprised of 23 4-point Likert response items (strongly disagree to strongly agree) based on seven dimensions: impact on critical thinking, use of technology in the classroom, influence on curriculum, improved teaching behaviors, application of critical thinking skills, logistics regarding the Christa McAuliffe Fellowship Program, and improving promotion of the Fellowship Program. The responses were converted from the verbal options (strongly disagree, disagree, agree, and strongly agree) to numerical indicators (1, 2, 3, and 4 respectively). Thus, a response of "1" would represent strong disagreement with a statement, a response of "4" would represent strong agreement with an item, and an average response of 2.5 would represent neither agreement nor

disagreement. Respondents were also given the opportunity to indicate that an item was not applicable. In addition to the 23 Likert items, the survey form included seven demographic items regarding gender, tenure classification, age, experience in current position, education, total experience, and number of students enrolled at their schools.

The survey was sent to all 517 recipients of the Christa McAuliffe Fellowship for its first 10 years (1987-1997). Completed surveys were received from 317 recipients for a 61% return rate. The data were hand-entered into a computer spreadsheet and checked for accuracy. Complete data were submitted by 217 respondents and usable data were submitted by 99 more respondents for a total of 316 or 61% usable surveys.

First, analyses were conducted to verify the reliability and validity of the survey instrument itself. The seven dimensions were verified using principal components analysis, a statistical grouping process. Item analyses and coefficient alphas (internal consistency indices) were computed for each dimension to establish the reliabilities.

Following the item reliability and validity analyses, the data were analyzed in two ways. First, the individual items were analyzed, computing the means, standard deviations, and confidence intervals for each item. Second, differences in seven dimension scores were compared across the demographic variables of gender, tenure, age, experience in current position, total experience, level of education, and size of enrollment. In order to consider these differences simultaneously, the data were analyzed using multivariate analyses of variance (MANOVAs). Specifically, differences in the seven dimensions of the instrument were compared across the levels of gender, tenure status, age, experience, degree, and school enrollment as independent variables in separate analyses.

As we move toward a global and information, technology-based society, it is important that our students understand international and cultural diversity and become sensitive to different points of view.

Results

The results were first analyzed on an item-by-item basis. Table 1 lists the individual items in order of magnitude of the means from the item with the largest mean to the item with the smallest mean. For an individual item, a mean response of 1.00 would indicate that all respondents "strongly disagreed" with the statement. A mean response of 4.00 would indicate that all of the respondents "strongly agreed" with the statement. A mean response of 2.50 would indicate that, on the average, the respondents were neutral with respect to their agreement with the statement. Table 1 also includes 95% confidence intervals for each item; that is, the probability is 95% that the mean response to an item is between the lower and upper confidence limits. Thus, two items can be considered significantly different if their confidence intervals do not overlap.

The two items with the largest means were "An experiential (hands-on) approach to teaching should be part of every classroom." (mean = 3.82) and "I improved my knowledge, skills, and abilities as a classroom teacher as a result of receiving the Christa McAuliffe Fellowship." (mean = 3.80). These two items were not significantly different from each other, but their means were significantly larger than those for all other items. Conversely, the item with the smallest mean, "The U.S. Secretary of Education should select one 'educational theme' as priority each year." (mean = 1.74 on 5-point scale) was significantly smaller than all other items.

Before examining the individual dimensions, it is important to verify their reliability and validity. The principal component analysis confirmed that seven dimensions were present in the instrument and the appropriate items were included in each dimension. The dimensionality of the instrument was supported by the Kaiser Criterion (or "eigenvalue greater than one" criterion) and the Cattell Screen Test, both standard indices used for determining dimensionality. Item membership in each dimension was confirmed through a principal factor analysis with varimax rotation. Every item but one correlated at least .50 with a specific dimension. Table 2 presents the items from the survey grouped within their dimensions and each item's correlation with its dimension. In addition, the means and standard deviations for the items are presented. One item, "I believe every Christa McAuliffe Fellow should understand Christa McAuliffe's commitment as a classroom teacher and the conditions of

Table 1. Survey Items with Means and Confidence Intervals by Order of Magnitude

Item	Mean	95% Confidence Interval
An experiential (hands-on) approach to teaching should be part of every classroom.	3.82	3.77-3.87
I improved my knowledge, skills, and abilities as a classroom teacher as a result of receiving the Christa McAuliffe Fellowship.	3.80	3.75-3.85
A creative environment is a necessary ingredient for teaching thinking and reasoning skills.	3.74	3.69-3.79
I believe every Christa McAuliffe Fellow should understand Christa McAuliffe's commitment as a classroom teacher and the conditions of this national award.	3.72	3.67-3.77
My receipt of the Christa McAuliffe Fellowship caused curriculum change in my class.	3.63	3.56-3.70
The Christa McAuliffe National Fellowship Program should be awarded only to outstanding full-time teachers.	3.56	3.48-3.64
I improved my ability to teach critical thinking skills to my students as a result of receiving the Christa McAuliffe Fellowship.	3.47	3.39-3.55
The use of space related technologies by teachers in the classroom enhances students' opportunities to live, work, and succeed in an internationally competitive society.	3.47	3.40-3.54
As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *interpretation* critical thinking skill.	3.31	3.24-3.38
As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *inference* critical thinking skill.	3.30	3.22-3.38
My receipt of the Christa McAuliffe Fellowship influenced curriculum change in my school.	3.28	3.18-3.38
Immediate aerospace technology transfer to the classroom environment would be useful to motivate students.	3.28	3.21-3.35
As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *deduction* critical thinking skill.	3.23	3.15-3.31
As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *evaluation of arguments* critical thinking skill.	3.19	3.11-3.27
As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *recognition of assumptions* critical thinking skill.	3.12	3.04-3.20
Spin-offs from space technology and other high technology research are important to my method of teaching (e.g., uplink/downlink satellites, microwaves, personal computers, robotics, laser devices, optical information storage devices, etc.)	3.11	3.01-3.21

Table 1. Continuted

Item	Mean	95% Confidence Interval
Federal and state regulations (red tape) required to ensure proper expenditure of the Christa McAuliffe Fellowship were minimal.	3.02	2.92-3.12
Space related classroom activities have had a significant, positive effect on the thinking and reasoning skills of my students.	3.01	2.92-3.10
My receipt of the Christa McAuliffe Fellowship influenced curriculum change in school system.	2.93	2.82-3.04
A major difficulty with the United States educational process is the inability of teachers to teach students how to think, reason, and apply knowledge.	2.92	2.82-3.02
The regulation that states that fellowships awarded may not exceed the average national salary of public school teachers in the most recent year is an appropriate amount for the purpose of the Fellowship.	2.91	2.82-3.00
The Christa McAuliffe Fellowship Program is promoted in my school system (LEA and/or school) as an important program for classroom teachers.	2.29	2.18-2.40
The U. S. Secretary of Education should select one "educational theme" as priority each year.	1.74	1.65-1.83

Table 2. Survey Items in Each Dimension, Correlations with Dimensions, Means, and Standard Deviations

Dimension	Item	Correlation with Dimension	Respnose Mean ± *SD*
1. Impact on critical thinking	• As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *inference* critical thinking skill.	.79	3.3 ± .69
	• As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *recognition of assumptions* critical thinking skill.	.88	3.1 ± .69
	• As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *deduction* critical thinking skill.	.88	3.2 ± .66
	• As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *interpretation* critical thinking skill.	.86	3.3 ± .67
	• As a result of the Christa McAuliffe Fellowship, my teaching methods include more exercises and experiences that require the *evaluation of arguments* critical thinking skill.	.86	3.2 ± .72

Table 2. Continuted

Dimension	Item	Correlation with Dimension	Respnose Mean ± *SD*
2. Use of technology in the classroom	• Spin-offs from space technology and other high technology research are important to my method of teaching (e.g., uplink/downlink satellites, microwaves, personal computers, robotics, laser devices, optical information storage devices, etc.).	.76	3.2 ± .84
	• The use of space related technologies by teachers in the classroom enhances students' opportunities to live, work, and succeed in an internationally competitive society.	.76	3.5 ± .55
	• Space related classroom activities have had a significant, positive effect on the thinking and reasoning skills of my students.	.83	3.1 ± .73
	• Immediate aerospace technology transfer to the classroom environment would be useful to motivate students.	.62	3.3 ± .57
3. Influence on curriculum	• My receipt of the Christa McAuliffe Fellowship influenced curriculum change at my school.	.88	3.3 ± .87
	• My receipt of the Christa McAuliffe Fellowship influenced curriculum change in my school system.	.90	3.0 ± .92
4. Improved teaching behaviors	• I improved my knowledge, skills, and abilities as a classroom teacher as a result of receiving the Christa McAuliffe Fellowship.	.85	3.8 ± .48
	• I improved my ability to teach critical thinking skills to my students as a result of receiving the Christa McAuliffe Fellowship.	.71	3.4 ± .68
	• My receipt of the Christa McAuliffe Fellowship caused curriculum change in my class	.70	3.6 ± .67
5. Application of critical thinking skills	• A major difficulty with the United States educational process is the inability of teachers to teach students how to think, reason, and apply knowledge.	.55	3.0 ± .86
	• A creative environment is a necessary ingredient for teaching thinking and reasoning skills.	.66	3.8 ± .42
	• An experiential (hands-on) approach to teaching should be part of every classroom.	.64	3.8 ± .39
6. Logistics regarding the Christa McAuliffe Fellowship	• The Christa McAuliffe National Fellowship Program should be awarded only to outstanding full-time teachers.	.64	3.6 ± .69
	• Federal and state regulations (red tape) required to ensure proper expenditure of the Christa McAuliffe Fellowship were minimal.	.57	3.0 ± .85
	• The regulation that states that fellowships awarded may not exceed the average national salary of public school teachers in the most recent year is an appropriate amount for the purpose of the Fellowship.	.59	2.9 ± .81

Table 2. Continuted

Dimension	Item	Correlation with Dimension	Respnose Mean ± *SD*
7. Improving promotion of the Fellowship Program	• The Christa McAuliffe Fellowship Program is promoted in my school system (LEA and/or school) as an important program for classroom teachers.	.52	2.3 ± .93
	• The U.S. Secretary of Education should select one "educational theme" as priority each year.	.81	1.7 ± .80

this national award," did not correlate .50 with any single dimension, but did correlate .36 and .39 with Dimensions 5 and 6 respectively.

Analyses of the individual items indicated that all items were appropriately related to their respective dimensions. The internal consistency reliable (coefficient alpha) for each dimension is presented in Table 3. It was concluded that only the first four dimensions were sufficiently reliability to use in further analyses. The first four dimensions were "impact on critical thinking," "use of technology in the classroom," "influence on the curriculum," and improved teaching behaviors." However, this does not mean that the individual items comprising the other three dimensions are invalid. The individual responses and means as presented in Table 1 still have much to contribute. The standard deviation represents an index of agreement. Agreement among the respondents is proportional to the standard deviation of an item. In general, the responses of approximately two-thirds of the respondents fall within one standard deviation of the mean.

For Dimension 5, applications of critical thinking skills, the means were at the "agree" level ("A major difficulty with the United States educational process is the inability of teachers to teach students how to think, reason, and apply knowledge," mean = 3.0) or near the "strongly agree" level ("A creative environment is a necessary ingredient for teaching thinking and reasoning skills" and "An experiential (hands-on) approach to teaching should be part of every classroom," had means = 3.8). All three items in Dimension 6, logistics regarding the Christa McAuliffe Fellowship Program, had means at or near the "agree" level (3.6, 3.0, and 2.9 for Items "The Christa McAuliffe National Fellowship Program should be awarded only to outstanding full-time teachers," "Federal and state regulations (red tape) required to ensure proper expenditure of the Christa McAuliffe Fellowship were minimal," and "The regulation that states that fellowships awarded may not exceed the average national salary of public school teachers in the most recent year is an appropriate amount for the purpose of the Fellowship," respectively). Dimension 7, improving promotion of the fellowship program, had the lowest means of all the items with both being below the "neutral" level. That is, on the average, respondents did not believe that the fellowship program was promoted at their schools and they did not believe that the U.S. Secretary of Education should select an educational theme for the program each year.

The four reliable dimensions were compared across the levels of the demographic variables using MANOVAs. The results are presented in Table 4. As can be seen in Table 4, the four dimensions are not significantly related to gender, tenure status, current classroom experience, total classroom experience, level of

Table 3. Reliability of Each Dimension

Dimension	Reliability (Coefficient Alpha)
1. Impact on critical thinking	.94
2. Use of technology in the classroom	.77
3. Influence on curriculum	.86
4. Improved teaching behaviors	.71
5. Application of critical thinking skills	.40
6. Logistics of fellowship program	.35
7. Promotion of fellowship program	.20

Table 4. Multivariance Analysis of Variance Results Where

Independent Variable	*F*-Statistic	*F*-Probability	Eta Square
Gender 1.07	.375	.020	
Tenure Status	1.29	.276	.026
Age	1.27	.231	.024
Experience in Current Position	.78	.669	.015
Total Experience	.67	.781	.013
Level of Education	1.18	.274	.022
Enrollment at Current School	1.27	.176	.037

Note. Dimensions 1, 2, 3, and 4 from Table 3 are dependent variables.

degree, or school enrollment. This is true whether considering statistical significance (minimum significance level is p = .231) or practical significance (maximum variance of a dependent variable accounted for by an independent variable is .026 or 2.6%). These results were cross-validated for the dichotomous variables of gender and tenure status using an second statistical method, logistic regression.

Discussion and Conclusions

Christa McAuliffe Fellowship recipients perceived the program to have impacted their effectiveness as science teachers. Specifically, they perceived the awarding of this Fellowship to have improved their ability to produce critical thinking in students, use technology in the classroom, improve the curriculum, improve teaching behaviors, and help students apply critical thinking skills. Collectively, these dimensions demonstrate the perceived impact the Christa McAuliffe Fellowships have had in the United States over a 10-year period and continue to have in the 21st century. Moreover, the recipients of the fellowship overwhelmingly agreed with the positive statements regarding the program's impact on their knowledge, teaching, and curriculum.

Fellowship recipients strongly agreed with most of the items and agreed, on the average, with all but two items. They agreed most strongly with items dealing with (1) experiential learning being part of every classroom and (2) receiving the Christa McAuliffe Fellowship as having improved their abilities to improve students' critical thinking skills. Award recipients disagreed with the idea that the U.S. Secretary of Education should select one "educational theme" as a priority each year and, to a lesser extent that the Christa McAuliffe Fellowship Program is promoted in their school systems.

Space still has a fascination for most students and this fascination can be used to motivate them to learn the principles behind the science.

It is interesting that the study did not find relationships between the four valid dimensions on the survey and gender, tenure status, classroom experience, age, education level, or size of school. This suggests that opinions of the program's effectiveness are independent of these variables. If this finding was confirmed through additional study, it would suggest that a strength of the program is its ability to transcend the variables of gender, experience, etc. This finding is supported very strongly in this study by the lack of both statistical and practical significance.

The findings of this study indicate that Christa McAuliffe Fellowship recipients believe that science teachers could benefit from similar sabbatical experiences which allow them time and resources to develop knowledge, skills, and abilities related to these dimensions. The broader conclusion is that space related information could provide a vehicle for motivating and explaining science to students. The recipients agreed that their involvement in this program influenced curriculum change not only in their own classrooms, but also in their schools and school systems. Space still has a fascination for most students

and this fascination can be used to motivate them to learn the principles behind the science. Further, it lends itself to hands-on activities to further enhance learning.

Although 17 years have passed, Christa McAuliffe's dream continues to live and influence classroom teachers and students throughout America. On February 1, 2003, the STS-107 Columbia and Crew recorded another tragedy while returning from orbit. Although their mission pushed the space frontier forward, the ultimate price was paid. As with the Apollo 1 and Challenger, the world grieves for the human loss. However, all three crews will be remembered as they boarded their ships: with their hearts and minds filled with hope and expectations for a better world because of their bold explorations and research. And, their contributions to humankind will continue to be appreciated by those who love and understand their willingness to accept the risk inherent in every mission. Ironically, this disaster has, once again, focused attention on the space program and the courage of those who pursue it. Whether in the teacher's classroom, or in the classroom without walls of the world, each astronaut's dream will live on through the people they represented and served—just as Christa McAuliffe's dream continues to live through teachers and students influenced by the Christa McAuliffe Fellowship Program.

References

Applebee, A. N., Langer, J. A., & Mullis, I. V. S. (1987). *Learning to be literate in America: reading, writing, and reasoning*. *The Nation's Report Card*. Report by the National Assessment of Educational Progress. Princeton, NJ : Educational Testing Services.

Beyer, B. K. (1984). Improving thinking skills—defining the problem. *Phi Delta Kappan*, *65*(7), 486-490.

Brookfield, S. D. (1987). *Developing critical thinkers: challenging adults to explore alternative ways of thinking and acting*. San Francisco, CA: Jossey-Bass, Inc.

Ginsburg, H., & Opper, S. (1969). *Piaget's theory of intellectual development: an introduction* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Hugenberg, L. W., & Patsey, B. S. (1995, November 18-21). *Helpful hints toward critical and creative thinking in the classroom.* Paper presented at the 81st Annual Meeting of the Speech Communication Association, San Antonio, TX.

Levy, L. (1965). *Space: Its impact on man and society*. New York: W. W. Norton.

NASA (2002, December 12). *A teacher in space: Educator-astronaut Barbara Morgan will visit the International Space Station in 2003*. Retrieved February 6, 2002 from <http://science.nasa.gov/headlines/y2002/ 12dec_teacher.htm>.

Public Law 99-498 (1986, October 17). U.S. Department of Education.

Reagan, R. (President Reagan at Houston Memorial Service) "We will not disappoint them". (1986, February 10). *U.S. News and World Report*, *100*(5), 14-20.

Richman, A. (1986, February 10). A lesson in uncommon valor. *People Weekly, 25*(4), 3

Wilford. J. N. (1986, January 5) A teacher trains for outer space. *The New York Times Magazine,* 18-21.

Bettye B. Burkhalter, Ph.D., Vice President, Associate Provost and Professor Emerita, Auburn University, P.O. Box 3155, Auburn, AL 36831-3155, <burkhbb@auburn.edu>.

James E. McLean, Ph.D.*, Professor and Chairholder, East Tennessee State University, 418 Warf-Pickel Hall, Box 70685, Johnson City, TN 37614-1709, <jmclean@mail.etsu.edu>.

Melaney A. Jones, M.S., Former Graduate Research Assistant, Office of the Vice President and Associate Provost, 775 Millers Point Road, Auburn, AL 36830, mail to: <melaneyjones@hotmail.com>.

* Corresponding Author