A Survey of Educators' Perceptions Concerning the Impact of the STARLAB Planetarium on Teaching and Learning

An independent research project by Gary Daniel Kratzer
for McNeese State University

Fall, 1997

Abstract

This study examined educators' perceptions of the effectiveness of the STARLAB Planetarium as a teaching tool and the impact it has made on student learning. The study sought information from STARLAB users from around the world. Over three thousand STARLAB educators worldwide were identified and mailed a survey by Learning Technologies, Inc. The researcher asked questions about the amount of teaching experience with and without STARLAB, personal academic background, the number of students taught , the effectiveness of STARLAB as a tool of technology, the amount and importance of STARLAB training received, and the ability of STARLAB to motivate student learning in astronomy, space science, and other subjects. Postpaid responses were mailed to Learning Technologies, Inc. and forwarded to the researcher for compilation.

A Survey of Educators' Perceptions Concerning the Impact of the STARLAB Planetarium on Teaching and Learning

The planetarium can be an exciting place for youngsters, especially for those visiting for the first time. The planetarium environment is especially useful in fostering in children some early positive attitudes and perceptions about learning in general (Chapman, 1994).

Research conducted by planetarium educators has undergone a metamorphosis over the years. Initial concerns focused on comparative studies between planetariums and the classroom as effective learning environments. Attention then began to focus on the nature of the planetarium presentation as studies examined participatory oriented planetarium settings compared to traditional lecture-demonstration presentations. More recent studies have focused on interaction of the planetarium learning environment with specific elements of learning as opposed to generalized achievement performance (Riordan, 1991).

We are in the midst of another technological revolution in the area of planetarium hardware development. But the educational questions remain irrespective of the level of technology available. How does this environment affect learning? It is critical that we view the planetarium not merely as a machine that projects points of light and that rotates with great precision. We must consider it in the broader context of its application capabilities in the light of learning theory (Riordan, 1991).

Statement of the Problem

The 1990s have seen a surge of educational reform movements that have penetrated levels of education including the classrooms. These movements seem to stem from a basic flaw of our educational system to enable our students to retain and apply basic concepts we all feel are vital to functioning in today's world. Tests of and interviews with students reveal "categorized conceptualizations." Students tend to identify composition with English, observing with science, measuring with mathematics and maps, and history with social studies. Neither do they see how these concepts and processes are interrelated, nor do they readily anticipate the need for them beyond school rooms.

This study sought to correlate educators' perceptions of teaching and student learning to the use of a STARLAB Portable Planetarium. This study determined the degree of effectiveness STARLAB provides in stimulating learning across the disciplines. Level of education, the amount of STARLAB training, years of teaching experience, and categories of teaching were also identified from the participants.

Review of the Literature

Perhaps one of the most powerful tools in capturing our students' imagination is the planetarium. For at least a small part of their school day, students can journey to the countryside and pick out familiar constellations against an inky black sky, or travel to Mars or a planet circling a red sun (Friedman and others, 1990).

The STARLAB portable planetarium provides an alternative or a useful previsit orientation to a large planetarium. Because STARLAB is small and intimate, it invites the discussion and commentary discouraged by a large planetarium's size and format. With STARLAB, the lights can be turned up at any point in the lesson to ask students what they saw or to invite them to work with a partner on a sky map. The teacher is the planetarium instructor. Instead of delivering a packaged speech, the teacher can talk through the experience, adapt to the needs of particular students, clear up a misunderstanding, or wonder with them about the universe (Cole & Mallon, 1987).

STARLAB consists of a fabric dome large enough to hold 30 children. A fan inflates the dome, and a small projector inside the dome creates images of the night sky on the ceiling. When deflated, the system stores in three suitcase-sized containers and fits into a car trunk (Cole & Mallon, 1987).

There is one major difference in history between portables and the small stationary planetariums. The latter represented a major investment by a school district and was meant to serve all students in the district. The teacher was assigned as full time planetarium instructor and given support from the school

to develop skills and expertise. They had incentives and support to seek out planetarium organizations for help. Many became very active in those organizations and played a major role in shaping them. In contrast, the typical portable planetarium instructor is one who may use the portable only a few days a year often for only that teacher's students. It is much harder for these instructors to develop the skills needed to become professional planetarians. More help is needed. Lying in the files of every school-based planetarium is material portable planetarium instructors could use, otherwise they would struggle alone to reinvent the wheel. Portables have been marked as a tool any teacher can use. It is true that any teacher can swiftly master the mechanics, but teaching well in a portable takes experience and support. Probably few school districts realize this or, if they do, they have not the expertise themselves to utilize fully the portable planetariums. Probably they have the all too common view that it is not a real planetarium and they have no vision of the possibilities that a portable offers (Rall et al., 1996).

But the efforts of planetariums extend to more than just the star theater, Astronomy classes, seminars, and workshops regularly combine classroom, planetarium, and outdoor learning. Teacher workshops offer in-service training and resource materials to teachers of all grades; one workshop took place in a tepee at the Museum of the Rockies' paleontology field camp, and included work in a portable STARLAB and night sky observations under a pristine Montana sky (Manning, 1995).

STARLABs and other portable planetariums are often used by educational facilities that have no fixed-based planetarium which tends to widen the outreach effect of their astronomy educators. Sue Reynolds of Syracuse, New York heads an International Planetarium Society committee which regularly collects and distributes tips and educational exercises to assist portable planetarium users in their efforts (Manning, 1995)

To understand the appeal the portable planetarium may have for students, we must consider how children develop and learn. All children wonder about the stars and planets. Children under the age of 5 or 6 observe and explain what they see in the skies in concrete and egocentric ways. Some common and clearly held beliefs are that the Moon follows the child; that the Sun exists to keep people warm; that when a cloud covers the Sun, the Sun is gone; and that stars exist only on one side of space (Cole & Mallon, 1987).

In a Norwegian educational experiment in 1991 (Urke & Laerarhogskule, 1993) (N=202), primary school students were taught astronomy using a STARLAB planetarium. The experimental group was compared with a control group (N=82) that had not had a planetarium lesson. When giving answers in a school test, the planetarium group based answers significantly on relevant real-world observations made with their own eyes.

The results, interpretations, conclusions, and implications of the experiment were as follows: 1) A planetarium visit is favorable when made in connection with an astronomy unit at school. 2) Girls seem to be more motivated than boys with planetarium teaching, and the planetarium education seems to do away with established gender roles. 3) Students with low and middle achievement on school tests and students with high achievement on school tests all seem to profit from teaching astronomy without a planetarium. 4) The planetarium lesson should be given in the middle of the unit.

The results from both main groups indicate that few students based their answers on authority or other sources (4% in both groups). Most students had an "official view." The Norwegian students who had a lesson with the planetarium used their knowledge significantly more often, and based their answers on their own experience of everyday events when answering the questions (12% in the no planetarium group and 34% in the planetarium group) (Urke & Laerarhogskule, 1993).

"Astronomers are concerned about astronomy education because it affects the recruitment and training of future astronomers. It also affects the awareness, understanding and appreciation of astronomy by the taxpayers who support us (Manning, 1995)." Astronomy has a wider educational and cultural significance, however, and most professional astronomers understand and support this. As our societies become more diverse and the modern world shrinks even further, it will continue to be important to learn about other cultures. Many cultures have inherited sky stories and most have important astronomical histories, and the planetarium will continue to facilitate their cultural needs. Astronomy is deeply rooted in almost every culture by virtue of its practical applications and its philosophical implications. "Astronomy shows us a universe that is vast, varied and beautiful; it shows our place in time and space, and gives us an improved cosmic perspective. It harnesses curiosity, imagination, and a sense of shared exploration and intellectual excitement" (Manning, 1995). It shows "how small our bodies, how large our minds" (Henri Poincare'). "It helps to advance physics and the other sciences by providing a cosmic laboratory with extreme environments (black holes). In its own right, it is one of the most rapidly moving sciences of our day. For all of these reasons, astronomy has the potential to increase public interest in science, and to attract young people to study science and engineering. It even provides an enjoyable hobby for millions of people" (Manning, 1995).

"Nothing can currently beat the planetarium in its ability to demonstrate basic astronomical principles and simulate the backyard sky. This will be of vital importance especially to school planetariums and planetarium with large student clientele. People still need to know the basics" (Manning, 1995).

Why, then, is astronomy so often the "poor cousin" in the school science curriculum? The same problem and issues seem to occur all over the world: (1) Few teachers, especially at the elementary level, have any training in astronomy. (2) Teachers think that astronomy must be technical and mathematical, and requires elaborate teaching equipment. (3) Simple, inexpensive, "hands-on" activities are needed-preferably ones which get around the problem that "the stars come out at night, the students don't." (4) Inappropriate teaching techniques fail to overcome students' ingrained misconceptions about physical and astronomical phenomena. (5) Many students, especially girls, are turned off to science at an early age. (6) Scientific illiteracy is widespread among students and the public (Percy, 1995).

Astronomy education involves the most abstract and complicated of ideas, concepts of time, space, and distances which are difficult even for adults to comprehend, let alone children. Earth does not seem to be spinning through space at 2000 km/hr.; instead the Sun appears to be moving across the sky. Astronomy education asks students to suspend belief in what they observe, to accept scientific explanations that seem to defy their experience (Cole & Mallon, 1987).

Young children are naturally interested in everything they see around them - soil, rocks, streams, rain, snow, clouds, rainbows, sun, moon, and stars. During the first years of school, they should be encouraged to observe closely the objects and materials in their environments, note their properties, distinguish one from another and develop their own explanations of how things become the way they are. As children become more familiar with their world, they can be guided to observe changes, including cyclic changes, such as night and day and the seasons; predictable trends, such as growth and decay; and less consistent changes, such as weather or the appearance of meteors. Children should have opportunities to observe rapid changes, such as the movement of water in a stream, as well as gradual changes, such as the erosion of soil and the change of the seasons (National Research Council, 1996).

Educators have long known that the essence of science and mathematics lies not in memorization of facts, but in an understanding of fundamental concepts and processes (Dewey, 1910). Schools and governments are working increasingly toward the integration of science and math and science disciplines to better prepare students for real world experiences (Manning, 1995). A recent Phi Delta Kappa Gallup Poll revealed that virtually the entire United States public believes that most students are capable of learning more math and science than they generally do (Elam, Rose, & Gallup, 1994). The advantage of the planetarium is that it can synthesize these disciplines, relating astronomy not only to mathematics and other sciences, but even to history, the arts, and language (Manning, 1995).

For technology use to grow in science and math, more teachers have to learn to use it in their classes. The Alabama School of Fine Arts science program is based on the principle of making science live through hands-on activities, the integrated study of related subjects, and the use of technology to facilitate discovery-based experiences (McCarthy, 1992). Activity-based programs will become increasingly important in meeting science curriculum objectives. People learn better by doing, and planetariums will be getting on board that bandwagon in greater numbers (Manning, 1995).

Questions to be Answered

The specific questions to be answered by this study were:

1. Do educators believe that the amount of training received in the use of STARLAB increases confidence in teaching astronomical concepts?
2. Do educators believe that after being trained in the use of STARLAB the amount of additional training is directly proportional to student learning?
3. Is the use of STARLAB effective in promoting students' interest in science?
4. Do educators believe that the use of STARLAB increases the use of hands-on activities in their classrooms?
5. Do educators believe that STARLAB is an effective teaching tool of technology compared to other tools of technology used in the classroom?

Definitions

Active users can be described as planetarium instructors who actively engage in planetarium lessons which result in significant student learning.

A portable planetarium is a small device capable of projecting star images onto a suspendable or inflatable dome and is easily transportable to fixed locations.

A fixed-base planetarium is a device capable of projecting star images onto a stationary dome and is permanently mounted in a special facility.

Outreach program includes educational experiences offered to students

Methodology

Subjects

The subjects of this study were STARLAB educators who have been identified by Learning Technologies, Inc., manufacturer of STARLAB, as active users. A total 3003 participants were surveyed, 90 percent of whom were from the United States and 10 percent from countries around the world.

Instrument

For this study, the STARLAB Educator's Survey was devised. The survey questions were drawn from the researcher's own experiences as a nationally recognized STARLAB educator and teacher trainer. The idea of conducting a STARLAB educator's survey was discussed on August 2, 1996 with Dr. Philip Sadler, Director of

Science Education at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. Dr. Sadler is the inventor of the STARLAB portable planetarium. The survey was validated by Dr. Philip Sadler, Alan Gould, Director of the Holt Planetarium at the Lawrence Hall of Science, University of California, Berkeley, John Erickson, Programs Representative at the Lawrence Hall of Science, University of California, Berkeley, and Dr. Joe Savoie, McNeese State University Professor of Administration and Supervision.

Procedure

STARLAB educators are located in all 50 states, Puerto Rico, and several countries around the world. In order to determine the number of subjects for this survey, Andrea Colby, Promotions Manager for Learning Technologies, Inc. sorted the company customer database to identify all active users of STARLAB. The subjects consisted of classroom teachers, planetarium directors, science consultants, museum educators, and private planetarium business owners.

A special mailing of the survey to STARLAB users in late December of 1996 was arranged and paid for by Learning Technologies, Inc. Return postage was provided except on foreign mailings. The deadline for returning responses was January 31, 1997.

Data Analysis

Of the 3003 surveys mailed, 755 surveys were received with 729 completed as requested. This constituted a 25% rate of return. A total of 26 surveys contained incomplete information and data, or arrived past the deadline for return. Respondents from 46 states returned surveys. One response came from Germany. The data were tabulated by computer to determine the percentages of item responses and possible correlation of selected variables.

Results

Table 1 contains the tabulation of gender for the 729 respondents. The data indicate there exists an approximately three to one ratio of female to male STARLAB educators.

TABLE 1 — GENDER OF RESPONDENTS

GENDER	NUMBER	PERCENTAGE
MALE	176	24.1
FEMALE	553	75.9
TOTAL	729	100.0

Table 2 presents data that indicate almost half of the respondent's ages fell within the 41-50 years category.

TABLE 2 — AGE OF RESPONDENTS

AGE	NUMBER	PERCENTAGE
30 and under	68	9.3
31-40	171	3.5
41-50	349	47.9
51-60	127	17.4
61 and over	14	1.9
TOTAL	729	100.0

The data presented in **Table 3** indicate an overwhelming majority of 613 (84.1%) respondents teach in public schools. Twenty-nine (4.0%) respondents work in other forms of educational services such as; educational service centers, and private or independently owned consulting firms.

TABLE 3 — TYPE OF TEACHING INSTITUTION

INSTITUTION	NUMBER	PERCENTAGE
Public school	613	84.1
College	7	1.0
Parochial school	18	2.5
Museum	39	5.3
Private school	9	1.2
Science institute	10	1.4
Junior College	4	.5
Other	29	4.0
TOTAL	729	100.0

Table 4 indicates that over half of the respondents (60.2%) are elementary teachers. Of a combined total of 85 respondents, 11 (1.5%) are private owners and offer a variety of educational services to schools on an independent contract basis. Only 32 (4.4%) of the respondents were secondary teachers.

TABLE 4 — TITLE THAT BEST DESCRIBES USERS OF STARLAB

TITLE	NUMBER	PERCENTAGE
Elementary teacher	439	60.2
Middle school teacher	111	15.2
Secondary teacher	32	4.4
University level teacher	4	.5
Planetarium director	24	3.3
Consultant	34	4.7
Private owner	11	1.5
Other	74	10.2
TOTAL	729	100.0

Respondents' years of teaching experience are shown in **Table 5**. The years of experience was evenly distributed between the categories of years. Very little difference exist between teachers with 6-10 years (18.9%) of experience and those with 25 years and over (18.7%).

TABLE 5 — TOTAL YEARS OF TEACHING EXPERIENCE

YEARS OF EXPERIENCE	NUMBER	PERCENTAGE
0-5	74	10.2
6-10	138	18.9
11-15	110	15.1
16-20	132	18.1
21-25	139	19.1
25 and over	136	18.7
TOTAL	729	100.0

Table 6 identifies the educator's years of experience using STARLAB. Six hundred-ninety (94.9%) of the respondents indicated having ten years or less experience. Only 37 (5.1%) of the respondents had eleven or more years of experience.

TABLE 6 — NUMBER OF YEARS EXPERIENCE USING STARLAB

YEARS	NUMBER	PERCENTAGE
0-5	490	67.4
6-10	200	27.5
11-15	29	4.0
over 15	8	1.1
TOTAL	727	100.0

Table 7 shows that the amount of respondent training in the use of STARLAB is fairly evenly distributed among amount categories. Of the 30 (4.1%) respondents with no training, several indicated they were self-trained by using the operator's manual. It is interesting to note that 398 (54.7%), over half of the respondents, have received two days of organized, instructor-led training or less. A total of 300 respondents (41.2%) have had three days of organized training or more.

TABLE 7 — AMOUNT OF STARLAB TRAINING RECEIVED

AMOUNT	NUMBER	PERCENTAGE
None	30	4.1
One day or less	198	27.2
	200	27.5
3-5 days	183	25.1
more than 5 days	117	16.1
TOTAL	728	100.0

Table 8 is a combination of Survey Items 8-18 and 24-27. All of these items contained the same choices for response.

The response in Survey Item 8 indicates that 632 (87%) respondents agreed or strongly agreed with the notion that the amount of training received in the use of STARLAB increase their ability to teach astronomy. This idea is strongly reinforced by the results of Survey Item 10. The results of Item 10 reveal that 672 (93%) respondents agreed or strongly agreed, that after they were trained in the use of STARLAB, astronomical concepts were easier for their students to understand. Data for Item 12 further support the notion that ability to teach astronomy increases with training. Six hundred-eighteen (86.3%) respondents agreed or strongly agreed that after being trained in the use of STARLAB their confidence in teaching astronomical concepts increased.

Data for Survey Item 9 indicate a lack of access to astronomical equipment, other than STARLAB, that assisted them in making astronomical concepts easier for their students to understand. Three hundred seventy-one (51.6%) respondents strongly disagreed or disagreed to having access to astronomical equipment other than STARLAB. Two hundred eighty-five (39.7%) respondents agreed or strongly agreed that they had access to astronomical equipment other than STARLAB.

Survey Items 13 and 14 suggest that educators using STARLAB tend to increase the amount of classroom hands-on astronomy activities in conjunction with using a STARLAB. Survey Item 13 suggest that 551 (76.2%) respondents agreed or strongly agreed that they used hands-on activities prior to their experiences with STARLAB. A slight increase was noticed in Survey Item 14 in which 608 (84.5%) respondents agreed or strongly agreed that the use of STARLAB increased the amount of classroom hands-on activities. This is an increase of only 8.8%. The strongly disagree to disagree responses reveal a greater increase in hands-on astronomy activities used in conjunction with STARLAB. One hundred twenty-three (17%) respondents infrequently used hands-on astronomy activities prior to their experiences with STARLAB. After being trained and having access to a STARLAB, the number of respondents who disagreed or strongly disagreed dropped to 63 (8.7%).

Survey Item 15 revealed that 548 (76.3%) respondents agreed or strongly agreed that the amount of educator training in the use of STARLAB is linked to student learning.

Survey Item 16 suggests that educators value STARLAB as an important tool of technology in the classroom. Five hundred forty-two (89.4%) agreed or strongly agreed that STARLAB was as conducive to student learning as other technologies used in the classroom. Of the 49 (6.8%) respondents that selected not applicable, many do not teach in a classroom and use STARLAB exclusively as private owners, a business, or as consultants.

Educators responded positively when asked in Survey Item 17 if they teach more astronomy and space sciences as a result of being able to use a STARLAB. Five hundred forty-nine (75.7%) respondents agreed or strongly agreed that they teach more.

Survey Item 18 revealed that 315 (44.4%) respondents strongly disagreed or disagreed that they had evaluated the effectiveness of STARLAB on student learning of astronomy concepts via pre/post or other assessment tools. Two hundred-seventeen (30.6%) respondents agreed or strongly agreed that they had assessed student learning. One hundred seventy-seven (25%) respondents selected not applicable. This response suggest that some respondents have not assessed their students or are not working in a teaching capacity that allows such an opportunity.

When asked about the ease of use compared to other technologies in Survey Item 25, 546 (76.3%) respondents agreed or strongly agreed that STARLAB was easy to use. Only 133 (18.6%) respondents disagreed or strongly disagreed that STARLAB was easy to use. Of the 36 (5.0%) respondents that selected not applicable, many had been recently been trained and had not yet used a STARLAB. A few respondents were supervisors or coordinators who do not actually use the STARLAB in the classroom.

Survey Items 26 and 27 revealed educator's thoughts about STARLAB's ability to generate student enthusiasm for science. A significant difference in the number of strongly agree responses can be seen between Item 26 and 27. One hundred fifty-two (21.2%) respondents indicated they strongly agreed that their students were enthusiastic about science before using STARLAB. After using STARLAB, 368 (52%) respondents voiced strong agreement that students' enthusiasm for science had increased.

TABLE 8 — PERCEPTIONS OF STARLAB TRAINING AND TEACHING

SD= STRONGLY DISAGREE D= DISAGREE A= AGREE SA= STRONGLY AGREE NA= NOT APPLICABLE

RESPONSES

	SD		D		A		SA		NA		TOTAL
SURVEY ITEMS	N	%	N	%	N	%	N	%	N	%	
8. I feel that the more training in the use of STARLAB I receive, the better prepared I am to teach astronomy.	32	4.4	38	5.2	237	32.6	395	54.4	24	3.3	726
9. I have access to astronomical equipment other than STARLAB that assists me in making astronomical concepts easier for my students to understand.	124	17.2	247	34.4	194	27.0	91	12.7	63	8.8	719
10. After being trained in the use of STARLAB, I found its capabilities helped make astronomical concepts easier for my students to understand.	9	1.2	11	1.5	302	41.8	370	51.2	30	4.2	722
11. Before being trained in the use of STARLAB, I felt confident in teaching astronomical concepts.	134	18.6	266	36.9	241	33.4	54	7.5	26	3.6	721
12. After being trained in the use of STARLAB, I felt confident in teaching astronomical concepts.	7	1.0	64	8.9	357	49.7	261	36.6	30	4.2	719
13. Before receiving STARLAB training and having the use of one, I used hands-on activities frequently in my classes.	20	2.8	103	14.2	297	41.1	254	35.1	49	6.8	723
14. After receiving STARLAB training and having the use of one, I used hands-on activities frequently in conjunction with STARLAB.	11	1.5	52	7.2	313	43.5	295	41.0	49	6.8	720

TABLE 8, (Continued)

	SD		D		A		SA		NA		TOTAL	
	N	%	N	%	N	%	N	%	N	%		
15. I feel that the amount of training I received the use of STARLAB is directly proportional to my students' learning.	27	3.8	101	14.0	342	47.6	206	28.7	43	6.0	719	in
16. After receiving training in the use of STARLAB, I find it as conducive to student learning as other technologies used in the classroom.	6	0.8	21	2.9	285	39.7	357	49.7	49	6.8	718	
17. As a result of being able to use a STARLAB, I teach more astronomy and space science.	15	2.1	101	13.9	267	36.8	282	38.9	60	8.3	725	
18. I have evaluated the effectiveness of STARLAB in student learning of astronomy concepts via pre/post or other assessment tools?	35	4.9	182	25.7	249	35.1	66	9.3	177	25.0	709	
24. Using STARLAB has increased the amount of interdisciplinary teaching I do.	17	2.4	201	28.4	330	46.6	60	8.5	100	14.1	708	
25. Compared to other technologies used in my classroom, I find STARLAB easy to use.	16	2.2	117	16.4	385	53.8	161	22.5	36	5.0	715	
26. My students were enthusiastic about science prior to using STARLAB.	5	0.7	60	8.4	454	63.3	152	21.2	46	6.4	717	
27. My students are enthusiastic about science since using STARLAB.	1	0.1	16	2.3	281	39.7	368	52.0	42	5.9	708	

The tabulation of responses for Survey Item 19 are shown in **Table 9**. Approximately one-half (49.8%) of the respondents indicated class sizes of between 21 and 25 students when teaching lessons in STARLAB. One hundred sixty-two (23%) of the respondents indicated having at or near the recommended student capacity of 30 when teaching lessons in STARLAB.

TABLE 9 — NUMBER OF STUDENTS PARTICIPATING IN EACH LESSON

STUDENTS	NUMBER	PERCENTAGE
0-5	6	0.9
6-10	6	0.9
11-15	28	4.0
16-20	110	15.6
21-25	351	49.8
26-30	162	23.0
31-35	42	6.0
TOTAL	705	100.0

The data in Survey Item 20 exhibit a wide range in the number of class periods devoted to using STARLAB for each lesson. Some respondents indicated that STARLAB lessons were incorporated into specific disciplines such as language arts or social studies; therefore with a limited number of class periods. Some educators employed at science centers or museums may teach more lessons than the normal six to seven class period day typically allows.

TABLE 10 — NUMBER OF CLASS PERIODS DEVOTED TO USING STARLAB EACH DAY

PERIODS	NUMBER	PERCENTAGE
1	95	14.6
2	68	10.4
3	49	7.5
4	74	11.4
5	114	17.5
6	140	21.5
7	43	6.6
8	30	4.6
MORE	38	5.8
TOTAL	651	100.0

Survey Item 21 asked for the number of days educators would like to use STARLAB. The respondent was to assume no barriers to using STARLAB existed. The number of days were quite varied. Four hundred (58%) of the respondents selected from one to ten days under ideal conditions. Two hundred eighty-nine (41.9%) respondents would use STARLAB for eleven days or more. The response tabulation is shown in **Table 11**.

TABLE 11 — HOW MANY DAYS WOULD YOU LIKE TO USE STARLAB?

DAYS	NUMBER	PERCENTAGE
1-5	182	26.4
6-10	218	31.6
11-15	105	15.2
15 days or more	184	26.7
TOTAL	689	100.0

Table 12 presents data concerning Survey Item 22 which solicited STARLAB educator's perceptions of discipline in the planetarium and classroom. Five hundred eighty-three (84.5%) respondents found discipline problems in STARLAB less than or the same as in the classroom.

TABLE 12 — DISCIPLINE IN STARLAB COMPARED TO THE CLASSROOM

PERCEPTION	NUMBER	PERCENTAGE
Less of a problem	227	32.9
The same	356	51.6
More of a problem	107	15.5
TOTAL	690	100.0

Survey Item 23 sought responses from STARLAB educators concerning the amount of mixing science with other subjects or interdisciplinary teaching they do. Four hundred-seven (64.8%) respondents indicated they mixed science with other subjects less than 50% of the time before having access to a STARLAB. Due to the interdisciplinary nature of STARLAB, 193 (30.7%) respondents claim they mixed science and other subjects more than 50% of the time but less than 100% of the time. Twenty-eight (4.5%) respondents were interdisciplinary teachers 100% of the time even before having access to a STARLAB. The results of the tabulation are shown in Table 13.

TABLE 13 — MIXED SCIENCE AND OTHER SUBJECTS BEFORE USING STARLAB

PERCENTAGE OF MIX	NUMBER	PERCENTAGE
Less than 25% of the time	206	32.8
More than 25%, less than 50%	201	32.0
More than 50%, less than 75%	120	19.1
More than 75%, less than 100%	73	11.6
100% of the time	28	4.5
TOTAL	628	100.0

Table 14 presents the frequency of occurrence of written responses by educators concerning the survey question, "What is the main value in using STARLAB in teaching?"

TABLE 14 — MAIN VALUE IN USING STARLAB

VALUE	NUMBER OF RESPONSES
Generates excitement, interest, motivation, enthusiasm, and fun	146
Teaching astronomical concepts	127
Provides more authentic and unique learning experiences	104
Makes abstract concepts more concrete and easier to understand	93
Promotes hands-on activities	67
Accurate depiction of the night sky	62
A visual learning tool	61
Multicultural experiences	30
Interdisciplinary capabilities	17
Fits easily in all subject areas / lessons	16
Simulation of classroom instruction	15
Makes learning relevant	9
Altered setting	8
Promotes learning	7
Promotes minds-on learning	5
Appeals to all modes of learning	5
Easy to use	2
Portability	2

The responses to this question underscore many of the areas already addressed in this study. Further research into areas mentioned above may need to be conducted in order to gain a stronger understanding of the educational benefits of using STARLAB.

Table 15 presents the frequency of occurrence of written responses by educators concerning the survey question, "What major difficulties do you encounter when using a STARLAB?"

TABLE 15 — MAJOR DIFFICULTIES ENCOUNTERED USING STARLAB

DIFFICULTY	NUMBER OF RESPONSES
Lack of space to setup STARLAB	152
Not enough time to use	93
Discipline problems	86
Scheduling	65
Setup / take-down cumbersome	52
Equipment problems (bulbs, fan, dome holes, etc.)	46
Not enough training	41
Physical challenges (sitting on floor, weight of equipment, claustrophobia)	35

Lack of user knowledge of astronomy	34
Lack of grade level activities	22
Noise level (fan noise, student noise)	19
Light pointer problems	18
Class size (in STARLAB)	17
Inappropriate ceiling height	14
Setting planet projectors and moon phases	8
Entering and exiting the dome	7
Rental fees too expensive	6
Keeping STARLAB secure	5
Motion sickness	2
No Milky Way projector	1
Lack of appropriate assessment	1

As with the previous question, the responses to this question underscore many of the areas already addressed in this study. Further research into areas mentioned above may need to be conducted in order to gain a stronger understanding of the educational benefits of using STARLAB.

Survey participants were asked to list the types of astronomical equipment available that assisted them in teaching concepts and making them easier for their students to understand. **Table 16** is a presentation of the compilation of all of the listed items and the frequency of occurrence.

TABLE 16 — TYPES OF EQUIPMENT USED TO ASSIST IN TEACHING ASTRONOMY

TYPE OF EQUIPMENT	NUMBER OF RESPONSES
Telescopes	113
Models (solar system, moon, mars, etc.)	47
Computers, software, CD-ROMS	47
Star maps and charts	44
Books	27
Access to a fixed planetarium	24
Video tape	19
Celestial spheres	17
Slides of astronomical objects	15
Spectroscopes	14
Posters	12
Laser Discs	9
Astronomical magazines	9
Binoculars	8
Small projectors (Star Theater, Nova)	8
Internet	7
Project STAR materials	7
ESCP materials	7
Special effects projectors (handmade)	7

Astrolabe	6
Styrofoam (moon ball) models	5
Large observatory	5
Solar filter for telescope	5
P.A.S.S. Volume	2
G.E.M.S. Activities	2
NASA activities	2
CCD camera	2
"The Universe at Your Fingertips"	2
Project ARIES materials	1
AASTRA materials	1
Visiting astronomer	1
T.O.P.S. activities	1
Project SPICA materials	1
Meteorites	1

It is clear to the reader that a wide variety of equipment is used to assist the teaching of astronomy. It is interesting to note that items such as resource materials (AASTRA, SPICA, ARIES, NASA, T.O.P.S.) are used less than items of greater cost.

Answering the Questions

Data generated by the chi square test of independence was used to determine if a relationship existed between variables in the five questions to be answered. Analysis of the findings for each question is discussed in the following section.

Question #1 — Do educators believe that the amount of training received in the use of STARLAB increases confidence in teaching astronomical concepts?

Yes. Survey Item 11 found that 397(55.4%) educators strongly disagreed or disagreed that they felt confident in teaching astronomical concepts before being trained in the use of STARLAB. Two hundred ninety-three (40.9%) respondents agreed or strongly agreed to being confident in teaching astronomical concepts before being trained in the use of STARLAB. When asked in Survey Item 12 if confidence increased after being trained in the use of STARLAB, 615 (85.9%) respondents agreed or strongly agreed that their confidence in teaching astronomical concepts after being trained in the use of STARLAB had increased. Only 71 (9.9%) respondents strongly disagreed or disagreed that their confidence level had increased after being trained.

The answer to research question one was yes. The variables of training and confidence showed a significant relationship (chi square = 315.69434). See Table 17 for data relating to this question.

TABLE 17 — CROSS TABULATION OF BEFORE TRAINING AND AFTER TRAINING CONFIDENCE IN TEACHING ASTRONOMICAL CONCEPTS

confidence after training

confidence before training

Count RowPct Col Pct Tot Pct	1.	2.	3.	4.	5.	Row Total
1.	4 3.0 57.1 0.6	20 14.9 31.3 2.8	74 55.2 20.9 10.3	35 26.1 13.4 4.9	1 0.7 3.3 0.1	134 18.7
2.	1 0.4 14.3 0.1	33 12.5 51.6 4.6	171 65.0 48.3 23.9	56 21.3 21.5 7.8	2 0.8 6.7 0.3	263 36.7
3.	1 0.4 14.3 0.1	7 2.9 10.9 1.0	102 42.5 28.8 14.2	121 50.4 46.4 16.9	9 3.8 30.0 1.3	240 33.5
4.	0 0.0 0.0 0.0	1 1.9 1.6 0.1	2 3.8 0.6 0.3	46 86.8 17.6 6.4	4 7.5 13.3 0.6	53 7.4
5.	1 3.8 14.3 0.1	3 11.5 4.7 0.4	5 19.2 1.4 0.7	3 11.5 1.1 0.4	14 53.8 46.7 2.0	26 3.6
Column Total	7 1.0	64 8.9	354 49.4	261 36.5	30 4.2	716 100.0

Question #2 — Do educators believe that after being trained in the use of STARLAB, the amount of additional training is directly proportional to student learning?

Yes. Survey Item 12 revealed that 614 (85.9%) respondents agreed or strongly agreed that after receiving training in the use of STARLAB confidence in teaching astronomical concepts increased. When asked in Survey Item 15 if students' learning increased proportionally to the amount of training a teacher receives, 545 (76.3%) respondents agreed or strongly agreed that the amount of training is proportional to student learning. One hundred twenty-seven (17.7%) respondents strongly disagreed or disagreed.

The answer to research question two was yes. The variables of training and proportionate learning showed a significant relationship (chi square = 196.82549). See Table 18 for data relating to this question.

TABLE 18 — CROSS TABULATION OF THE AMOUNT OF TEACHER TRAINING IN PROPORTION TO STUDENT LEARNING

amount of training in proportion to student learning

confidence after training

Count RowPct Col Pct Tot Pct	1.	2.	3.	4.	5.	Row Total
1.	1 5.0 9.1 0.1	2 10.0 4.0 0.3	10 50.0 3.2 1.4	6 30.0 2.0 0.8	1 5.0 2.0 0.1	20 2.8
2.	2 2.0 18.2 0.3	19 18.6 38.0 2.6	54 52.9 17.3 7.5	26 25.5 8.8 3.6	1 1.0 2.0 0.1	102 14.2
3.	3 1.0 27.3 0.4	19 6.4 38.0 2.6	184 62.2 59.0 25.7	81 27.4 27.5 11.3	9 3.0 18.4 1.3	296 41.3
4.	5 2.0 45.5 0.7	8 3.2 16.0 1.1	51 20.2 16.3 7.1	174 69.0 59.0 24.3	14 5.6 28.6 2.0	252 35.1
5.	0 0.0 0.0 0.0	2 4.3 4.0 0.3	13 27.7 4.2 1.8	8 17.0 2.7 1.1	24 51.1 49.0 3.3	47 6.6
Column Total	11 1.5	50 7.0	312 43.5	295 41.1	49 6.8	717 100.0

Question #3 — Is the use of STARLAB effective in promoting interest in science?

Yes. For Survey Item 26, 598 (84.6%) respondents agreed or strongly agreed their students were enthusiastic about science prior to using STARLAB. Sixty-five (9.2%) respondents strongly disagreed or disagreed to the notion that their students were enthusiastic. For Survey Item 27, 649 (91.8%) respondents agreed or strongly agreed that their students were enthusiastic about science since using STARLAB. Only 16 (2.2%) respondents disagreed or strongly disagreed their students were enthusiastic after using STARLAB.

The answer to research question three was yes. The variables of enthusiasm and using STARLAB showed a significant relationship (chi square = 599.19653). See Table 19 for data relating to this question.

TABLE 19 — CROSS TABULATION OF STUDENT ENTHUSIASM FOR SCIENCE PRIOR TO AND AFTER USING STARLAB

enthusiasm for science after STARLAB

enthusiasm for science prior to STARLAB

Count RowPct Col Pct Tot Pct	1.	2.	3.	4.	5.	Row Total
1.	1 20.0 100.0 0.1	1 20.0 6.7 0.1	0 0.0 0.0 0.0	3 60.0 0.8 0.4	0 0.0 0.0 0.0	5 0.7
2.	0 0.0 0.0 0.0	8 13.3 53.3 1.1	29 48.3 10.3 4.1	23 38.3 6.3 3.3	0 0.0 0.0 0.0	60 8.5
3.	0 0.0 0.0 0.0	4 0.9 26.7 0.6	231 51.6 82.2 32.7	204 45.5 55.4 28.9	9 2.0 21.4 1.3	448 63.4
4.	0 0.0 0.0 0.0	2 1.3 13.3 0.3	17 11.3 6.0 2.4	128 85.3 34.8 18.1	3 2.0 7.1 0.4	150 21.2
5.	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 9.1 1.4 0.6	10 22.7 2.7 1.4	30 68.2 71.4 4.2	44 6.2
Column Total	1 0.1	15 2.1	281 39.7	368 52.1	42 5.9	707 100.0

Question #4 — Do educators believe that the use of STARLAB increases the use of hands-on activities in their classrooms?

Yes. For Survey Item 13, 548 (76.4%) respondents used hands-on activities frequently in their classes before receiving STARLAB training and the use of one. One hundred twenty-two (17%) respondents strongly disagreed or disagreed that they used hands-on activities frequently. For Survey Item 14, 607 (84.6%) respondents used hands-on activities in conjunction with using STARLAB. Only 61 (8.5%) respondents disagreed or strongly disagreed that they used hands-on activities frequently in conjunction with using STARLAB.

The answer to research question four was yes. The variables of hands-on activities and using STARLAB showed a significant relationship (chi square = 310.51855). See Table 20 for data relating to this question.

TABLE 20 — CROSS TABULATION OF THE USE OF HANDS-ON ACTIVITIES BEFORE AND AFTER USING STARLAB

		hands-on activities in conjunction with STARLAB					
	Count RowPct Col Pct Tot Pct	1.	2.	3.	4.	5.	Row Total
hands-on activities before STARLAB	1.	1 5.0 9.1 0.1	2 10.0 4.0 0.3	10 50.0 3.2 1.4	6 30.0 2.0 0.8	1 5.0 2.0 0.1	20 2.8
	2.	2 2.0 18.2 0.3	19 18.6 38.0 2.6	54 52.9 17.3 7.5	26 25.5 8.8 3.6	1 1.0 2.0 0.1	102 14.2
	3.	3 1.0 27.3 0.4	19 6.4 38.0 2.6	184 62.2 59.0 25.7	81 27.4 27.5 11.3	9 3.0 18.4 1.3	296 41.3
	4.	5 2.0 45.5 0.7	8 3.2 16.0 1.1	51 20.2 16.3 7.1	174 69.0 59.0 24.3	14 5.6 28.6 2.0	252 35.1
	5.	0 0.0 0.0 0.0	2 4.3 4.0 0.3	13 27.7 4.2 1.8	8 17.0 2.7 1.1	24 51.1 49.0 3.3	47 6.6
	Column Total	11 1.5	50 7.0	312 43.5	295 41.1	49 6.8	717 100.0

Question #5: — Do educators believe that STARLAB is an effective teaching tool of technology compared to other tools of technology used in the classroom?

Yes. For Survey Item 16, 632 (89.6%) respondents find STARLAB as conducive to student learning as other technologies used in the classroom. Only 27 (3.9%) respondents strongly disagreed or disagreed. Survey Item 25 asked respondents if STARLAB was as easy to use as other classroom technologies. Four hundred thirty-six (76%) respondents agreed or strongly agreed that it was as easy to use. One hundred thirty-three (18.9%) respondents strongly disagreed or disagreed.

The answer to research question five was yes. The variables of STARLAB conducive to student learning and ease of use compared to other technologies showed a significant relationship (chi square = 204.59625). See Table 21 for data relating to this question.

TABLE 21 — CROSS TABULATION OF CONDUCIVENESS TO LEARNING AND EASE OF USE OF STARLAB COMPARED TO OTHER TECHNOLOGIES

ease of use

conducive to learning

Count RowPct Col Pct Tot Pct	1.	2.	3.	4.	5.	Row Total
1.	2 33.3 12.5 0.3	1 16.7 0.9 0.1	2 33.3 0.5 0.3	0 0.0 0.0 0.0	1 16.7 2.8 0.1	6 0.9
2.	2 9.5 12.5 0.3	11 52.4 9.4 1.6	8 38.1 2.1 1.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	21 3.0
3.	8 2.8 50.0 1.1	59 20.9 50.4 8.4	172 61.0 45.3 24.4	29 10.3 18.6 4.1	14 5.0 38.9 2.0	282 40.0
4.	3 0.9 18.8 0.4	40 11.4 34.2 5.7	184 52.6 48.4 26.1	118 33.7 75.6 16.7	5 1.4 13.9 0.7	350 49.6
5.	1 2.2 6.3 0.1	6 13.0 5.1 0.9	14 30.4 3.7 2.0	9 19.6 5.8 1.3	16 34.8 44.4 2.3	46 6.5
Column Total	16 2.3	117 16.6	380 53.9	156 22.1	36 5.1	705 100.0

Conclusions

The costly fixed-based planetarium has fallen victim to innovation. The portable planetarium has given educators an inexpensive alternative to improving student learning with astronomy as the central theme. Today over one-thousand STARLAB portable planetaria are being utilized in educational capacities on a daily basis.

Little research exists on the effectiveness of the portable planetarium as a tool of teaching and learning. What does exist, including the research done in this study, points to a number of significant educational benefits that school systems stand to gain by implementing the use of a cost-effective technological tool such as the STARLAB portable planetarium.

National reform movements in science education demand that students participate in experience learning situations that foster positive attitudes and perceptions about learning. Teachers must strive to make abstract concepts more concrete for their students which in turn promotes a better understanding of the real world.

The findings of this study indicate that there exists a three to one ratio of female STARLAB educators to male, most of which teach elementary grades (60.2%) in public schools (84.1%). Of the educators surveyed, 93% felt that after having completed training in the use of STARLAB, its capabilities made astronomical concepts easier for students to understand. It allows the learner to visually conceptualize abstract concepts and create relevant associations to scientific phenomena observed in the real world. When asked if additional training increased preparedness to teach astronomy, 87% of the educators agreed. Additionally, 89.4% of the educators responded positively when asked if the amount of training was proportionate to student learning. One can take this to mean that the more training teachers receive, the more student learning takes place. Educators (86%) surveyed felt that their own confidence in teaching astronomical concepts had increased. This is possibly due in part to the fact that many of today's educators received no formal training in astronomy at the college level. As a result of this improved level of confidence in teaching astronomical concepts, educator responses (84.5%) indicated an increase in hands-on activities conducted in their classrooms in conjunction with using STARLAB, and 75.7% teach more astronomy and space sciences.

When educators were asked about students' enthusiasm for science before and after the STARLAB experience, 91.7% agreed a significant increase in enthusiasm had resulted. Most notably was the increase from 21.2% who strongly agreed their students were enthusiastic about science before using STARLAB to 52% who strongly agreed their students were enthusiastic about science after using STARLAB.

One might suspect students' behavior to be different as a result of the altered classroom setting of STARLAB. A surprising 84.5% of the respondents indicated discipline in STARLAB to be less of a problem or the same as in the regular classroom.

When asked to compare STARLAB to other tools of technology used in the classroom, 76% of the educators applauded the ease of use and 89.6% found it to be as conducive to learning as other tools. One hundred-four educators stated in writing that STARLAB provided more authentic and unique learning experiences for their students than normally provided in a classroom setting. It was genuinely appreciated by most educators that the simplicity of use was designed by a teacher for teachers. The teaching versatility of STARLAB, due in part to interchangeable thematic projection cylinders of various subject matter, is no doubt a driving force behind its interdisciplinary teaching capabilities. Of the 720 educators responding to this survey item, 55.1% have increased the amount of interdisciplinary teaching they do as a result of the availability of a STARLAB.

When asked to indicate in writing the main value perceived in using STARLAB, 146 educators cited the generation of student excitement, interest, motivation, enthusiasm, and fun as most important. One hundred twenty-seven respondents stressed the ability of STARLAB to teach difficult astronomical concepts as the main value. Ninety-three respondents stated that the use of STARLAB makes astronomical concepts more concrete and easier for students to understand. Other positive comments were that the STARLAB environment promotes the use of hands-on activities, creates an accurate depiction of the night sky, is a visual learning tool, can be used in multicultural and interdisciplinary lessons, and is a useful tool in simulating classroom instruction.

Educators were asked to identify in writing the major difficulties encountered when using STARLAB. One hundred fifty-two respondents wrote that a lack of facility space to set up STARLAB was most troublesome. Ninety-three respondents indicated they were not allowed enough time to use STARLAB. Eighty-six respondents claimed discipline problems interfered with their use of STARLAB. Sixty-five respondents cited the logistics of scheduling the STARLAB as quite difficult. Many of these respondents found it difficult to make arrangements with co-workers for using or sharing facilities. It is interesting to note that a small number of respondents indicated problems with the mechanical operation of the STARLAB. Only 52 respondents found the setup and take-down of STARLAB to be cumbersome. Many of the respondents blamed their own physical limitations as part of the problem. Forty-six respondents had problems with projector lamps, bulbs, the fan, and holes in the STARLAB. The reader should understand that problems exist with most tools of technology and are virtually impossible to prevent. Other complaints expressed by respondents were the lack of training in the use of STARLAB, class size, lack of grade level STARLAB lessons, and the general lack of astronomical knowledge. Clearly one can rationalize from the above mentioned problems that STARLAB is seldom at fault and some of the circumstances identified were beyond the control of the STARLAB users.

When examining survey responses by states, the researcher found high numbers of responses from states known to have active STARLAB programs as well as highly trained specialists and institutions that offer in-depth training in the use of STARLAB. The top five states responding were Louisiana (138 respondents), Indiana (98 respondents), Minnesota (68 respondents), New York (49 respondents), and Georgia (46 respondents).

The purpose of this study was to identify educators' perceptions of the impact of the STARLAB planetarium on teaching and learning. This information as presented in the findings is substantial reason for school systems nationwide as well as worldwide to carefully study the educational benefits verified by the users of STARLAB.

Recommendations

The statistical information in this study could provide valuable support for any educator's proposal requesting funding support for the purchase of a STARLAB. With the results of this study, one could easily demonstrate the effectiveness of STARLAB as an important and viable teaching and learning tool that could generate student excitement and love for learning.

The results of this study support a recommendation that every school district or educational institution in Louisiana should give strong consideration to acquiring a STARLAB Planetarium. It is an extremely cost-effective purchase, especially when utilized in a shared capacity between district schools. Goals should be set to purchase more planetaria as funds come available to meet the needs of more populated school districts.

Finally, this study indicates the benefits of adequately preparing and training teachers involved with STARLAB and of providing follow-up training at various times during the school year. A program of support would be needed to supplement routine maintenance and provide needed accessory items. A district coordinator or supervisor should oversee the STARLAB program and coordinate scheduling of the planetarium as well as the routine up keep.

References

Chapman, S. (1994). Focus on Education. The Planetarian, 23(4), 29.

Cole, P. and Mallon, G. (1987). One Planetarium to Go. Science and Children. March.

Dewey, J. (1910). Science, 31(787), 121-127.

Elam, S.M., Rose, L.C. and Gallup, A.M. (1994). The 26th Annual Phi Delta Kappa Gallup Poll. Phi Delta Kappan, 76(1),51.

Friedman, A.J., Lowery, L.F., Pulos, S., Schatz, D., and Sneider, C.I., (1990). Planetarium Educator's Workshop Guide. Planetarium Activities for Student Success, 1, 3.

Manning, J.G. (1995) The Role of Planetariums in Astronomy Education. The Planetarian, 24(4), 5-8.

McCarthy, R., (1992). Four Sure-Fire Ways To Reach Math and Science Teachers. Electronic Learning, 12 (1), 9-15.

National Research Council (1996), National Science Education Standards. Washington D.C.: National Academy Press, p.130.

Percy, J. (1995). Astronomy Education: A Global Perspective. The Planetarian, 24(3), 6-9.

Rall, G.; and others. (1996). The M.A.P.S. '95 STARLAB Conference. The Planetarian, 25(1), 24-27.

Riordan, R. (1991). Planetarium Education: A Review of the Literature. The Planetarian, 20(3). 18-25.

Urke, T. and Laerarhogskule, V. (1993). Research on the Effects of Teaching Astronomy with a Planetarium. The Planetarian, 22(4), 19-20.