

THEMIS—TIME HISTORY of EVENTS and MACROSCALE INTERACTIONS during SUBSTORMS

February 2005 SSL Workshop

SUBMITTED—August 2005

BACKGROUND

Offered four times each year, the Space Sciences Laboratory (SSL) Teacher Professional Workshops represent a collaborative effort among the THEMIS E/PO team, the Sun-Earth Connection Education Forum at the University of California/Berkeley and other E/PO programs of NASA Missions. The overarching goal of these workshops is to provide professional development opportunities to teachers—most of whom come from California and many of whom teach minority children; particularly Chicanos.

Since the foremost aim of the THEMIS E/PO effort is to reach such underserved, minority children, the SSL workshops serve as an excellent forum for providing professional development opportunities to teachers working with minority students.

In February 2005, twenty-seven teachers attended the SSL Workshop. The session focused on the connection between the Sun and Earth's Magnetosphere and auroras and the way this connection influences human society. Data collected from the workshop participants indicate that the number of students reached by these teachers totaled almost 2,400. These teachers also reported that they would be sharing workshop materials and information with about 110 colleagues.

A total of 27 teachers attended the workshop, nearly reaching the goal of 30, which was also the room's capacity. Of the 27 teachers, 24 responded to a question regarding grade levels at which they currently teach. Some participants reported teaching at more than one grade level resulting in percentages totaling more than 100% in Figure 1.

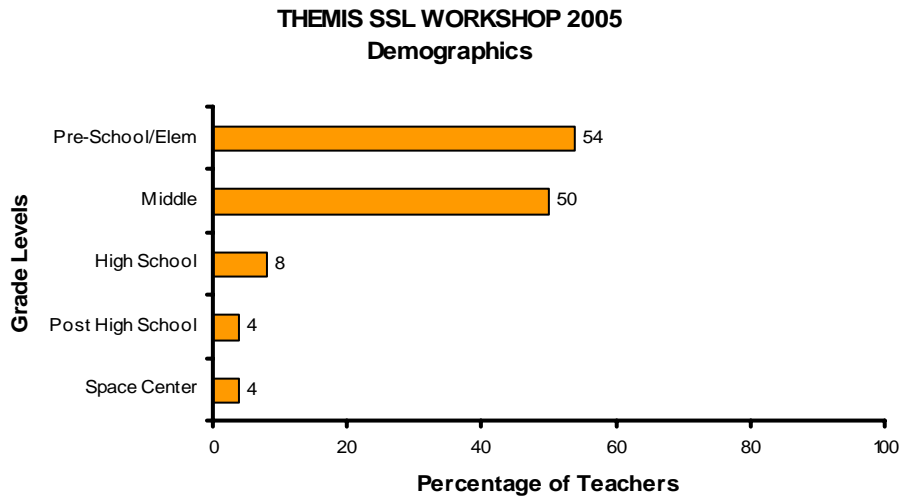


FIGURE 1. THEMIS SSL Workshop 2005—Demographics. Grade levels at which teachers currently teach (N=24).

More than half of the teachers are teaching in a pre-school/elementary school setting—Teachers reporting that they are teaching at the pre-school/elementary level represented 54% of the teachers responding.

Exactly half of the teachers reported teaching in middle schools—Of the teachers responding, 50% said they are teaching at the middle school level.

Nearly a fifth of the teachers are teaching in high schools, post-high school or a space center—
 Teachers reporting that they teach in a high school setting represented 8% of those responding with 4% reporting a post-high school setting and another 4% in a space center.

FINDINGS

At the end of the workshop, participating teachers were asked to complete a questionnaire that presented both quantitative, rating scale items and qualitative, open-ended queries. These questions covered the following areas...

- Understanding topics presented
- Lessons learned
- Anticipated use of materials
- Workshop likes and dislikes
- Additional comments

Teachers' responses to these questions are presented in the remainder of this document.

Understanding Workshop Topics

The end of workshop questionnaire asked participating teachers to use a 5-point scale to rate their understanding of five topics presented in the THEMIS workshop...

- Electromagnetism
- Sun
- Magnetic fields
- Reasons for the Seasons
- Earth's orbit

Teachers' mean responses are graphed in Figure 2. Teachers were asked to rate their understanding of these topics both 'before today' and 'after the workshop'. Clearly, the 'before today' question requires teachers to look retrospectively at what they felt their understanding or knowledge level was before the workshop. These responses are referred to in this section as 'start' of the day responses.

Responses reflecting the teachers' understanding 'after the workshop' are described here as 'end' of the day responses. These 'start' of the day and 'end' of the day descriptions are used in Figures 2 and 3.

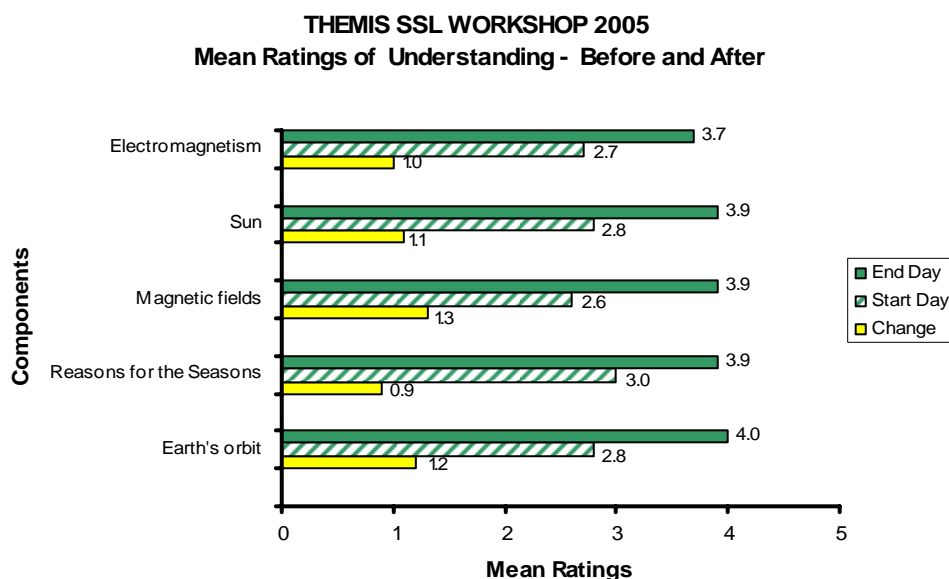


FIGURE 2. THEMIS SSL Workshop 2005—Mean Ratings of Understanding—Before and After. Mean ratings (5-point scale) for teachers' understanding of the topics presented at the THEMIS SSL Workshop 2005 before and after the workshop (N ranges from 21 to 24 across items).

Rating Scale Values Assigned

- 1=None
- 2=Novice
- 3=Intermediate
- 4=Advanced
- 5=Expert

Teachers rated their understanding of each of the topics very highly by the end of the workshop—The teachers' understanding of the topics at the end of the day (solid green bars) ranged from 3.7 (Electromagnetism) to 4.0 (Earth's Orbit). All these ratings are close to or at the 'advanced' level.

At the 'start' of the workshop, teachers rated their understanding of the topics at the intermediate range or below—At the start of the day (striped green bar), the teachers' understanding of the workshop topics ranged from 2.6 (Magnetic Fields) to 3.0 (Reasons for the Seasons). Given that 3.0 is the midpoint of a 5-point scale, teachers' ratings of their prior knowledge of workshop topics were all at or below this mid-point or 'intermediate' level.

Gains in teachers' knowledge on all topics were substantial—Across all workshop topics, teachers' ratings of their understanding increased anywhere from 0.9 of a rating scale point (Reasons for the Seasons) to 1.3 points (Magnetic Fields)—thus, making substantial progress in their knowledge on these subjects.

It is interesting to note that teachers made the most knowledge gains for Magnetic Fields—the topic in which they initially felt least knowledgeable. Conversely, they made the least gains for Reasons for the Seasons—the topic in which they initially felt most knowledgeable.

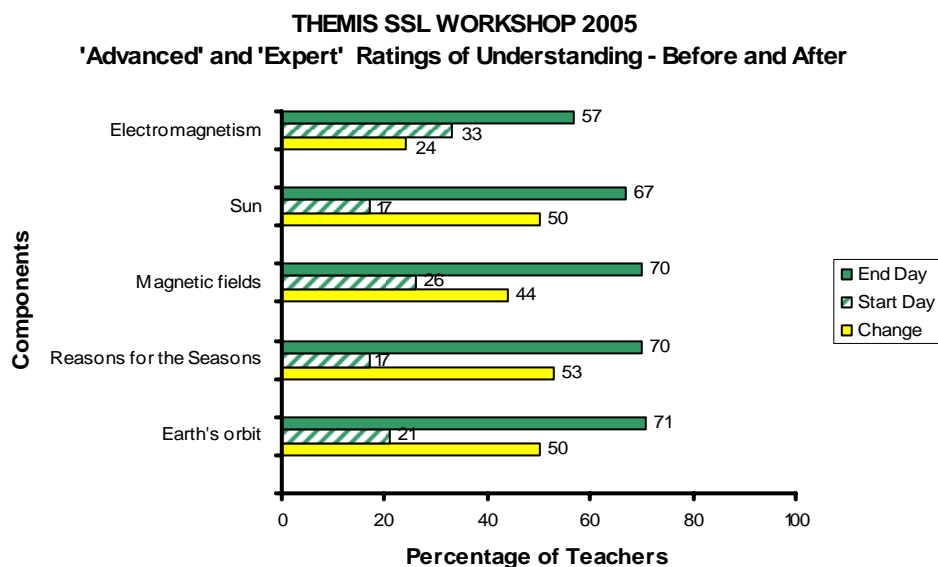


FIGURE 3. THEMIS SSL Workshop 2005—'Advanced' and 'Expert' Ratings of Understanding—Before and After. Percentage of 'Advanced' and 'Expert' ratings for components of the THEMIS SSL Workshop 2005 before and after the workshop (N ranges from 21 to 24).

Rating Scale Values Assigned

- 1=None
- 2=Novice
- 3=Intermediate
- 4=Advanced
- 5=Expert

At the end of the workshop, the great majority of teachers rated their understanding as 'advanced' or 'expert' for all workshop topics—By the end of the day (solid green bars), anywhere from 57% of the teachers (Electromagnetism) to 71% of the teachers (Earth's Orbit) rated themselves as either 'advanced' or 'expert' on workshop topics.

Prior to the workshop (striped green bars) these percentages ranged from 17% of the participants (Sun and Reasons for the Seasons) to 33% of the teachers (Electromagnetism).

The percentage of teachers rating their understanding of Reasons for the Seasons as 'advanced' or 'expert' increased most dramatically by the end of the workshop—Teachers rating their understanding of Reasons for the Seasons at the 'advanced' or 'expert' level at the start of the day (striped green bar) was among the lowest at 17%, but increased dramatically to 70% at the end of the day (solid green bar). This represented the greatest growth with an increase of 53%.

In sum, the fewest teachers considered themselves advanced/experts at the 'start' on Reasons for the Seasons, but by the 'end' of the workshop this topic had more advanced/experts than any other except Earth's Orbit.

Except for Electromagnetism, all other workshop topics—Earth's Orbit, Magnetic Fields and the Sun—followed a similar pattern, that is, these topics had a relatively low percentage of teachers considering themselves advanced/experts at the 'start', but by the 'end' of the workshop these topics sported a relatively large percentage of teachers who considered themselves advanced/experts. The percentage of change for these four topics range from 53% (Electromagnetism) to 44% for Magnetic Fields.

The percentage of teachers rating understanding of Electromagnetism as ‘advanced’ or ‘expert’ increased the least by the end of the workshop—A third of the teachers, 33%, rated their understanding of Electromagnetism at the ‘advanced’ or ‘expert’ level at the start of the day (striped green bar)—a higher percentage than for any of the other components. By the end of the day (solid green bar), however, only 24% more teachers rated their understanding at the ‘advanced’ or ‘expert’ level resulting in a final percentage of 57% for teachers with ‘advanced’ or ‘expert’ ratings.

In sum, the greatest percentage of teachers considered themselves advanced/experts at the ‘start’ of Electromagnetism, but by the ‘end’ of the workshop this topic had fewer advanced/experts than any other topic.

Lessons Learned

The end of workshop questionnaires presented open-ended queries asking participating teachers to list two things they learned in the workshop. Table 1 summarizes teachers’ comments.

These comments are clustered according to themes that emerged in a content analysis. For each thematic cluster, the percentage of teachers offering comments in that cluster is provided. Because teachers were asked to list at least two things learned and some listed as many as three, the percentage of teachers who provided responses totals more than 100%. Of the 27 teachers attending the workshop, 23 responded to this question.

THEMIS SSL WORKSHOP 2005 Things Learned in the Workshop	Teachers (N=23)
The Sun —Reasons for the sun’s features; I learned more detailed information about the Sun; the Sun is made up of gas; the Sun is very dynamic; how sunspots are formed; coronal mass ejections explained	52%
Magnetism/magnetosphere —Venus has no magnetic field; how the Earth’s magnetosphere works; magnetosphere on Earth; magnetism has different poles; I learned about what type of radiation enters the Earth’s magnetosphere	39
Auroras —I knew nothing about auroras until today; auroras—what they are and why they happen; auroras aren’t caused by solar wind directly	35
True nature of Earth/Sun orbits —Sun’s ‘ellipse’ is more circular in nature than I expected—this blew my mind; what elliptical rotation of the Earth really looks like; actual orbit of the Earth around the sun	35
Engaging teaching methods —Engaging meaningful way to teach about the Sun; how to make science fun and exciting for our students; how to work solar flares into a forensic science course	17
Relationship of the Earth and Sun —Earth/Sun scale; the size of Earth and Sun relationship; importance of the seasons	13

TABLE 1. THEMIS SSL Workshop 2005. Percentages of teachers offering various responses to an open-ended question about things they learned in the workshop (N=23).

A little more than half of the teachers cited learning about the Sun—Learning about the Sun was cited as one of the two things learned by 52% of the teachers. Confirming data in Figure 2 show that the mean rating for the teachers’ understanding of the Sun topic by the workshop’s end was one of the highest at 3.9 rating points with a 1.1 gain from their prior knowledge.

Nearly two-fifths of the teachers indicated they learned about Magnetism/Magnetometers—Learning about Magnetism/Magnetometers was cited by 39% of the teachers. Confirming data in Figure 2 reveal that the mean rating for the teachers' understanding of the Magnetic Fields topic was one of the highest at 3.9 rating points with a 1.3 gain from their prior knowledge—the highest increase across all topics.

Over one-third of the teachers mentioned both auroras and the true nature of Earth/Sun orbits—The topics of Auroras and the true nature of Earth/Sun orbits each drew 35% of the teachers' responses.

Engaging teaching methods and the relationship of the Earth and Sun drew the interest of the least number of teachers—Teachers mentioning 'engaging teaching methods' totaled 17% while 13% mentioned the relationship of the Earth and Sun.

Anticipated Use of Materials

The end of workshop questionnaires presented open-ended queries asking participating teachers to list the most useful classroom lessons presented in the workshop. Table 2 summarizes their comments.

These comments are clustered according to themes that emerged in a content analysis. For each thematic cluster, the percentage of teachers offering comments in that cluster is provided. Because teachers may have listed more than one 'useful lesson', the percentage of teachers who provided responses totals more than 100%. Of the 27 teachers attending the workshop, 24 provided responses to this question.

THEMIS SSL WORKSHOP 2005 Most Useful Classroom Lessons Presented in the Workshop	Teachers (N=24)
Sun information/activities —The Sun, solar eclipse; giant sun model; Tilted Earth—walking around room/pointing North Star, seeing how the earth rotates around Sun—could do this with really young children; the layers of the sun booklet (w/eclipse activity) looks good; Size/distance of Sun/Earth; Earth, moon, Sun comparison in size; the pizza sun is very easy and useful	54%
Reasons for the Seasons activities —All the Reasons for the Seasons activities; I'll definitely do some of the Reasons for Season activities; simulating the seasons by walking around the room	46
Magnets/magnetic fields activities —I liked the drawing of the magnetic field using bar magnets & clear magnets; tracing magnetic field; Magnets with compass & iron filings; magnetism with the compass arrows	42
UV sensitive beads —UV testing with beads: UV sensitive beads	17
Other information/activities —Making the book with different paints on the cover; I'll definitely use the CD's in both GEMS guides; fluorescent paints	13
Unsure how will use/not using —Not sure; not applicable for me but I will recommend to other teachers	8

TABLE 2. THEMIS SSL Workshop 2005. Percentages of teachers offering various responses to an open-ended question about the most useful classroom lessons presented in the workshop (N=24).

More than half of the teachers cited Sun information/activities as being the most useful classroom lessons presented—Information regarding the Sun and Sun activities were seen as the most useful classroom lessons by 54% of the teachers. This is nearly the same number of teachers (52%) who cited learning about the Sun (Table 1) as one of the two lessons learned.

More than two-fifths of the teachers cited either Reasons for the Seasons or Magnets/Magnetic fields activities as being the most useful—Large percentages of teachers mentioned Reasons for the Seasons (46%) and Magnets/Magnetic Fields activities (42%) as most useful classroom lessons.

Small percentages of the teachers found either UV sensitive beads or other information/activities to be the most useful lessons learned—UV sensitive beads were cited by 17% of the teachers as being the most useful classroom lessons presented, while 13% of the teachers cited other information or activities such as the CD's in the GEONS guides.

The smallest percentage of teachers indicated they were uncertain about using the classroom lessons—Only 8% of the teachers indicated that they were unsure if or how they might use the lessons.

In addition to this open-ended query about the usefulness of workshop materials, teachers were asked to use a 5-point scale to rate their intention to implement specific lessons in their classrooms. These materials included...

- Living with a Star
- Eye in the Sky
- Reasons for the Seasons
- Exploring Magnetism

Teachers' mean responses are graphed in Figure 3.

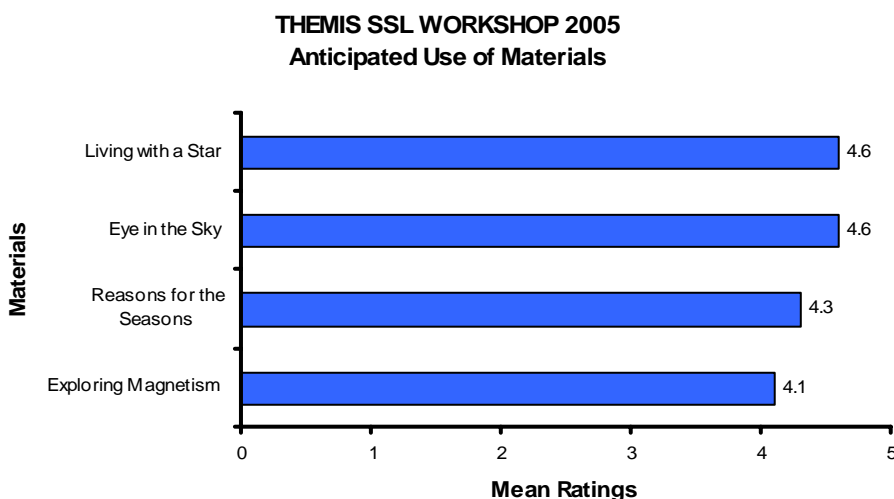


FIGURE 4. THEMIS SSL Workshop 2005—Anticipated Use of Materials. Mean ratings (5-point scale) for teachers' anticipated use of materials presented at the THEMIS SSL Workshop 2005 (N ranges from 14 to 22).

Rating Scale Values Assigned

- 1=Not likely
- 2=Somewhat likely
- 3=Likely
- 4=Very likely
- 5-With certainty

Teachers overwhelmingly agreed that they intended to use all lessons—On average, teachers' ratings of their intention to use these lessons ranged from 4.1 (Exploring Magnetism) to 4.6 (Living with a Star and Eye in the Sky). All these ratings land solidly between 'very likely' (4.0) and 'with certainty' (5.0).

In addition to examining mean ratings for intent to use these lessons, we also looked at the percentage of teachers rating each lesson with a '5.0'—meaning that they were certain to use the lesson. Figure 5 summarizes these percentages.

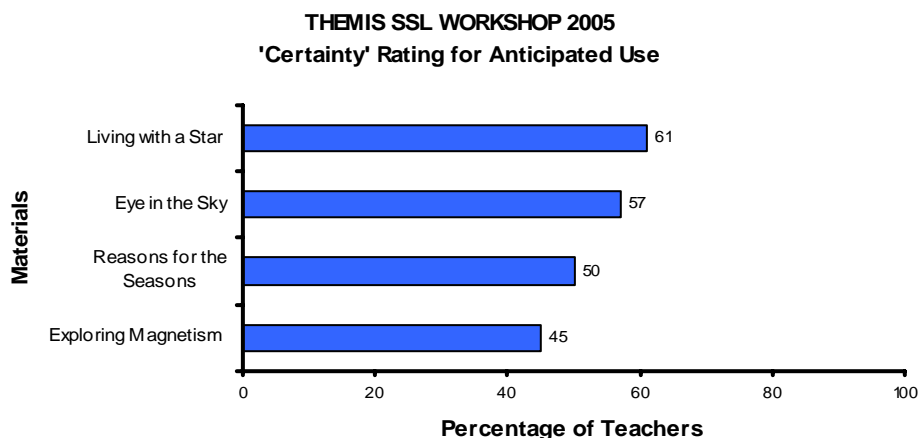


FIGURE 5. THEMIS SSL Workshop 2005—'Certainty' Rating for Anticipated Use. Percentage of 'with certainty' ratings for using materials from the THEMIS SSL Workshop 2005 (N ranges from 14 to 22).

Rating Scale Values Assigned

- 1=Not likely
- 2=Somewhat likely
- 3=Likely
- 4=Very likely
- 5-With certainty

Three-fifths of the teachers indicated 'with certainty' that they would use Living with a Star materials edging out Eye in the Sky by just a few percentage points—61% of the teachers indicated 'with certainty' that they would use Living with a Star, slightly more than 57% of the teachers who indicated 'with certainty' that they would use Eye in the Sky.

Half of the teachers said they would use Reasons for the Seasons materials 'with certainty'—Teachers indicating that they would use Reasons for the Seasons 'with certainty' represented exactly 50%.

Less than half of the teachers said they would use 'with certainty' Exploring Magnetism materials—Only 45% of the teachers said that they were certain to use the Exploring Magnetism lessons.

Ranking lessons with regard to intention to use—either by mean or percentage with 'certain' ratings—shows same pattern—Comparing Figures 4 and 5 shows the ranking of lessons with regard to intention to use—Figure 4 ranks lessons by mean ratings and Figure 5 orders lessons by percentage of 'certain' ratings. Both these patterns are the same with Living with a Star showing highest intent, then Eye in the Sky, then Reasons for the Seasons and finally Exploring Magnetism with the lowest intention for using.

In addition to rating the usefulness of workshop materials, teachers were asked to use the same 5-point scale to rate their intention to recommend specific lessons to their colleagues. These materials included...

- Living with a Star
- Eye in the Sky
- Reasons for the Seasons
- Exploring Magnetism

Teachers' mean responses are graphed in Figure 6.

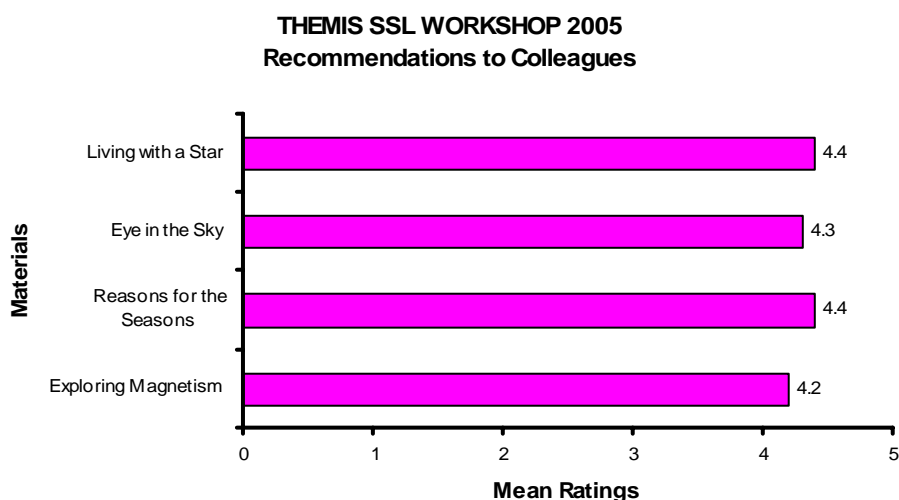


FIGURE 6. THEMIS SSL Workshop 2005—Recommendations to Colleagues. Mean ratings (5-point scale) for teachers' recommendations of material presented at the THEMIS SSL Workshop 2005 (N ranges from 15 to 24).

Rating Scale Values Assigned

- 1=Not likely
- 2=Somewhat likely
- 3=Likely
- 4=Very likely
- 5-With certainty

Teachers indicated that they are very likely to recommend all of the materials to their colleagues—The teachers' mean ratings for all of the materials ranged from 4.2 to 4.4, solidly between the 'very likely' (4.0) and 'with certainty' (5.0) ratings.

Teachers rated both Living with a Star and Reasons for the Seasons as being most likely to be recommended to their colleagues—Teachers gave their highest mean ratings for recommendations to colleagues to Living with a Star and Reasons for the Seasons—both at 4.4.

Teachers are slightly more likely to recommend Eye in the Sky materials than Exploring Magnetism to their colleagues—Teachers indicated they were slightly more likely to recommend Eye in the Sky, with a 4.3 mean rating, than Exploring Magnetism, with a 4.2 mean rating.

In addition to examining mean ratings for intent to recommend lessons to colleagues, we also looked at the percentage of teachers rating each lesson with a '5.0'—meaning that they were certain to share these lessons with their fellow teachers. Figure 7 summarizes these percentages.

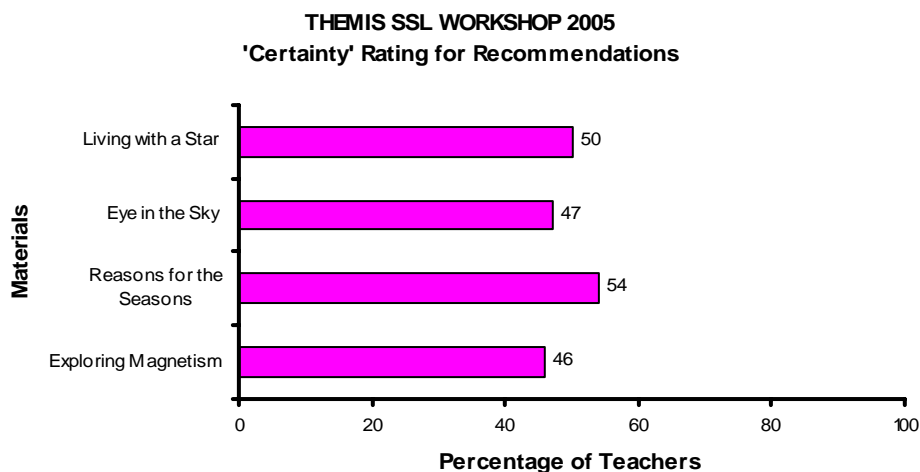


FIGURE 7. THEMIS SSL Workshop 2005—'Certainty' Rating for Recommendations. Percentage of 'with certainty' ratings for recommending materials from the THEMIS SSL Workshop 2005 (N ranges from 15 to 24).

Rating Scale Values Assigned

- 1=Not likely
- 2=Somewhat likely
- 3=Likely
- 4=Very likely
- 5-With certainty

Half or more of the teachers said they would recommend 'with certainty' Living with a Star and Reasons for the Seasons—54% of the teachers reported that they were certain to recommend Reasons for the Seasons lessons to their colleagues, while exactly 50% said that they were certain to encourage their fellow teachers to use Living with a Star.

Just under half of the teachers said they would recommend 'with certainty' Eye in the Sky and Exploring Magnetism materials to their colleagues—47% of the teachers indicated they would recommend Eye in Sky 'with certainty' and 46% said they were certain to encourage their colleagues to use Exploring Magnetism.

Ranking lessons with regard to intention to recommend—either by mean or percentage with 'certain' ratings—shows same pattern—Comparing Figures 6 and 7 shows the ranking of lessons with regard to intention to recommend—Figure 6 ranks lessons by mean ratings and Figure 7 orders lessons by percentage of 'certain' ratings. Both these patterns are the same with Reasons for the Seasons showing highest intent to recommend, then Living with a Star, then Eye in the Sky and finally Exploring Magnetism with the lowest intention for recommending.

This pattern of intention to recommend lessons (Figures 6 and 7) is not unlike the pattern for intention to use lessons (Figures 4 and 5).

Workshop Likes and Dislikes

The end of day questionnaires presented open-ended queries asking teachers to list what they most liked about each session. Table 3 summarizes teachers' comments.

These comments are clustered according to themes that emerged in a content analysis. For each thematic cluster, the percentage of teachers offering a comment in that cluster is provided. Multiple responses result in percentages totaling more than 100%. Of the 27 teachers attending, 24 provided responses to this question.

THEMIS SSL WORKSHOP 2005 MOST Liked about the Workshop	Teachers (N=24)
Good resource materials/lessons —Quality of materials; compass and magnetism activities; materials/handouts, information imparted; interactive lessons; getting lots of great resource materials (websites & stuff you will send later); lessons were great	38%
Hands-on activities —Hands-on activities; I liked going through each guide and experiencing the activity and what the supplies would look like (very important!); interactive lessons	33
Qualities of presenters/workshop structure —Enthusiasm of presenters; you presented info to us as adults but also explained how to make that info accessible to students; very knowledgeable presenters; it was well-balanced between clarification of concepts (for adults) and activities for kids	21
Presentations/demonstrations —The presentations about the Sun and aurora; the presentations and demonstrations on the topics; Sun UV presentations	17
Interactions with colleagues/experts —Getting together with like-minded people (the participants and the presenters); the experts; having the scientist to help	13
All aspects —Everything	4

TABLE 3. THEMIS SSL Workshop 2005. Percentages of teachers offering various responses to an open-ended question about what they most liked about the workshop (N=24).

Nearly two-fifths of the teachers liked the good resource materials/lessons from the workshop the most—Good resource materials/lessons presented were cited by 38% of the teachers as what they liked the most about the workshop.

A third of the teachers cited hands-on activities as what they most liked—The hands-on activities were cited by 33% of the teachers as what they most liked about the workshop.

About a fifth of the teachers cited either the qualities of the presenters/workshop structure or the presentations/demonstrations as what they most liked about the workshop—The presentations themselves were the subject of the most liked aspects of the workshop for 21% of the teachers who cited the qualities of presenters/workshop structure and 17% who cited the presentations and demonstrations about the Sun and auroras.

An eighth of the teachers liked the interactions with colleagues/experts the most—Teachers also appreciated the opportunity to interact with colleagues/experts with 13% of them citing it was what they liked the most about the workshop.

A small number of the teachers said they liked all aspects of the workshop— 4% of the teachers reported liking all aspects of the workshop.

The end of workshop questionnaires presented open-ended queries asking teachers to list what they least liked about each session. Table 4 summarizes teachers' comments.

These comments are clustered according to themes that emerged in a content analysis. For each thematic cluster, the percentage of teachers offering a comment in that cluster is provided. Due to rounding, percentages do not sum to exactly 100%. Of the 27 teachers attending, 17 teachers responded to this question.

THEMIS SSL WORKSHOP 2005 LEAST Liked about the Workshop	Teachers (N=17)
Comfort issues —The annex was crowded; it was a bit cold and the chairs were uncomfortable; kind of a climb to get to	29%
Time/ management issues —A little long; the presentations in the last part were too long; somewhat disorganized	24
Grade level issues —It was more geared toward the higher grades—I was interested in grade 3—it is easier for me to take a simple lesson and adapt to higher grades than adapt a high lever activity to younger students; sun session (primary/elementary) was useful, but needed more content at adult level despite being used in primary grades; some of the content was too much for my level; I wish there were more activities to use for lower grades	24
Communication issues —Not talking with Eye in the Sky people as well as learning about the star—have done Eye in the Sky and have some questions; tell the group you will give them notes about the Sun-Earth connection—I spent time furiously scribbling during the presentations	12
No issues —Really enjoyed it all; no issues	12

TABLE 4. THEMIS SSL Workshop 2005. Percentages of teachers offering various responses to an open-ended question about what they least liked about the workshop (N=17).

Nearly a third of the teachers cited comfort issues when asked what they least liked about the workshop—Comfort issues affecting the environment and the physical conditions within the workshop drew the comments of 29% of the teachers.

Nearly a quarter of the teachers cited either time/management issues or grade level issues as being the least liked aspects of the workshop—24% of the teachers commented on time/management issues stressing that the workshop was a bit long and in spots disorganized. Another 24% of the teachers felt that the level of the materials was too difficult for their students—remember that most of the teachers taught at the elementary/middle school level.

A little more than one-tenth of the teachers cited communication issues as the least liked aspect of the workshop—Various communication issues were cited as the least liked aspect of the workshop by 12% of the teachers—presenters need to let teachers know beforehand that notes will be provided; presenters need to answer questions about lessons.

A little more than one-tenth of the teachers had no issues with the workshop—12% of the teachers said that they had no issues with the workshop and really enjoyed it.

Additional Comments

Teachers were asked to share any additional comments they might have after the end of the workshop. Twenty-one of the 27 teachers shared their comments. Table 5 shows thematic clusters and percentages.

THEMIS SSL WORKSHOP 2005 Additional Comments from the Workshop	Teachers (N=21)
Positive comments —Thank you for all the materials; great workshop, well-paced; great workshop and great food; thanks for the handouts and supplies, I look especially forward to the CD-ROM's, DVD's and videos; presenters did a wonderful job of presenting without being condescending; you are all incredibly knowledgeable	81%
'Housekeeping' and procedural issues —Introduce workshop participants at the beginning; rearrange workshop rooms for maximum benefit; don't hand out or collect materials while presenters are talking; review focus of activity and desired outcomes before presenting	29
Structural issues/shorten or separate workshop sessions —It could be a tad bit shorter; maybe break it into two separate workshops for upper and lower grades, because I would have liked to spend more time on Eye in the Sky	10

TABLE 5. THEMIS SSL Workshop 2005. Percentages of teachers offering various responses to an open-ended question about additional comments from the workshop (N=21).

An overwhelming percentage of the teachers had positive comments about the workshop—When asked for additional comments, 81% of the teachers took the opportunity to share their positive comments about the experience.

Nearly a third of the teachers cited 'housekeeping' issues and procedural issues as needing attention for future workshops—29% of the teachers mentioned 'housekeeping' and procedural issues as needing attention for future workshops. These comments/suggestions ranged from when to introduce workshop participants and seating arrangements to how to handle materials and activities.

A tenth of the teachers commented on the structural issues/shortening or separating workshop sessions—Drawing the comments of 10% of the teachers were structural issues and calls for shortening or separating workshop sessions.