 Reported is a study of the development of a set of elementary school science teaching competencies with significant elementary school teacher input and of a comparison of ratings of elementary school teachers with science teacher educators on three scales: (1) when a competency should be taught, (2) what role the university should have in teaching a competency, and (3) how important the competency is to elementary science teaching. Competencies were generated and grouped and then rated by 14 elementary classroom teachers and 7 teacher educators. The responses of these two groups furnished the data base. Comparison of data was made using the Mann-Whitney U statistic. There were significant differences between the ratings of the two groups on 19 percent of the 230 competencies selected for items in the study. The items in this 19 percent group fell into the categories of Control, Materials, Inservice Opportunities, and Involvement of Students. In general, teacher educators rated inservice opportunities, child-centered activities, and use of material competencies higher than did the teachers. Teachers rated classroom control and organization of materials as being more important for science education than did the teacher educators. (Author/EB)
A Comparison of Ratings of Elementary Science Teaching Competencies by Teachers and Teacher Educators

A paper presented to The National Association for Research in Science Teaching

Forty-Eighth Annual Meeting Los Angeles, 1975

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The University of Michigan
A Comparison of Ratings of Elementary Science Teaching Competencies by Teachers and Teacher Educators

Carl F. Berger
The University of Michigan

The evaluations and assessment of competencies has two large components. The first is the evaluation of the competency itself, the second is the evaluation of students to find how well they have obtained the stated competency. This paper addresses the former.

The objectives of the inquiry were:

1) To develop a set of elementary school science teaching competencies with significant elementary school teacher input.

2) To compare the ratings of elementary school teachers with science teacher educators on two scales:
   A) when a competency should be attained.
   B) how important the competency is to elementary science teaching.

Under a grant from the Michigan State Department of Education, the University of Michigan in cooperation with the elementary school teachers in the Ann Arbor, Michigan, area developed a list of 230 competencies. The competencies were chosen as "Characteristics a competent elementary teacher should have in order to teach science."
Methodology and Design

Classroom teachers, administrators, and teacher educators gathered on a voluntary basis to write competencies. Of the 19 participants, 13 were elementary classroom teachers, 2 were administrators, and 4 were teacher educators. These competencies were grouped into ten categories which were: Philosophy of Teaching, Safety, Resources, Materials, Personal Education, Teaching Strategy, Assessment, Classroom Management, Curriculum, and Teaching Background.

To first evaluate the competencies, similar competencies from each group were edited to obtain a single competency statement. Then the competencies were ranked by the teachers as to importance for elementary science teaching and how much involvement the University of Michigan should have in developing the competency. Teachers rated the competencies from 1 to 7 in importance and from 1 to 4 in University involvement. The ratings of 14 teachers and 4 teacher educators were analyzed. Means and standard deviations were generated for all competencies. Competencies were removed if two conditions were met. The competency had to be rated less than average in importance and also be rated in the lower quartile for University involvement. Of the 230 competencies, 50 met both conditions and were considered for dropping. Analysis of those competencies considered for rejection indicated a difference in ratings between teachers and teacher educators. To find if the difference in rating was significant, data about the 230 competencies were run through the MIDAS computer program
system where a Man Whitney U Test was performed. The Man Whitney U Test was performed because it allows relaxation of parametric assumptions of normality necessary for a small N. Of the 230 competencies, 44 (approximately 20%) were significantly different at the $\alpha = .05$ level in either importance for science teaching or University of Michigan involvement. A list of the 44 competencies showing such differences is shown in Appendix I. Competencies which occurred on this list and were included in the list of 50 competencies which were selected for removal were reinstated for purposes of future research.

Independent consensus and editing was done during this time by assessment specialists. The project staff synthesized the products and further reduced the list to a final list of 143 competencies. This list may be found in Appendix II.

Data Sources

To explore differences between teachers and teacher educators as they ranked competencies, the sample was increased. The resulting data base consisted of 22 teachers and 18 teacher educators. Analysis of variance indicated that more differences occurred when 8 teachers in areas around Ann Arbor were included and 11 teacher educators not directly involved in science education were included. Differences in ratings occurred in 66 of 143 competencies (approximately 46%).

Of interest was the distribution of differences when compared to when a competency should be attained. Using
modes of the entire sample the competencies were categorized as to when the competency should be obtained. The categories and differences in ratings between teachers and teacher educators are shown in Table 1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Differences in Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Before entering an education program</td>
<td>40%</td>
</tr>
<tr>
<td>2) Initial field experience (observation)</td>
<td>30%</td>
</tr>
<tr>
<td>3) Undergraduate education courses.</td>
<td>45%</td>
</tr>
<tr>
<td>4) Student teaching.</td>
<td>41%</td>
</tr>
<tr>
<td>5) In-service experience.</td>
<td>73%</td>
</tr>
<tr>
<td>6) In-service workshops, professional meeting and education courses.</td>
<td>100%</td>
</tr>
</tbody>
</table>

The 66 competencies which indicated a difference in ratings between teachers and teacher educators are shown in Appendix III. Numbers appearing beside each competency indicate the category. The direction of difference is indicated by an asterisk beside each of those competencies rated as more important or should be attained earlier by teacher educators. Note that 25 of 33 competencies (75%) were rated as more important or should be attained earlier.
by teacher educators. Note also that 25 of 33 competencies (75%) were rated earlier by teacher educators.

Conclusions

As can be concluded from this preliminary research, large differences between ratings of teachers and teacher educators were found—teacher educators appear to attach less importance to classroom discipline and record-keeping and more importance to working with students. Teacher educators appear to believe that competencies should be attained earlier in the student's career.

Significance

The development of a model using teacher input in competency writing may be necessary to discover differences between groups which are extremely necessary in educating new teachers. The impact to a teacher program of differences between teachers in the field and teacher educators cannot be overstated. As an example, supervising teachers in the field may place a very important value on competencies which have received low or no value by teacher educators. Such differences in perception may create critical problems for student teachers who may not be aware of the source of such problems.

Finally, the differences found between teachers and teacher educators indicate that assessment of the competencies themselves is as important a task as assessing students' attainment of the tasks and should be included in any competency-based program.
References Cited


APPENDIX 1

COMPETENCIES WITH SIGNIFICANT DIFFERENCES
BETWEEN TEACHERS
AND
TEACHER EDUCATORS
1. Utilize free and inexpensive materials
2. Utilize process of measuring (metric)
3. Establish with children importance of applying science knowledge in C.
4. Select and involve community resources
5. Participate in inservice workshops
6. Relate science to daily life
7. Maintain room cleanliness and organization with children
8. Locate and evaluate new materials
9. Evaluate activity and reorganize when unsuccessful
10. Incorporate organization in preparation and arrangement of materials
11. Synthesize relevant material into the curriculum
12. Plan child-centered activities
13. Maintain effective classroom controls
14. Incorporate feedback from students
15. Respond to unexpected situations efficiently and with common sense
16. Prepare lesson plans and materials
17. Evaluate progress in goals with individual children and groups of chid
18. Design science materials from trash or junk
19. Demonstrate proper classroom care for living things
20. Recognize positive student information and share it with other teachers
21. Utilize measuring systems which are relevant to students
22. Use library resources of school or community
23. Provide atmosphere for respect
24. Utilize inservice training opportunities
25. Ask differing cognitive questions
26. Establish media center for individual research
27. Demonstrate ability to effectively communicate with various types of E.
28. Develop in students excitement and enthusiasm for science
29. Use a variety of classroom objectives
30. Visit other classrooms
31. Regain positive equilibrium after discouraging events
32. Develop lessons which relate to the students
33. Control experimental variables
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>36902</td>
<td>USE VARIETY OF AUDIO-VISUAL MATERIALS</td>
</tr>
<tr>
<td>37102</td>
<td>DESIGN REALISTIC TESTS AND WORKSHEETS</td>
</tr>
<tr>
<td>37201</td>
<td>SELECT COLLECTION MATERIALS CRITICALLY</td>
</tr>
<tr>
<td>37404</td>
<td>IDENTIFY VALUE FOR MAINTAINING LIVING THINGS IN THE CLASSROOM</td>
</tr>
<tr>
<td>39434</td>
<td>UTILIZE PROCESS OF HYPOTHESIS TESTING</td>
</tr>
<tr>
<td>39901</td>
<td>KEEP RECORDS OF MATERIALS</td>
</tr>
<tr>
<td>39802</td>
<td>PERFORM DEMONSTRATIONS</td>
</tr>
<tr>
<td>40423</td>
<td>FORMULATE ACCURATE UP-TO-DATE RECORDS OF STUDENT ACHIEVEMENT</td>
</tr>
<tr>
<td>40803</td>
<td>DEVELOP VOCABULARY OPERATIONAL (THROUGH USE)</td>
</tr>
<tr>
<td>41300</td>
<td>CONSTRUCT SIMPLE EQUIPMENT</td>
</tr>
<tr>
<td>41400</td>
<td>UTILIZE PROFESSIONAL JOURNALS FOR INSTRUCTION AND RESEARCH</td>
</tr>
</tbody>
</table>
APPENDIX II

MASTER LIST OF ELEMENTARY SCHOOL

SCIENCE TEACHING COMPETENCIES

BY CATEGORY
MASTER LIST OF ELEMENTARY SCHOOL SCIENCE TEACHING COMPETENCIES

BY CATEGORY

ACADEMIC BACKGROUND

193 DEMONSTRATE UNDERSTANDING OF CONSTANT CHANGE
197 DEMONSTRATE UNDERSTANDING OF ECOSYSTEMS
220 KNOW DEVELOPMENTAL STAGES
223 DEMONSTRATE ABILITY TO RESEARCH AND ORGANIZE FACTS
239 KNOW CONTENT ENOUGH TO RESPOND TO STUDENT QUESTIONS
252 KNOW METHODS OF SCIENTIFIC INQUIRY
257 KNOW MICHIGAN MINIMAL PERFORMANCE OBJECTIVES
277 DEMONSTRATE UNDERSTANDING OF SPACE AND TIME CONCEPTS
298 DEMONSTRATE UNDERSTANDING OF STRUCTURAL PATTERN CONCEPTS
* 309 DEMONSTRATE PROPER CLASSROOM CARE FOR LIVING THINGS
353 DEMONSTRATE UNDERSTANDING OF GEOLOGICAL CONCEPTS
375 UTILIZE LOGIC IN SCIENTIFIC INVESTIGATION
382 DEMONSTRATE UNDERSTANDING OF CONSERVATION OF MATTER AND ENERGY
387 DEMONSTRATE UNDERSTANDING OF INTERDEPENDENCE OF LIVING OBJECTS
399 DISCRIMINATE PROPERTIES OF LIVING AND NONLIVING OBJECTS AND CLASSIFY
405 DEMONSTRATE UNDERSTANDING OF ENERGY CONCEPTS
406 DEMONSTRATE UNDERSTANDING OF INTERACTION CONCEPTS

ASSESSMENT

189 EVALUATE APPROPRIATENESS OF MATERIALS AND ACTIVITIES RELATIVE TO THE CURRICULUM
210 EVALUATE SCIENCE PROGRAMS
230 EVALUATE LESSONS AND TEACHING PROCEDURES
* 240 EVALUATE ACTIVITY AND REORGANIZE WHEN UNSUCCESSFUL
250 ANALYZE SITUATION TO DETERMINE APPROPRIATE ASSESSMENT MODES
* 260 INCORPORATE FEEDBACK FROM STUDENTS AND PARENTS
273 GENERATE CONSTANT FEEDBACK TO STUDENTS
281 APPLY CONTINUOUS SELF-EVALUATION PROCEDURES
* 282 EVALUATE PROGRESS ON GOALS WITH INDIVIDUALS AND GROUPS
287 FORMULATE REALISTIC GROUP AND INDIVIDUAL EXPECTATIONS
292 EVALUATE USE OF MEDIA
356 EVALUATE INTERACTION OF SELF AND STUDENTS
367 INVOLVE CHILDREN IN SELF-EVALUATION
395 EVALUATE HOW WELL EACH CHILD'S NEEDS HAVE BEEN MET
* 396 KEEPER RECORDS OF MATERIALS
* 404 FORMULATE ACCURATE UP-TO-DATE RECORDS OF STUDENT ACHIEVEMENT

* Those competencies with significant differences in ratings among teachers and teacher educators.
CLASSROOM MANAGEMENT

191 DEMONSTRATE ABILITY TO MANAGE GROUPS OF VARIOUS SIZES
216 ORGANIZE CLASSROOM WITH CHILDREN TO PROVIDE LEARNING VARIETY
222 ESTABLISH A CREATIVE AND ATTRACTIVE LEARNING ENVIRONMENT
* 231 MAINTAIN ROOM CLEANLINESS AND ORGANIZATION WITH CHILDREN
233 FORMULATE ROUTINES AND CLASSROOM LIMITS WITH CHILDREN
* 258 MAINTAIN EFFECTIVE CLASSROOM DISCIPLINE
* 266 RESPOND TO UNEXPECTED SITUATIONS EFFICIENTLY AND WITH COMMON SENSE
288 ESTABLISH ENVIRONMENT TO ENCOURAGE ORGANIZATION AND SHARING
366 ESTABLISH AN OPEN, RELAXED CLASSROOM ENVIRONMENT
370 DEMONSTRATE SENSE OF FAIRNESS THROUGH CONSISTENCY
402 ESTABLISH CLASSROOM ENVIRONMENT WHICH DEVELOPS INDIVIDUAL LEARNING

CURRICULUM

* 187 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF MEASURING (METRIC)
192 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF COMMUNICATING
* 229 ADAPT MATERIAL RELATING TO DAILY LIFE INTO THE CURRICULUM
246 UTILIZE VARIOUS SUB-GROUPS OF SOCIETY AND OF THE LOCAL COMMUNITY
* 254 SYNTHESIZE RELEVANT MATERIAL INTO THE CURRICULUM
259 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF OBSERVING
284 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF INTERPRETING DATA
285 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF CLASSIFYING
286 SELECT CONTENT WITH SUFFICIENT DEPTH FOR MULTIPLE ACTIVITIES
289 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF PREDICTING
294 DEVELOP CONCEPT OF INTERRELATIONSHIP OF ORGANISMS AND THEIR ENVIRONMENT
* 313 UTILIZE MEASURING SYSTEMS WHICH ARE RELEVANT TO STUDENTS
334 DEVELOP AND USE CLEARLY DEFINED PERFORMANCE OBJECTIVES
363 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF RECORDING
* 378 PROVIDE GUIDANCE IN STUDENT MAINTENANCE OF ORGANISMS IN CLASSROOM
381 INCORPORATE READING AND MATH SKILLS
392 ESTABLISH CONTENT BACKGROUND APPROPRIATE TO TEACHING LEVEL
393 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF FORMULATING HYPOTHESIS
* 394 INVOLVE STUDENTS IN UTILIZING THE PROCESS OF HYPOTHESIS TESTING
MATERIALS

*105 UTILIZE FRFE AND INEXPENSIVE MATERIALS
*237 LOCATE AND EVALUATE NEW MATERIALS
243 SELECT AND USE APPROPRIATE MEDIA, MATERIALS, AND RESOURCES
*244 INCORPORATE ORGANIZATION IN PREPARATION AND ARRANGEMENT OF MATERIALS
263 PREPARE LIVING MATERIALS FOR CLASSROOM USE
276 OPERATE SCIENCE EQUIPMENT
*293 DESIGN SCIENCE MATERIALS FROM TRASH OR JUNK
303 USE RELEVANT PRINTED MATERIALS
323 MODIFY MATERIALS FOR CLASSROOM ACTIVITIES
*327 ESTABLISH MEDIA CENTER FOR INDIVIDUAL RESEARCH
332 CONSTRUCT AND CARE FOR AQUARIA AND TERRARIA
346 LOCATE SCIENCE EQUIPMENT SOURCES FOR A SPECIFIC CLASSROOM/TEACHER
357 FIND APPROPRIATE REFERENCE MATERIAL
*369 USE AND OPERATE A VARIETY OF AUDIO-VISUAL MATERIALS AND/OR EQUIPMENT
*372 SELECT COLLECTION MATERIALS CRITICALLY (E.G., ROCKS AND MINERALS)
385 PLAN AND ORGANIZE FOR USE OF MANIPULATIVE MATERIALS
390 USE A VARIETY OF MATERIALS
*413 CONSTRUCT SIMPLE EQUIPMENT

PERSONAL DEVELOPMENT (PUPIL OR TEACHER)

209 GUIDE CHILDREN IN MAKING REALISTIC GOALS AND CHOICES
214 EXPAND PROFICIENCY IN SCIENCE EDUCATION BEYOND PRESERVICE
*226 PARTICIPATE IN IN-SERVICE WORKSHOPS
290 ORGANIZE EXPERIENCES WHICH WILL GIVE CHILDREN POSITIVE RELATIONSHIPS
308 RECOGNIZE ASSET OF HUMOR AND UNPLANNED DISCOVERY IN CLASSROOM EXPERIENCE
*318 PROVIDE ATMOSPHERE FOR RESPECT
*320 UTILIZE IN-SERVICE TRAINING OPPORTUNITIES
326 DEVELOP CONTINUING INTEREST IN NEW SCIENCE FINDINGS
*329 DEMONSTRATE ABILITY TO EFFECTIVELY COMMUNICATE WITH VARIOUS PEOPLE
344 APPRECIATE VALUE IN STUDENT RESPONSE
*345 VISIT OTHER CLASSROOMS
*347 REGAIN POSITIVE EQUILIBRIUM AFTER DISCOURAGING EVENTS
354 DEMONSTRATE FOLLOW THROUGH ON COMMITMENTS
359 BE TACTFUL WITH STUDENTS
384 SHARE MUTUAL RESPECT FOR SELF AND OTHERS
397 RECOGNIZE INDIVIDUAL CHILD'S GOALS, STRENGTHS, WEAKNESSES, NEEDS

PHILOSOPHY

321 CREATE AN APPRECIATION FOR THE BEAUTY, WONDER AND OPENNESS OF SCIENCE
271 DISTINGUISH BETWEEN VALUE JUDGMENT AND POINT OF VIEW
RESOURCES

*212
SELECT AND INVOLVE COMMUNITY RESOURCES

232
USE STUDENTS AS RESOURCE

*315
USE LIBRARY RESOURCES OF SCHOOL OR COMMUNITY

324
USE ENVIRONMENT AS A SCIENCE LABORATORY

*414
USE PROFESSIONAL JOURNALS FOR INSTRUCTION AND RESEARCH

SAFETY

202
RECOGNIZE AND EVALUATE SAFETY HAZARDS IN EVERYDAY EXPERIENCES

251
USE SAFETY PROCEDURES IN SCIENCE EXPERIMENTS AND DEMONSTRATIONS

306
KNOW STATE AND SCHOOL SAFETY RULES

325
STRUCTURE ACCIDENT PROCEDURES FOR CHILDREN

333
DEVELOP SAFETY CONSCIOUSNESS IN THE STUDENTS

TEACHING STRATEGIES

186
UTILIZE GAMES AND SIMULATIONS

201
PLAN AND CONDUCT FIELD TRIPS

*204
ESTABLISH WITH CHILDREN IMPORTANCE OF APPLYING SCIENCE KNOWLEDGE

217
USE POSITIVE REINFORCEMENT TECHNIQUES

228
USE VARIOUS QUESTIONING TECHNIQUES, COGNITIVE AND AFFECTIVE

235
INCORPORATE SPONTANEOUS CLASSROOM CHANGES INTO LESSONS

*255
PLAN CHILD-CENTRED ACTIVITIES

261
PROVIDE FOR ACTIVE STUDENT PARTICIPATION AND DISCUSSION

264
PLAN ACTIVITIES APPROPRIATE TO AVAILABLE TIME

*268
PREPARE LESSON PLANS AND MATERIALS

275
USE INDUCTIVE AND DEDUCTIVE REASONING

279
USE STUDENT'S IDEA TO DEVELOP LOGICAL SOLUTION TO A PROBLEM

299
UTILIZE TEACHING BEHAVIORS WHICH MOTIVATE STUDENTS

300
DEVELOP QUESTIONING OF CONCLUSIONS

310
ASK QUESTIONS APPROPRIATE TO CONTENT AND AGE LEVEL

311
FORMULATE MEANINGFUL EXPERIENCE FROM EXPERIMENTAL FAILURE

314
INCORPORATE AN ATMOSPHERE OF SCIENTIFIC CURIOSITY AND CONDUCT

319
REFRAIN FROM FORCING CONCLUSIONS

*322
ASK DIFFERING COGNITIVE QUESTIONS

331
ESTABLISH OPEN-ENDED DISCUSSIONS

336
USE PUPIL-TEACHER AND PUPIL-PUPIL PLANNING

*337
DEVELOP IN STUDENTS EXCITEMENT AND ENTHUSIASM FOR SCIENCE

338
USE EXPERIMENTS WHICH UTILIZE THE SCIENTIFIC PROCESSES

343
PROVIDE INDIVIDUAL AND GROUP INSTRUCTION

*355
DEVELOP LESSONS WHICH RELATE TO THE STUDENTS

361
DEVELOP SELF-DIRECTED SMALL GROUPS

*368
CONTROL EXPERIMENTAL VARIABLES

373
PROVIDE A VARIETY OF LEARNING SITUATIONS

383
PROVIDE FOR FURTHER STUDENT INQUIRY

386
USE PROBLEM APPROACH

*398
PERFORM DEMONSTRATIONS

401
IMPLEMENT A VARIETY OF ACTIVITIES CONCURRENTLY

403
INVOLVE STUDENTS IN OPEN EXPLORATION

*408
DEVELOP VOCABULARY OPERATIONALLY (THROUGH USE)
COMPETENCIES IN WHICH THERE WERE SIGNIFICANT DIFFERENCES BETWEEN RATINGS OF TEACHERS AND TEACHER EDUCATORS
When the Competency should be First Attained

Before entering an education program

Develop concept of interrelationship of organisms and their environment. (1*)
Demonstrate ability to effectively communicate with various people. (1*)
Regain positive equilibrium after discouraging events. (1*)
Respond to unexpected situations efficiently and with common sense. (1-)

Initial field experience (observation)

Use library resources of school or community. (2*)

Undergraduate education courses

Use professional journals for instruction and research. (3-)

Student teaching

Use student's idea to develop logical solution to a problem. (4*)
Develop questioning of conclusions. (4-)
Guide children in making realistic goals and choices. (4*)
Involve students in utilizing the process of hypothesis testing. (4*)
Develop safety consciousness in the students. (4*)
Develop in students excitement and enthusiasm for science. (4-)
Develop lessons which relate to the students. (4*)
Involve students in utilizing the process of measuring (metric). (4*)
Control experimental variables. (4*)
Select and involve community resources. (4*)
Formulate accurate up-to-date records of student achievement. (4*)
Provide atmosphere for respect. (4-)
Establish open-ended discussions. (4*)
Use various questioning techniques, cognitive and affective. (4*)
Formulate meaningful experience from experimental failure. (4-)
Incorporate spontaneous classroom changes into lessons. (4*)
 Demonstrate proper classroom care for living things. (4*)
Provide guidance in student maintenance of organisms in classroom. (4*)

In-service experience

Establish with children importance of applying science knowledge. (5*)
Structure accident procedures for children. (5*)
Locate science equipment sources for a specific classroom/teacher. (5*)
Utilize various sub-groups of society and of the local community when planning instruction. (5*)
Adapt materials relating to daily life into the curriculum. (5-)
Analyze situation to determine appropriate assessment modes. (5*)
In-service experience con't.

Apply continuous self-evaluation procedures. (5*)
Establish media center for individual research. (5-)

In-service workshops, professional meetings and education courses

Develop continuing interest in new science findings. (6*)
Competencies in which there were Significant Differences between Ratings of Teachers and Teacher Educators

**Importance for Science Teaching**

**Before entering an education program**
- Recognize and evaluate safety hazards in everyday experiences. (1*)
- Demonstrate follow through on commitments. (1*)
- Share mutual respect for self and others. (1*)
- Distinguish between value judgment and point of view. (1*)
- Know methods of scientific inquiry. (1*)

**Initial field experience (observation)**
- Utilize free and inexpensive materials. (2*)
- Visit other classrooms. (2*)

**Undergraduate education courses.**
- Plan child-centered activities. (3*)
- Select collection materials critically (e.g., rocks and minerals). (3*)
- Design science materials from trash or junk. (3*)
- Incorporate organization in preparation and arrangement of materials. (3-)
- Construct simple equipment. (3*)
- Use problem approach. (3*)
- Use and operate a variety of audio-visual materials and/or equipment. (3-)
- Prepare lesson plans and materials. (3*)
- Locate and evaluate new materials. (3*)

**Student teaching**
- Maintain effective classroom discipline. (4-)
- Perform demonstrations. (4-)
- Maintain room cleanliness and organization with children. (4-)
- Evaluate progress on goals with individuals and groups. (4*)
- Utilize measuring systems which are relevant to students. (4*)
- Construct and care for aquaria and terraria. (4*)
- Evaluate activity and reorganize when unsuccessful. (4-)
- Develop vocabulary operationally (through use). (4-)
- Ask differing cognitive questions. (4*)

**In-service experience**
- Keep records of materials. (5-)
- Incorporate feedback from students and parents. (5*)
- Synthesize relevant material into the curriculum. (5*)
In-service workshops, professional meetings and education courses

Participate in in-service workshops. (6*)
Utilize in-service training opportunities. (6*)
Expand proficiency in science education beyond pre-service. (6*)