STANDARDS-BASED TEACHING AND EDUCATIONAL DIGITAL LIBRARIES AS INNOVATIONS: UNDERGRADUATE SCIENCE FACULTY IN THE ADOPTION PROCESS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for

the Degree of Doctor of Philosophy in the

Graduate School of The Ohio State University

By

Judith Sulkes Ridgway, M.S.

*****

The Ohio State University
2005

Dissertation Committee

Professor Donna F. Berlin, Adviser

Professor Arthur L. White

Professor Stephen Acker

Approved by

______________________________

Adviser

College of Education
ABSTRACT

This study describes undergraduate science faculty in terms of their feelings of preparedness for and their use of standards-based teaching methods, their stages of concern related to Educational Digital Libraries (EDLs), and their adoption and diffusion of both innovations. These innovations may have a synergistic relationship that may result in enhanced adoption of both.

The investigation began with a series of group meetings with life science, chemistry, physics, and geology faculty from a 2-year and a 4-year institution. Faculty were introduced to dimensions of standards-based teaching and examples of EDLs. Faculty completed the Demographics and Experience Questionnaire, the Standards-Based Teaching Instrument, and the Stages of Concern Questionnaire (SoCQ). Semi-structured interviews containing literature-based questions were conducted with one faculty member from each discipline from the 2-year and 4-year institutions. Document analyses were performed on mission/goal web-based statements for the institutions and their science departments.

Triangulated data were used to construct individual faculty case studies based on four facets: background, standards-based teaching profile, EDLs profile, and rate of innovation diffusion. The individual case studies were used to perform cross-case analyses by type of institution, discipline, and locus of control.

Individual case studies and cross-case analyses suggest the following conclusions: (a) faculty felt prepared to use and frequently used textbooks as a reference, (b) feelings of preparedness and frequency of use of standards-based teaching categories may be related
to discipline, (c) all faculty had relatively high awareness and informational EDL concerns, and (d) faculty central to the locus of control were more likely to use methods to develop student conceptual understanding, use inquiry methods, and be agents of change. A grounded theoretical model connects study results with literature related to educational change and innovation adoption. The model suggests undergraduate science faculty professional developers and innovation developers should establish a shared understanding of vocabulary related to innovations, conduct national innovation awareness and informational campaigns, consider faculty pre-existing understanding of the innovations, align with organizational norms, and clarify the relationship between institutional mission/goal statements and the innovations. The study protocols and instruments may be valuable tools for others studying educational change and innovations.
Dedicated to Dick, Katie, and Billy,

who fill my heart with love and life with beauty.
ACKNOWLEDGMENTS

I wish to thank my adviser, Donna Berlin, who has been unwavering in her role as a mentor and guide. With her patience, enthusiasm, and insight, she helped me progress along the apprenticeship continuum from novice to expert. I could not have asked for a more dedicated or caring role model. Thanks also go to the other members of my committee, Drs. Arthur L. White and Stephen Acker, for their ongoing encouragement and advice.

I am grateful to the eight science faculty members who made this research possible by repeatedly volunteering their time and participating in discussions about science teaching and digital libraries. Their contribution will give others a chance to better understand science faculty.

I thank Kimberly S. Lightle for opening the door to the NSDL community, providing opportunities for professional growth, and helping me to think in ways I could have never imagined.

Finally, I would like to thank my family and friends, who helped me remember what was important, supported me with love and humor, and helped me keep in mind Paul Vellom’s advice to take it bird by bird.
VITA

March 16, 1957 .................................................. Born - East Liverpool, Ohio, USA

1979 .......................................................... B.S. Zoology, The University of Michigan

1982 .......................................................... M.S. Zoology, The Ohio State University

1984 – 1999 ............................................. Adjunct Faculty, Columbus State Community College

1999 – 2000 ................................................ Graduate Research Associate, Eisenhower National Clearinghouse (ENC), Columbus, OH

2000 – 2001 ................................................ Senior Science Abstractor, Eisenhower National Clearinghouse (ENC) Columbus, OH

2001 – 2005 ................................................ Assistant Director, Eisenhower National Clearinghouse (ENC) Columbus, OH

2005 – Present ........................................... Instructional Development Specialist, The Ohio State University, Columbus, OH

PUBLICATIONS


FIELDS OF STUDY

Major Field: Education

Special Area: Science Education
TABLE OF CONTENTS

Abstract ............................................................................................................................ ii
Dedication ........................................................................................................................ iv
Acknowledgments .......................................................................................................... v
Vita ................................................................................................................................... vi
List of Tables ................................................................................................................... xvi
List of Figures .................................................................................................................. xix

Chapters: 

1 The Problem ............................................................................................................. 1
   Background .............................................................................................................. 1
   Nature of the Problem .............................................................................................. 3
   Statement of the Problem ......................................................................................... 7
   Significance of the Study .......................................................................................... 7
   Methodology ............................................................................................................. 8
      Participants ........................................................................................................... 8
      Data Collection ..................................................................................................... 9
      Data Analyses ....................................................................................................... 11
   Definition of Terms ............................................................................................... 12

vii
Inquiry Approach

Reflective Teaching Practices

Environment Focused on Learning

Teachers as Active Participants in Systemic Planning

Obstacles to Adoption of Standards-Based Teaching

Lack of Systemic Support

Comfort Using Traditional Methods

Science Faculty Habits of Mind

Training in Science, Not Necessarily Science Education

Support for Adoption of Standards-Based Teaching

Characteristics of the Undergraduate Science Faculty Social System

Administration Participation

Faculty as Agents of Change

Teaching as a Focus for Employment and Faculty Rewards

Faculty Discussion and Collaboration About Teaching-Related Issues

Professional Development Initiatives

Educational Digital Libraries (EDLs)

Examples of Educational Digital Libraries

Multimedia Educational Resource for Learning and Online Teaching (MERLOT)

Digital Library for Earth Systems Education (DLESE)

MathDL
Committee for Physics and Astronomy Digital Resources in Education (comPADRE) 48
BiosciEdNet (BEN) 49
The MicrobeLibrary 49
The Learning Matrix 50
iLumina 50
The Virtual Skeletons Project 51
National Science Digital Library (NSDL) 51
Technology Support of Education 54
Previous Evaluation of Digital Libraries 56
Summary 59

3 Methodology 61
Introduction 61
Methodology Selection 62
The Study Sample 64
Study Tools and Protocols 67
The Researcher as Research Tool 67
Surveys 70
Demographics and Experience Questionnaire 70
Standards-Based Teaching Instrument 70
Stages of Concern Questionnaire (SoCQ) 72
Group Meetings 76
Semi-Structured Interviews 79
Document Analyses ................................................................................................. 83

Analyses of the Data ............................................................................................... 84

Surveys .................................................................................................................... 85

Demographics and Experience Questionnaire ............................................. 85

Standards-Based Teaching Instrument ......................................................... 85

Stages of Concern Questionnaire (SoCQ) ..................................................... 90

Semi-Structured Interviews ........................................................................ 93

Document Analyses ............................................................................................... 94

Trustworthiness and Authenticity ................................................................. 96

Credibility .............................................................................................................. 96

Transferability ....................................................................................................... 97

Dependability ....................................................................................................... 98

Confirmability ......................................................................................................... 99

Utilization ............................................................................................................ 100

Limitations ....................................................................................................... 101

4 Individual Case-Study Analyses ................................................................. 104

Structure of the Case Descriptions ............................................................... 104

Cases at 2-Year Institution .............................................................................. 106

Life Science Faculty at the 2-Year Institution (LS-2) .................................... 106

   LS-2 Background ......................................................................................... 106

   LS-2 Standards-Based Teaching Profile ............................................... 108

   LS-2 EDLs Profile ....................................................................................... 114

   LS-2 Rate of Innovation Diffusion ....................................................... 116
<table>
<thead>
<tr>
<th>Department</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry Faculty at the 2-Year Institution (Chem-2)</td>
<td>120</td>
</tr>
<tr>
<td>Chem-2 Background</td>
<td>120</td>
</tr>
<tr>
<td>Chem-2 Standards-Based Teaching Profile</td>
<td>120</td>
</tr>
<tr>
<td>Chem-2 EDLs Profile</td>
<td>126</td>
</tr>
<tr>
<td>Chem-2 Rate of Innovation Diffusion</td>
<td>129</td>
</tr>
<tr>
<td>Physics Faculty at the 2-Year Institution (Phys-2)</td>
<td>131</td>
</tr>
<tr>
<td>Phys-2 Background</td>
<td>131</td>
</tr>
<tr>
<td>Phys-2 Standards-Based Teaching Profile</td>
<td>132</td>
</tr>
<tr>
<td>Phys-2 EDLs Profile</td>
<td>138</td>
</tr>
<tr>
<td>Phys-2 Rate of Innovation Diffusion</td>
<td>141</td>
</tr>
<tr>
<td>Geology Faculty at the 2-Year Institution (Geo-2)</td>
<td>143</td>
</tr>
<tr>
<td>Geo-2 Background</td>
<td>143</td>
</tr>
<tr>
<td>Geo-2 Standards-Based Teaching Profile</td>
<td>144</td>
</tr>
<tr>
<td>Geo-2 EDLs Profile</td>
<td>149</td>
</tr>
<tr>
<td>Geo-2 Rate of Innovation Diffusion</td>
<td>151</td>
</tr>
<tr>
<td>Cases at 4-Year Institution</td>
<td>153</td>
</tr>
<tr>
<td>Life Science Faculty at the 4-Year Institution (LS-4)</td>
<td>154</td>
</tr>
<tr>
<td>LS-4 Background</td>
<td>154</td>
</tr>
<tr>
<td>LS-4 Standards-Based Teaching Profile</td>
<td>155</td>
</tr>
<tr>
<td>LS-4 EDLs Profile</td>
<td>161</td>
</tr>
<tr>
<td>LS-4 Rate of Innovation Diffusion</td>
<td>164</td>
</tr>
<tr>
<td>Chemistry Faculty at the 4-Year Institution (Chem-4)</td>
<td>167</td>
</tr>
<tr>
<td>Chem-4 Background</td>
<td>167</td>
</tr>
</tbody>
</table>
# Appendices:

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sample E-Mail to Chairpersons</td>
<td>289</td>
</tr>
<tr>
<td>B</td>
<td>Sample E-Mail Invitation to Group Meeting</td>
<td>291</td>
</tr>
<tr>
<td>C</td>
<td>Demographics and Experience Questionnaire</td>
<td>293</td>
</tr>
<tr>
<td>D</td>
<td>Standards-Based Teaching Instrument</td>
<td>295</td>
</tr>
<tr>
<td>E</td>
<td>Stages of Concern Questionnaire (SoCQ)</td>
<td>302</td>
</tr>
<tr>
<td>F</td>
<td>Semi-Structured Interview Data Rubric</td>
<td>307</td>
</tr>
</tbody>
</table>
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Stages of concern: Typical expressions of concern about the innovation</td>
<td>26</td>
</tr>
<tr>
<td>2.2</td>
<td>A comparison of traditional and constructivist classrooms</td>
<td>34</td>
</tr>
<tr>
<td>3.1</td>
<td>Number of participants in group meetings identified by type of institution and discipline</td>
<td>66</td>
</tr>
<tr>
<td>3.2</td>
<td>Interview participants’ background information</td>
<td>67</td>
</tr>
<tr>
<td>3.3</td>
<td>Stages of concern about the innovation</td>
<td>74</td>
</tr>
<tr>
<td>3.4</td>
<td>Group meeting dates and activities</td>
<td>77</td>
</tr>
<tr>
<td>3.5</td>
<td>Literature basis for interview questions</td>
<td>80</td>
</tr>
<tr>
<td>3.6</td>
<td>Categories assigned to the Standards-Based Teaching Instrument items</td>
<td>86</td>
</tr>
<tr>
<td>3.7</td>
<td>Adjusted scores related to the standards-based teaching profiles</td>
<td>89</td>
</tr>
<tr>
<td>3.8</td>
<td>Stages of concern associated with the items of the SoCQ</td>
<td>90</td>
</tr>
<tr>
<td>3.9</td>
<td>Checklist matrix to categorize semi-structured interview data</td>
<td>94</td>
</tr>
<tr>
<td>4.1</td>
<td>Definitions of the adjusted scores used in the standards-based teaching profiles</td>
<td>105</td>
</tr>
<tr>
<td>4.2</td>
<td>LS-2 responses related to the diffusion of standards-based teaching and EDLs</td>
<td>118</td>
</tr>
<tr>
<td>4.3</td>
<td>Chem-2 responses related to the diffusion of standards-based teaching and EDLs</td>
<td>130</td>
</tr>
<tr>
<td>4.4</td>
<td>Phys-2 responses related to the diffusion of standards-based teaching and EDLs</td>
<td>142</td>
</tr>
</tbody>
</table>
4.5 Geo-2 responses related to the diffusion of standards-based teaching and EDLs .......................................................................................................................... 152

4.6 LS-4 responses related to the diffusion of standards-based teaching and EDLs ................................................................. 166

4.7 Chem-4 responses related to the diffusion of standards-based teaching and EDLs ....................................................................................................................... 178

4.8 Phys-4 responses related to the diffusion of standards-based teaching and EDLs ....................................................................................................................... 192

4.9 Geo-4 responses related to the diffusion of standards-based teaching and EDLs ....................................................................................................................... 205

5.1 Preparedness and use of standards-based teaching (extreme scores) for 2-year institution faculty .................................................................................................... 214

5.2 Highest stages of concern for 2-year institution faculty ................................................................. 216

5.3 Diffusion of standards-based teaching and EDLs for 2-year institution faculty .... 216

5.4 Preparedness and use of standards-based teaching (extreme scores) for 4-year institution faculty ........................................................................................................ 221

5.5 Highest stages of concern for 4-year institution faculty ................................................................. 222

5.6 Diffusion of standards-based teaching and EDLs for 2-year institution faculty ....................................................................................................................... 223

5.7 Preparedness and use of standards-based teaching (extreme scores) for life science faculty ........................................................................................................ 226

5.8 Highest stages of concern for life science faculty ................................................................. 227

5.9 Diffusion of standards-based teaching and EDLs for life science faculty .... 228

5.10 Preparedness and use of standards-based teaching (extreme scores) for chemistry faculty ............................................................................................................... 230

5.11 Highest stages of concern for chemistry faculty ................................................................. 231

5.12 Diffusion of standards-based teaching and EDLs for chemistry faculty .................. 232

5.13 Preparedness and use of standards-based teaching (extreme scores) for physics faculty ........................................................................................................ 234
5.14 Highest stages of concern for physics faculty

5.15 Diffusion of standards-based teaching and EDLs for physics faculty

5.16 Preparedness and use of standards-based teaching (extreme scores) for geology faculty

5.17 Highest stages of concern for geology faculty

5.18 Diffusion of standards-based teaching and EDLs for geology faculty

5.19 Preparedness and use of standards-based teaching (extreme scores) for faculty who are central to the locus of control

5.20 Highest stages of concern for faculty who were central to the locus of control

5.21 Diffusion of standards-based teaching and EDLs for faculty who were central to the locus of control

5.22 Preparedness and use of standards-based teaching (extreme scores) for faculty who were peripheral to the locus of control

5.23 Highest stages of concern for faculty who were peripheral to the locus of control

5.24 Diffusion of standards-based teaching and EDLs for faculty who were peripheral to the locus of control

5.25 Cross-case facet patterns of the majority of faculty (extreme scores) based on type of institution, discipline, and locus of control
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Science educators exposed to standards-based teaching and EDLs</td>
<td>5</td>
</tr>
<tr>
<td>1.2</td>
<td>Undergraduate science faculty reflecting on their concerns and practices to facilitate adoption</td>
<td>6</td>
</tr>
<tr>
<td>4.1</td>
<td>LS-2 standards-based teaching profile</td>
<td>109</td>
</tr>
<tr>
<td>4.2</td>
<td>LS-2 stages of concern profile related to her adoption of EDLs</td>
<td>115</td>
</tr>
<tr>
<td>4.3</td>
<td>Chem-2 standards-based teaching profile</td>
<td>121</td>
</tr>
<tr>
<td>4.4</td>
<td>Chem-2 stages of concern profile related to his adoption of EDLs</td>
<td>127</td>
</tr>
<tr>
<td>4.5</td>
<td>Phys-2 standards-based teaching profile</td>
<td>133</td>
</tr>
<tr>
<td>4.6</td>
<td>Phys-2 stages of concern profile related to his adoption of EDLs</td>
<td>139</td>
</tr>
<tr>
<td>4.7</td>
<td>Geo-2 standards-based teaching profile</td>
<td>145</td>
</tr>
<tr>
<td>4.8</td>
<td>Geo-2 stages of concern profile related to his adoption of EDLs</td>
<td>149</td>
</tr>
<tr>
<td>4.9</td>
<td>LS-4 standards-based teaching profile</td>
<td>156</td>
</tr>
<tr>
<td>4.10</td>
<td>LS-4 stages of concern profile related to his adoption of EDLs</td>
<td>162</td>
</tr>
<tr>
<td>4.11</td>
<td>Chem-4 standards-based teaching profile</td>
<td>169</td>
</tr>
<tr>
<td>4.12</td>
<td>Chem-4 stages of concern profile related to his adoption of EDLs</td>
<td>175</td>
</tr>
<tr>
<td>4.13</td>
<td>Phys-4 standards-based teaching profile</td>
<td>180</td>
</tr>
<tr>
<td>4.14</td>
<td>Phys-4 stages of concern profile related to his adoption of EDLs</td>
<td>188</td>
</tr>
<tr>
<td>4.15</td>
<td>Geo-4 standards-based teaching profile</td>
<td>195</td>
</tr>
</tbody>
</table>
4.16 Geo-4 stages of concern profile related to his adoption of EDLs ..................200

5.1 Preparedness profiles related to standards-based teaching for 2-year institution faculty .................................................................................................................................................................213

5.2 Use profiles related to standards-based teaching for 2-year institution faculty ......214

5.3 Stages of concern profile related to the adoption of EDLs for 2-year institution faculty .................................................................................................................................................................215

5.4 Preparedness profiles related to standards-based teaching for 4-year institution faculty .................................................................................................................................................................219

5.5 Use profiles related to standards-based teaching for 4-year institution faculty ......220

5.6 Stages of concern profiles related to the adoption of EDLs for 4-year institution faculty .................................................................................................................................................................222

5.7 Preparedness and use profiles related to standards-based teaching for life science faculty .................................................................................................................................................................225

5.8 Stages of concern profiles related to the adoption of EDLs for the science faculty .................................................................227

5.9 Preparedness and use profiles related to standards-based teaching for chemistry faculty .................................................................................................................................................................229

5.10 Stages of concern profiles related to the adoption of EDLs for the chemistry faculty .................................................................................................................................................................231

5.11 Preparedness and use profiles related to standards-based teaching for physics faculty .................................................................................................................................................................233

5.12 Stages of concern profiles related to the adoption of EDLs for physics faculty ......235

5.13 Preparedness and use profiles related to standards-based teaching for geology faculty .................................................................................................................................................................237

5.14 Stages of concern profiles related to the adoption of EDLs for geology faculty .................................................................239

5.15 Preparedness profiles related to standards-based teaching for faculty who were central to the locus of control .................................................................................................................................................................243

5.16 Use profiles related to standards-based teaching for faculty who were central to the locus of control .................................................................................................................................................................244
5.17 Stages of concern profiles for the adoption of EDLs for faculty who were central to the locus of control

5.18 Preparedness profiles related to standards-based teaching for faculty who were peripheral to the locus of control

5.19 Use profiles related to standards-based teaching for faculty who were peripheral to the locus of control

5.20 Stages of concern profiles for faculty who were peripheral to the locus of control

6.1 Adapted innovation model from Roger’s description of the rate of adoption

6.2 Adapted Concerns-Based Adoption Model

6.3 Adapted innovation model from Roger’s rate of adoption in terms of standards-based teaching

6.4 Combined adaptations of Rogers’ Rate of Adoption Model and the SoC dimension of CBAM
CHAPTER 1

THE PROBLEM

Background

The educational reform movement in the 1990s and 2000s has focused on standards-based teaching. These standards stress the importance of the following dimensions: the scope of the program that fits within a large plan of study; authentic student tasks; student construction of ideas; teacher role as facilitator rather than sole knowledge expert; student use of learning tools and resources in a safe, nurturing environment; student-student interaction that promotes critical thinking and intellectual rigor; authentic embedded assessment; teacher conception of knowledge as changing and growing; and teacher behaviors that increase student motivation and self-confidence (Ross, McDougall, Hogaboam-Gray, & LeSage, 2003). These dimensions are currently evident in national standards for many disciplines, including science, mathematics, and technology education (International Technology Education Association [ITEA], 1996; National Council of Teachers of Mathematics [NCTM], 2000; National Research Council [NRC], 1996). These teaching methods were first associated with science education in the publication of Science for All Americans (American Association for the Advancement of Science, 1990) and then were elaborated in the Benchmarks for Science Teaching (American Association for the Advancement of Science, 1993) and the National Science Education
Standards (NRC, 1996). These standards are designed to provide K-12 science teachers with the guidance that they need to support students as they learn science and become scientifically literate.

Recently, the methods promoted in the National Science Education Standards ([NSES] NRC, 1996) have been suggested for use in the undergraduate science education setting (Chickering & Gamson, 1998; McIntosh, 2000, 2001; Society for College Science Teachers, 1997). Faculty have started switching from a teacher-centered environment to a student-centered environment (Barr & Tagg, 1998; Caprio, Dubowsky, Micikas, & Wu, 1997; Wyckoff, 2001).

Also, during the past 15 years, educational digital libraries (EDLs) have begun to be developed. The term “digital library” has been defined both broadly and narrowly, often with references to characteristics of traditional libraries (Harter, 1996). According to the Digital Library Federation (1998, paragraph 1):

Digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities.

Many definitions of digital libraries include the notion that they are an online environment in which digital resources are stored and accessed and digital services are delivered (Tennant, 1999).

Many of these digital libraries have the mission of helping educators find the resources that they need to support standards-based teaching. Some examples of EDLs for undergraduate science faculty include Multimedia Educational Resource for Learning and Online Teaching (MERLOT), Digital Library for Earth System Education (DLESE),
and the Learning Matrix. All three of these belong to a community called the National Science, Technology, Engineering, and Mathematics (STEM) Digital Library (NSDL) sponsored by the National Science Foundation. These EDLs have been in existence for less than 10 years, which might not be enough time for undergraduate science faculty to learn how EDLs can help them in their teaching.

There are currently efforts to support undergraduate science faculty in their adoption of standards-based teaching and EDLs by such organizations as Project Kaleidoscope (Project Kaleidoscope, 2005) and the Society for College Science Teachers (The Society of College Science Teachers, 2005). Since EDLs have resources that promote standards-based teaching and faculty who adopt standards-based teaching need excellent resources, the two advancements may act synergistically. Unfortunately, little is known about undergraduate science faculty’s perceptions about and use of standards-based teaching, their concerns about digital libraries, or their role in the diffusion of these advancements.

Nature of the Problem

Standards-based teaching has not yet been completely adopted in all learning environments in the United States. EDLs are a new virtual environment to find and access digital curricular and professional development resources. Similarly, EDLs have not been adopted by all educators in the United States. Because neither standards-based teaching nor the EDLs have been completely adopted, they are considered innovations. Some EDLs have resources that support standards-based teaching. When educators seek, access, and use the standards-based resources within these digital libraries, they are implementing both innovations. These two overlapping innovations can work synergistically. When the new technology (EDLs) supports the education change
(standards-based teaching) in a way that was previously unavailable, then both changes can be adopted and implemented more quickly (Means, 1994a).

The adoption of innovations is a change process. Change in education is a long and often difficult journey. The potential adopter, the pre-K–12 and undergraduate educators, might feel that the innovations (i.e., standards-based teaching and EDLs) are beyond their reach because they feel that there are too many obstacles blocking the adoption process (see Figure 1.1). Those proposing the change (agents of change) need to support the potential adopters in the change process (Hall & Hord, 2001; Horsely & Loucks-Horsely, 1998; Rogers, 1995). The current study focused on undergraduate science faculty as potential adopters of both standards-based teaching and EDLs (see Figure 1.2). It gives the faculty a chance to reflect on their current practices and offer insight for the development of a grounded theoretical model that will support the faculty’s implementation of standards-based teaching and EDLs.
Figure 1.1: Science educators exposed to standards-based teaching and EDLs
This study offered undergraduate science faculty an opportunity to reflect on their preparation for and levels of use of standards-based teaching. Faculty considered the characteristics of standards-based teaching in terms of the degree of comfort in implementation and frequency of use. The act of reflecting, both individually and with their colleagues, gave study participants the opportunity to consider their current practices and the possibilities that could occur if they change teaching methods and use EDLs.
This study used the Concerns-Based Adoption Model (CBAM) to identify undergraduate science faculty stages of concern and levels of adoption related to the EDLs (Hord, Rutherford, Huling-Austin, & Hall, 1987; Horsely & Loucks-Horsely, 1998). This approach can help EDL collection developers make design decisions that meet the undergraduate science faculty needs as well as support the undergraduate science faculty as they reflect on their thinking in the change or adoption process.

Statement of the Problem

The research questions examined in this study are as follows:

1. How can undergraduate science faculty be described in terms of their feeling of preparedness for and their use of standards-based teaching?
2. What are the concerns of undergraduate science faculty with regard to adopting Educational Digital Libraries?
3. How can undergraduate science faculty be described in terms of their adoption and diffusion of both innovations?

Significance of the Study

Undergraduate science faculty have been the focus of interest for educational reformers who are interested in improving teaching and learning on the undergraduate level and for those who are interested in providing positive role models for future teachers who are taking undergraduate science classes. In addition, undergraduate science faculty are an important portion of the intended user population of EDLs. For these reasons, understanding the undergraduate science faculty, both at 2- and 4-year undergraduate institutions, in terms of their teaching methods and role as EDL users has
become increasingly important. The more that is understood about these faculty, the better the educational reformers and EDL promoters can design support systems that meet faculty needs.

The current study was designed to benefit the supporters of standards-based teaching at the undergraduate level, the designers of EDLs, and undergraduate science faculty participants. The supporters of standards-based teaching at the undergraduate level and the designers of EDLs may benefit because the information gathered in this study may help them understand the areas in which undergraduate science faculty need support if the two innovations are to be completely adopted. The undergraduate science faculty participants may benefit because of the opportunities, as part of their participation, to better understand the characteristics of standards-based teaching and the features of the EDLs. Their participation may also provide them with an opportunity to reflect on their own attitudes and practices, which is an important part of individual professional development.

Methodology

A qualitative design was chosen so that a rich description of undergraduate science faculty could be constructed. The research environment was structured to triangulate the data collected from group discussions, individuals’ responses to surveys, individual semi-structured interviews, and document analyses.

Participants

The study subjects were all undergraduate science faculty at 2- and 4-year institutions. These 8 faculty included one life science, chemistry, physics, and geology instructor from each of the 2-year and 4-year institutions. The participants were chosen
on the basis of setting (2-year versus 4-year institutions) and science discipline because it is possible that these groups might approach their teaching methods and adoption of digital libraries differently. In this way, the resulting descriptions may be more likely to capture any differences between faculty member professional contexts related to their work environment and/or discipline.

Data Collection

To get an individual profile for each faculty member, data related to four facets were collected: (a) background, (b) categories of standards-based teaching, (c) EDLs, and (d) adoption and diffusion. The profiles were based on responses to surveys and enriched with data gathered in groups, semi-structured interviews, and institutional mission/goal statements. All descriptors used to construct the profiles were selected because they were relevant to the research questions and made analysis of the data manageable. The Demographics and Experience Questionnaire was used to gather data to describe the participants in terms of their gender, age, and professional experience. Their professional experience was identified by their discipline, type of institution, years of teaching, and tenure status.

Three additional facets were described. First, data were collected with the Standards-Based Teaching Instrument to describe each participant’s standards-based teaching facet. The instrument used a 4-point Likert scale for respondents to indicate both their feelings of preparedness for and frequency of use of 42 teaching methods. This facet describes the participant’s feelings of preparedness for and frequency of use of categories of standards-based teaching methods. These categories, which were quantifiable and emerged during the analysis, depict standards-based teaching in terms of the development of student
conceptual understanding, use of inquiry methods, use of textbooks as a reference, response to student diversity, use of computers and/or the Internet, creation of a student-centered environment, and use of multiple means of assessment. The profiles were enriched with data based on responses to surveys and gathered in group meetings, semi-structured interviews, and institutional mission/goal statements.

Second, the EDLs facet describes participant’s feelings about adopting EDLs. The Stages of Concern Questionnaire (SoCQ) was used to collect and categorize data related to the participant’s relative intensities of concerns related to the adoption of EDLs. The questionnaire had an 8-point Likert scale with which the participants could indicate how true each of 35 statements were regarding their concerns about EDLs. The categories, which were quantifiable and identified a priori, classified the participant’s awareness, informational, personal, management, consequence, collaboration, and refocusing concerns.

Third, the adoption and diffusion facet describes each participant in terms of the variables that might influence the rate of his/her adoption and diffusion of standards-based teaching and EDLs (i.e., potential agents of change). The adoption and diffusion categories are based on an a priori, literature-based theoretical framework. These descriptive categories include the innovation’s complexity, comfortability, trialability, observability, relative advantage, and compatibility; the learner-centeredness of the participant’s classroom; the source of information about the innovation; the participant’s willingness to change; aspects of the participant’s professional environment such as the type of innovation decision, the methods for sharing ideas, and institutional support for the adoption of the innovation; and the influence of the research culture.
Data Analyses

The data from the Demographics and Experience Questionnaire were used to create the background facet of the participant case descriptions. The construction of the standards-based facet of the case description is based on the analysis of the Standards-Based Teaching Instrument, the group meetings, the semi-structured interviews, and the document analyses. The data from the Standards-Based Teaching Instrument were grouped into seven standards-based teaching methods categories. The Likert scale scores related to the participants’ preparation for and use of each item were averaged within each of the seven categories to produce seven scores. The scores were then adjusted into the low, high, and middle-two quartiles to highlight the extremes. The data from the semi-structured interviews were coded and analyzed in terms of the participants’ responses regarding their feelings related to adopting standards-based teaching and EDLs as well as their implementation of the two innovations. Using a researcher-developed rubric to analyze the responses, a checklist matrix was completed for each of the participants. Mission/goal documents were analyzed by categorizing statements relevant to the standards-based teaching categories.

The EDLs facet of the profiles was based on the data from the SoCQ, group meetings, semi-structured interviews, and institutional mission/goal statement document analyses. The analysis of the SoCQ included the addition of item scores within each of seven stages of concern categories, conversion of raw sums to percentiles that reflected the relative intensity of each category of concern, and graphical representations of the relative intensities that depict each participant’s concern profile. The semi-structured
interview data and institutional mission/goal statement document analyses were conducted relevant to the potential adoption and/or diffusion of EDLs.

The background, standards-based teaching, EDLs, and adoption and diffusion facets were used for both individual case descriptions and cross-case analyses. The individual cases identified trends in each of the facets to create a rich description of each of the participants. In the cross-case analyses, the standards-based, EDLs, and adoption and diffusion profiles for the individual participants were compared to identify patterns and trends within groups based on three characteristics. These characteristics were the participant’s type of institution, discipline, and locus of control. Type of institution and discipline were identified a priori whereas locus of control emerged during the study as a characteristic that might be related to the facets.

Definition of Terms

Concern, as defined by Hall, George, & Rutherford (1998), is a state of mental arousal that is influenced by past experience, perceptions, and degree of involvement with an innovation. The categories of concern are awareness, informational, personal, management, consequence, collaboration, and refocusing.

Digital library, as defined by Collier (1997, 7th paragraph), is “A managed environment of multimedia materials in digital form, designed for the benefit of its user population, structured to facilitate access to its contents, and equipped with aids to navigation of the global network.” “An electronic library in which the users and the holdings are totally distributed, yet still managed as a coherent whole” (Collier, 8th paragraph).
Innovation, as defined by Hall, George, & Rutherford (1978), is a challenging idea (e.g., standards-based teaching) or tool (e.g., Educational Digital Libraries) that is causing a change but has not been implemented completely in the specific population, and is the focus of concern.

Standards-based teaching – teaching methods described in the *NSES* (NRC, 1996). Categories of standards-based teaching methods include developing student conceptual understanding, using inquiry methods, using textbooks as a reference, responding to student diversity, using computers and the Internet, creating a student-centered environment, and using multiple means of assessment.
CHAPTER 2
REVIEW OF LITERATURE

Introduction

This study focused on the receptivity of undergraduate science faculty to standards-based teaching and Educational Digital Libraries (EDLs). Standards-based teaching is currently accepted as the best way to support student learning (NRC, 1996; Siebert & McIntosh, 2001). EDLs have resources and services that support STEM learning for people in all age groups. The degree to which undergraduate science faculty are receptive to EDLs may be related to the level at which they have accepted and implemented standards-based teaching. By viewing the faculty as the potential adopters of or change agents for the innovations of standards-based teaching and the EDLs, the current study describes a small group of undergraduate science faculty in terms of their feelings of preparedness for and use of standards-based teaching as well as their stages of concern related to EDLs.

This chapter provides background information and context to the description of undergraduate science faculty as potential users of standards-based teaching and EDLs. It is divided into sections about (a) innovation and change, (b) the Concerns-Based Adoption Model, (c) standards-based teaching, and (d) EDLs.
Innovation and Change

Nature of Innovation

An innovation is the introduction of something new. It can be a new idea, method, or device. “An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (Rogers, 1995 p. 11). The age of the innovation is not related to the potential adopter’s perception of its newness. Even if an innovation has been available for a long time, the individual might not understand the innovation well enough to make an informed decision about its value and whether or not they should adopt it.

Change experts often divide innovations into two categories. Rogers (1995) divides them into hardware and software components. Hall and Hord (2001) divide them into product and process components. The hardware or product aspect includes the physicality of the innovation. The software or process component refers to the information about the innovation. Idea-only innovations are totally categorized as software components. Examples of innovations with only the software component, according to Rogers, are Marxism, a religious idea, and a rumor. The diffusion of idea-only innovations has been hard to monitor and infrequently studied. Irrespective of the type of innovation, innovators should spend as much time in the development of an innovation as they do for the implementation. In addition, the innovators should plan on facilitation of the change being a team effort so that all participants can feel invested in the innovation.

Examples of both hardware and software components can be identified in the current study. Since there is no physical aspect to standards-based teaching, it is going to be considered a process, idea-only innovation, or an innovation with only a software
component. Undergraduate science faculty may make decisions about and implement the information related to standards-based teaching recommended by the *NSES* (NRC, 1996). EDLs can be considered product and process innovations that have both hardware and software components. An example of a hardware component would be the user interface. In this case, the user’s computer is an extension of the EDLs’ hardware. The metadata used to describe the resources, the collection development plan, and the search engine are examples of the software component of the EDLs.

Tobias (1992) distinguishes between innovation and change. She says that not only do they not necessarily coincide, but in fact might compete with one another. Change requires greater input from those who are changing. They have to bargain and negotiate to get the information, support, and resources needed for the change. With innovation, those who develop the innovation should work as hard on getting the users to accept the innovation as they do on the design of the innovation.

In the context of the current study, both the standards-based teaching and the EDLs are considered innovations, but both adoption and change are considered part of the same process. This is reasonable because the adoption of both innovations requires a great deal of effort and negotiation on the part of the adopter.

The current study is based on the theory that undergraduate science faculty are potential adopters of the innovations of standards-based teaching and EDLs. The purpose of these innovations is to provide tools to improve student learning. The *NSES* (NRC, 1996) are idea-only tools that provide a guide for what should be taught, when it should be taught, and how it should be taught. Some of the EDLs are online environments in which digital science education resources that support the *NSES* can be found.
Adoption is a change process (Hord et al., 1987). Since innovations are most often adapted to meet the specialized needs of the user, it is important to know what those needs are (Hall & Hord, 2001). The current study describes undergraduate science faculty in terms of their adoption of standards-based teaching and EDLs and identifies their feelings and concerns related to these innovations.

*Characteristics of Innovations That Affect Rates of Adoption*

“Rate of adoption is the relative speed with which an innovation is adopted by members of a social system” (Rogers, 1995 p. 206). The rate of adoption is influenced by the following factors: (a) perceived attributes of the innovation, (b) types of innovation decisions, (c) communication channels, (d) nature of the social system, and (e) change agent’s promotion efforts.

*Perceived Attributes of Innovation*

People have different ideas about the elements involved in an innovation. Some suggest that those involved in the development construct a profile of the elements and how they intend for them to be implemented (Horsely & Loucks-Horsely, 1998). The clearer the potential users are about the different aspects of the innovation and how they relate to them and their situation, the better they will be able to make decisions about adoption. If their perceptions are that the innovation will have limited value, their rate of adoption will be very slow.

People have different degrees of clarity about different innovations. Science faculty’s perceived attributes of standards-based teaching would be related to their understanding of the teaching methods described in the *NSES* (NRC, 1996) as well as the educational theories from which the standards were derived. Since the EDLs are so new and...
ever-expanding, science faculty could have a difficult job completely perceiving all that they involve. Since the attributes of the EDLs are changing, it is reasonable that potential users’ perceptions of them might also be changing.

Rogers (1995) identifies the following characteristics of an innovation as they are perceived by individuals: (a) Relative advantage – How does this compare to what I use now? (b) Compatibility – How does this fit with my current practices? (c) Complexity – Can I understand what this is or how to use it? (d) Trialability – Can I easily try this out? and (e) Observability – Can I see a difference resulting from my use of this? When potential adopters perceive these characteristics positively, they will be more apt to implement the innovation and the rate of adoption will be high.

Types of Innovation Decisions

Innovation decisions can be optional, collective, or mandated by authority. Innovation decisions are influenced by the number of people involved in making the decision to adopt the innovation and the freedom that the adopters have in doing so. If one person has the freedom to choose whether or not to adopt, the rate of adoption will be much faster than if a group is involved. For example, if individual science faculty members have the choice whether or not to adopt standards-based teaching, the adoption process will be much faster than if it is a collective department or campus-wide decision to implement these methods. The rate also will be affected by whether or not a greater authority is mandating the adoption, as would be the case if a college or university became members of a digital library community. In this situation, the faculty could be required to be active participants. Depending upon the community characteristics, the
mandate of the authority could speed up or slow down the speed at which the faculty
become aware of the elements of the digital library and their implementation of the
elements.

Communication Channels

If information about the innovation is spread through the mass media, one might
expect that adoption would take place much faster than if the information was to be
spread by word of mouth. Rogers (1995) states that this is dependent on the complexity
of the innovation. If the innovation is not too complex, it has been found that mass media
is the more effective means of communication. If the innovation is very complex, the
interpersonal contact is more important.

In the current study, the best choice for communication channels is dependent upon
the undergraduate science faculty’s perceptions of standards-based teaching and the
EDLs. If these innovations are perceived to be easy, the best way to communicate their
features may be through journals that undergraduate science faculty read. If they are
perceived as complex, the faculty might need face-to-face introductions to the features
and modes of implementation of standards-based teaching and the EDLs.

Nature of the Social System

It is important to remember that the rate of adoption being discussed is the rate at
which the population changes. Populations have cultures which include acceptable ways
of communicating and working. The social system addressed in the current study is that
of undergraduate science faculty. The characteristics of this social system are discussed
in greater depth in the section titled “Teachers are Active Participants in Systemic
Planning.”
Change Agent’s Promotion Efforts

Agents of change are those that are spreading information about the innovation and helping potential adopters implement the innovation. Rogers (1995) states that the efforts of the agents of change are greatest at the early stages of diffusion. Once enough people have adopted the innovation, others will follow along without active participation of the change agents. One purpose of the current study was to determine the undergraduate science faculty’s role in the diffusion process. Determining the level of acceptance can help those promoting standards-based teaching and the EDLs know better how much effort should be expended on active promotion of these innovations.

Successful Change Strategies for the Adoption Process

Fullan and Miles (1992) suggest that instead of developing a new strategy for each wave of reform, it is important to identify successful strategies for continuous improvement. To facilitate change in a complex system that has many problems, they suggest integrating concrete attempts at change so that they can work together to cause a greater improvement. It is important to remember that change must be systemic (Fullan & Miles; Rothman & Narum, 1999). In the current study, many groups of people were considered to be part of the change process related to standards-based teaching and the use of the EDLs. Whether one is a potential adopter or an agent of change, an understanding of the change process and successful change strategies can make the process smoother.

It is helpful if the potential adopters realize that their uneasy feelings are natural. Because change is a learning process, the people involved in the change have a lot of uncertainty about what they have not yet learned. This causes people to become anxious.
It is important for potential adopters to remember that if a drastic change is needed, the process will most likely be difficult (Fullan & Miles, 1992).

It is important that potential adopters have enough information at the beginning of the adoption process to understand the different aspects of the innovation. Fullan and Miles (1992) state that adopters cannot feel ownership of the innovation until they have learned what the innovation is and how it can be used. Often potential adopters reject the innovation before they have had the time to learn enough about it to make a well-reasoned decision.

Potential adopters and agents of change often want to simplify the change process with the illusion that an initial set plan will satisfy all of the needs to effect change. It is better to think of change as a journey than a set plan. Any change process requires reflection, refinement, and additional planning along the way. A recursive refinement approach is more responsive to the needs of the potential adopters and engages the developers as well as the rest of the social system in the change process. The continual refinement and reflection process is evident with both the standards-based teaching and the EDLs. The adoption of standards-based teaching in the undergraduate science classroom requires the faculty to look at the standards, try and implement them as written, and then adjust them to each individual learning environment. The EDLs are early in the development and adoption process, so following the recursive reflection and refinement approach benefits the EDL developers as well as the potential users.

Fullan and Miles (1992) encourage people involved in the change process to remember that the identification of problems is important. If the problems are not identified and corrected, they will come back to cause harm again in the future. The
The importance of identifying problems underscores the importance of the current study. If the problems that undergraduate science faculty are having in the adoption of standards-based teaching and the EDLs become evident, the solutions can be sought and the system can be improved.

Fullan and Miles (1992) stress the importance of remembering that change requires many resources. This can be in many forms such as money, time, and energy. Those who are preparing for change should budget for all of the resources that might be required. Fullan and Miles also stress the fact that for change to occur successfully, it has to happen throughout the various systems, but that all large scale change is implemented on the local level. Hall and Hord (2001) agree that the school is the local level where the change primarily occurs. They say that the rate of change is dependent upon factors related to the context of the school environment. In the current study, it is important to identify the resources that the faculty perceive as important for their adoption of standards-based teaching and EDLs. Instead of the school being the local level, in the current study, the department could be considered the local level since that would be analogous to a school in the K-12 environment.

Hall and Hord (2001) similarly have a set of principles about change. They state that change is a process that can take many years. They point out that people are anxious to see the fruits of change quickly, and if the change is not apparent before the next election, education policies are often thrown out. People need to grieve the loss of the existing status before they can embrace the new. This compounds the difficulty of effecting change. This relates to the current study because faculty might be anxious to see results from changing their teaching methods or impatient to perceive the value of EDLs.
Even though Hall and Hord (2001) call for systemic support of innovation, they state an organization will not change until the individuals within it change. This principle can be applied to efforts on the college or university level to encourage faculty to participate in standards-based teaching and EDLs. Just because the administrators say that they want the department or college to use specific teaching methods or EDLs as tools, it does not mean that it will happen. The individuals have to implement the teaching methods or EDLs before the organization can claim adoption. Conversely, it will be difficult for the individuals to become adopters without the organizational support. Hall and Hord also state that even though change can be initiated from the top-down or the bottom-up, a horizontal perspective is best. In addition, for organizational change to occur, all of the potential adopters must realize that they are part of a larger system and all members of the organization must trust one another in terms of the innovation. Hall and Hord add that mandates can help make it clear to all participants in the organization what is expected.

Using undergraduate science faculty and standards-based teaching as an example, it might be decided on a college or department level to use the *NSES* (NRC, 1996) as a guide. The Department Chair could issue a mandate that all of the faculty will learn about the teaching techniques and the education philosophy in the *NSES*. Standards-based teaching cannot be considered to be adopted until the individual faculty members execute its implementation. If faculty are told that they are to use standards-based teaching, they must trust the administration to give them the time they need to develop the instructional plans and skills. The faculty should not have to worry that they will have problems during promotion and tenure reviews if they have used their time to change their teaching
instead of conducting research projects and writing papers. The faculty must also trust their colleagues to implement standards-based teaching so that the students will have a cohesive, coordinated learning experience. The adoption of standards-based teaching would be dependent on the culture of that particular department. The greater the support given to the faculty, the easier the change will be. A nationwide shift to standards-based teaching would depend upon implementation at individual schools as well as departments and universities.

The Concerns-Based Adoption Model

Previous studies have investigated digital library users’ needs and preferences in terms of the content of the library and the interface (Bishop, 1995; Bollen & Luce, 2002; Choudhury, Hobbs, Lorie, & Flores, 2002; Dorward, Reinke, & Recker, 2002); the current study’s approach of considering the digital library as an innovation is new. This section will discuss the Concerns-Based Adoption Model (CBAM) which is what the current study employs to assess potential users’ concern and levels of use regarding EDLs. This model was chosen because it offers insight into potential user needs. This is a departure from other studies that only investigate what current users think and feel about an innovation. This model is considered to be an important tool for those who want to facilitate a change in education (Horsely & Loucks-Horsely, 1998). In the current study, the change is undergraduate science faculty’s use of EDLs to find and access digital resources for science teaching and learning.

Components

CBAM consists of three tools for diagnosing the potential adopters’ status in the adoption process. These identify the potential adopters’ stages of concern about the
innovation, their levels of use of the innovation, and an inventory of the intended uses of the innovation. The combination of these three components offers descriptions for both the personal reactions to the innovation as well as the operational use of the innovation.

Stages of Concern

The concerns aspects of CBAM came originally from Frances Fuller in the 1960s. Stages of concern identify potential adopters’ feelings as they are moving through the developmental process of change. In this model, the potential adopters are teachers or other educators. By identifying teachers’ concerns, facilitators are better able to help teachers in the change process if the teachers’ perceptions about the innovation related to themselves, their jobs, and their students’ learning are identified.

Table 2.1 illustrates the three categories of concern, the seven stages of concern within these categories, and the expressions that are symptomatic of each stage. People usually progress through these stages in a developmental fashion, but this is not always the case. Hord et al. (1987) say that often the concerns come in waves.
Table 2.1: Stages of concern: Typical expressions of concern about the innovation.

<table>
<thead>
<tr>
<th>Stages of Concern</th>
<th>Expressions of Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>I have some ideas about something that would work even better.</td>
</tr>
<tr>
<td>5</td>
<td>I am concerned about relating what I am doing with what other instructors are doing.</td>
</tr>
<tr>
<td>4</td>
<td>How is my use affecting kids?</td>
</tr>
<tr>
<td>3</td>
<td>I seem to be spending all of my time getting material ready.</td>
</tr>
<tr>
<td>2</td>
<td>How will it affect me?</td>
</tr>
<tr>
<td>1</td>
<td>I would like to know more about it.</td>
</tr>
<tr>
<td>0</td>
<td>I am not concerned about it (the innovation)</td>
</tr>
</tbody>
</table>


The Stages of Concern component of CBAM identifies concerns related to the self, the task, or the impact. The self stages of concern are awareness, informational, and personal. A person with awareness concern does not know about the change or does not want to learn about it. Someone with self concern wants more information to better understand the change (informational) and how it affects them (personal). Management is a task stage of concern. The task concern emerges when someone is trying to understand the constraints of implementing the change. These constraints include time, materials, and skills. The three impact stages of concern are consequence, collaboration, and refocusing. The impact concern relates to the user's ideas about how to improve or
adapt the innovation, specifically the consequences the innovation has on the students, the collaborations the potential adopter would have with colleagues, and possible ways to refocus the innovation so that it would be even more effective (Horsely & Loucks-Horsely, 1998).

Three procedures to determine concern include: face-to-face conversations, open-ended statements, and the Stages of Concern Questionnaire (SoCQ). The face-to-face conversation requires the facilitator to be a good listener; to know how to analyze the data; and to be able to engage the participant in informal, easy conversation. The open-ended statements can be given to a lot of people at one time. Each sentence that the participants write should be analyzed independently. The SoCQ, which is a 35-item instrument, is an accurate, reliable, and valid assessment that has been used widely and well researched. It does not require the researcher to analyze statements because it produces quantitative data. It thoroughly shows the relative intensity levels of each of the seven stages of concern. The SoCQ also can be administered to the same person repeatedly. The data can be used to develop a profile for a group or an individual (Hord et al., 1987).

Participants’ Stages of Concern should not be considered good or bad. These stages only help the facilitator understand how to best interact with the participant. Just as people go through developmental changes as they age, they go through developmental changes with respect to their reactions to change. One developmental stage is no better than another, but effective communication relies on an understanding of where a person is in their development. The goal of CBAM and using the SoCQ is to support the person through their stages of concern.
Levels of Use

The Levels of Use component for CBAM is an interview, formal or informal, in which the facilitator works through a hierarchy of questions that identify the users’ decision points and levels of use (Hord et al., 1987; Horsely & Loucks-Horsely, 1998). The levels of use describe the behavioral changes that a person exhibits when they are transitioning through their adoption of the change. There are three levels for nonusers and five for users. The three levels are Nonuse, Orientation, and Preparation. Nonuse, as the name implies, indicates that the person is taking no action related to the change. Orientation is when a person is finding out about the proposed change. Finally, Preparation is when the person has decided to adopt the change and is getting ready to implement it. The levels of use for users includes: Mechanical (the person still feels awkward as they use the innovation), Routine (the pattern is satisfactory), Refinement (this includes some reflection on use and adaptation to increase impact), Integration (this includes collaboration with others), and Renewal (people are looking forward to new changes or innovations to start a new cycle).

Innovation Configuration

The innovation configuration is a method of describing an innovation in operational terms identifying such things as the innovation’s main components and how these components are intended to be used (Hord et al., 1987). These components can include materials, teacher behaviors, and student activities as well as all of the variations in actual practice. The major operational features of the change or innovation are called components. The components that are necessary are labeled as critical and the ones that would be nice if they happened are called related. It is recommended that the
components be arranged into an innovation configuration checklist, which can be used to identify which components of the innovation the potential adopter is using and how these components are being used.

The change facilitator does not need to make sure that the innovation is used as its designers had intended. This is particularly important when considering the features of the digital libraries because their potential is undiscovered. The applications of the digital libraries can emerge as the users interact with it.

Hord et al. (1987) recommend that the innovation configuration checklist be organized into either outline form or a left-to-right continuum. The continuum has the advantage of providing a graphical representation of the data with the acceptable on the left side of a dotted line and the unacceptable on the right side of a solid line. The variations between the lines represent an array of acceptable but not ideal situations. There is no set number of components or variations within those components. It is important to carefully consider the different options without clouding the situation to the point that clear patterns cannot be discerned.

Hord et al. (1987) suggest coming up with the list by reviewing the developers' written materials; however, in the case of the digital libraries, this has not been developed to date. The construction of the innovations configuration list is a complex task. The innovative configurations can be used for both formative and summative evaluation. In many situations, it is recommended that both site-visit observations and interviews be used to get a complete picture of the innovation. A written questionnaire can be used if the participants know the facilitator of change and realize that the instrument is meant to support them in their transition into using the innovation.
Applications Related to Educational Change

CBAM has been used as a pretest and posttest to determine how professional development can be used to improve teachers’ adoption of portfolio assessments (Roempler, 1995). By measuring the teachers’ concerns after repeated professional development interventions, the study could determine the effectiveness of the professional development approach. Another study used CBAM to investigate the effectiveness of professional development in St. Louis schools regarding the adoption of reform-based instructional models. In this study, CBAM protocols were administered annually for 3 years so that it would be possible to identify clusters of teachers who were grouped based on their concerns and progression in the adoption process (Kedro & Short, 2004). CBAM was also used to determine the concerns and levels of adoption of the Alaska and Anchorage Standards and Benchmarks across disciplines in the Anchorage, Alaska secondary schools (Fenton, 2002). In this study, it was not the success of the professional development efforts that were being investigated, but rather, the adoption of the innovations which were the standards and benchmarks.

Applications Related to Technological Change

Newhouse (2001) describes a study in which CBAM was used to assess the implementation of laptop computers in a Western Australian private girls' school. All aspects of the CBAM model, the stages of concern, levels of use, and innovation configuration, were measured. Some of the respondents in this study misinterpreted the word concern to mean worry. As a result, some of the participants might have been incorrectly categorized into the awareness group.
Using the CBAM data, Newhouse (2001) constructed a model that explains teacher responses to the availability of portable computers. The model has nine descriptors of teacher actions, ranging from dissension to evolution. Newhouse found CBAM to be helpful in understanding how the innovation affected teachers and in the development of in-depth case studies of teachers. Based on his findings, he felt that CBAM could be used to recommend specific professional development supports in the adoption of laptop computers for classroom use.

Standards-Based Teaching

Standards-based teaching of science is an approach to teaching and learning that was formally released for grades K-12 in 1996 with the publication of the *NSES* (NRC, 1996). The concepts in the *NSES* were later applied to the undergraduate setting (Siebert & McIntosh, 2001). The *NSES* grounds its teaching standards in the following assumptions: standards-based teaching requires systemic change, teaching influences student learning, teachers need to reflect on their practices and beliefs during the change process, learning is a constructivist process, and teachers need to actively interact with their students to appreciate and address diverse needs for learning. Since the ideas in the teaching standards are based on the assumption that systemic change is necessary to move from the teacher-centered approach to the student-centered approach, standards-based teaching can be considered an innovation. This innovation has no hardware components, so it can be considered an idea-only innovation (Rogers, 1995).
Characteristics of Standards-Based Teaching

Central to the standards-based teaching model are techniques that facilitate the development of an active, student-centered learning environment so that scientific literacy will be improved for all students. This is a paradigm shift from traditional teacher-centered models.

Teaching Standards

The *NSES* (NRC, 1996) offer characteristics that can be used to identify standards-based teaching (Siebert & McIntosh, 2001). These characteristics include constructivism, active learning, the inquiry approach, reflective teaching practices, and an environment that focuses on learning. Constructivism stresses the importance of creating a student-centered learning environment so that students can construct their own meaningful conceptual understanding (Brooks & Brooks, 1993; von Glasersfeld, 1995). Constructivism encourages active learning which can involve an inquiry approach that encourages students to be active participants in their learning as they identify questions to investigate (Chickering & Gamson, 1998; NRC, 2000). In the pursuit of creating an environment that is focused on learning, educators may use textbooks as a reference, respond to student diversity, encourage the use of technology such as computers and the Internet, and use multiple means of assessment (Chickering & Gamson; Rothman & Narum, 1999).

Constructivism

Constructivism is a learning theory stating that students build their knowledge based on their previous understanding and knowledge (Brooks & Brooks, 1993). There are
different varieties of constructivism, including radical constructivism and social constructivism (von Glasersfeld, 1993, 1995), but the current study focused on the general views of constructivism as embodied in the NSES (NRC, 1996). As described in Table 2.2, teachers in a constructivist classroom act as facilitators as the students actively construct their new world view. Students are responsible for their own learning as well as encouraged to develop and explore their own questions. The content discussed in a course taught using the constructivist model is viewed as a part of a larger body of knowledge with fewer concepts being covered, but in greater depth. Group work is encouraged. Teachers first ask questions to determine students pre-existing understanding of the concepts and student learning is assessed as an integral part of the instructional and learning process (Brooks & Brooks).
<table>
<thead>
<tr>
<th>Traditional Classrooms</th>
<th>Constructivist Classrooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum is presented part to whole, with emphasis on basic skills.</td>
<td>Curriculum is presented whole to part with emphasis on big concepts.</td>
</tr>
<tr>
<td>Strict adherence to fixed curriculum is highly valued.</td>
<td>Pursuit of student questions is highly valued.</td>
</tr>
<tr>
<td>Curricular activities rely heavily on textbooks and workbooks.</td>
<td>Curricular activities rely heavily on primary sources of data and manipulative materials.</td>
</tr>
<tr>
<td>Students are viewed as &quot;blank slates&quot; onto which information is etched by the teacher.</td>
<td>Students are viewed as thinkers with emerging theories about the world.</td>
</tr>
<tr>
<td>Teachers generally behave in a didactic manner, disseminating information to students.</td>
<td>Teachers generally behave in an interactive manner, mediating the environment for students.</td>
</tr>
<tr>
<td>Teachers seek the correct answer to validate student learning.</td>
<td>Teachers seek the students' points of view in order to understand students' present conceptions for use in subsequent lessons.</td>
</tr>
<tr>
<td>Assessment of student learning is viewed as separate from teaching and occurs almost entirely through testing.</td>
<td>Assessment of student learning is interwoven with teaching and occurs through teacher observations of students at work and through students’ exhibitions and portfolios.</td>
</tr>
<tr>
<td>Students primarily work alone.</td>
<td>Students primarily work in groups.</td>
</tr>
</tbody>
</table>

**Note.** From *In Search of Understanding: The Case for Constructivist Classrooms* (p. 17) by J. G. Brooks and M. G. Brooks, 1993, Alexandria, VA: Association for Supervision and Curriculum Development. Copyright 1993 by the Association for Supervision and Curriculum Development. Reprinted with permission. The Association for Supervision and Curriculum Development is a worldwide community of educators advocating sound policies and sharing best practices to achieve the success of each learner. To learn more, visit ASCD at [www.ascd.org](http://www.ascd.org)

Table 2.2: A comparison of traditional and constructivist classrooms.
Active Learning

Students are mentally and physically involved in the learning process when they are actively learning. This is in contrast to the passive role that students take when they are receiving information in a lecture setting. Active learning does not mean that there is no place for lectures, only that they should be a component of a larger model that gives students more responsibility and control. In this student-centered environment, the faculty give students direction and model expert practices (Brooks & Brooks, 1993). This can happen in undergraduate science classrooms when instructors coordinate small group discussions, ask probing questions in the laboratory, and challenge students to clarify their explanations and reasoning (Siebert & McIntosh).

Inquiry Approach

The inquiry approach is an instructional strategy and a learning goal that is modeled on the way that scientists approach their work. It involves the skills that scientists use and rules that they follow when they are gathering and evaluating evidence (Siebert & McIntosh, 2001). It is recommended that students start with a simple hypothesis and develop an experimental process that moves into more complex concepts and techniques. Students could work collaboratively in an environment where the lecture, laboratory, and discussion sections of the course are all integrated (Siebert & McIntosh).

The inquiry approach is characterized by an environment in which the learners are working on scientifically-oriented questions using the work strategies that are implicit to the culture of scientific research. These work strategies include the development of questions and explanations based on evidence, the evaluation of explanations based on existing scientific understanding, and the clear communication of those explanations.
Reflective Teaching Practices

Teachers reflect on their own practices and their students’ learning. The reflection on student learning includes a variety of formal and informal assessments such as portfolios, open-ended response tests, and long-term projects. Teachers use the results of these assessments to refine their teaching practices to meet the needs of the students (Siebert & McIntosh, 2001).

Environment Focused on Learning

In a standards-based classroom, teachers create learning environments that are focused on learning instead of on teaching. This includes elements such as enough time, adequate and appropriate space, and tools to engage in inquiry. Students should be active participants in the design of the learning environment. Even though undergraduate science faculty say that the development of this environment is difficult, they find it is beneficial to student learning (Siebert & McIntosh, 2001).

The NSES recommends the development of communities of learners that “reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning” (NRC, 1996, pp. 45-46). This could encourage students to enter the scientific community and develop the common language and tacit understandings that are common to that culture (Lave & Wenger, 1991). In addition, this community would honor the students’ diverse backgrounds and encourage their collaboration. Because students feel part of a collaborative effort to answer questions that are meaningful to them, the environment is exciting and the undergraduate students are more motivated to learn (Siebert & McIntosh, 2001).
McIntosh (2001) emphasizes the importance of undergraduate science faculty learning about the national standards (i.e., NSES) and participating in programs to help students learn science from kindergarten through college in a consistent, well integrated program. To do this, faculty are encouraged to implement the standards-based teaching practices in their own classroom as well as collaborating with colleagues on a local or national level to effect this change. To participate in the systemic reform, undergraduate science faculty need to consider both the science content and the teaching practices that promote scientific literacy. If undergraduate science faculty adopt standards-based teaching and become active agents of change, the chances of a well integrated science education system are greatly increased (Rothman & Narum, 1999).

Obstacles to Adoption of Standards-Based Teaching

The research about undergraduate science teaching focuses on questions more related to didactic teaching methods, such as which is better, discussions or lectures, the effects of class size, and independent study compared to peer learning (McKeachie, 1998). This indicates that the standards-based teaching methods have not been fully adopted by the undergraduate science teaching community. Undergraduate science faculty must overcome many obstacles if they are to adopt standards-based teaching. These obstacles, which range from systemic factors to individual processes, include the lack of systemic support, comfort using traditional methods, science faculty habits of mind, and training in science and not science education. It is important to identify the roadblocks to facilitate systemic change to standards-based teaching.


Lack of Systemic Support

Historically, the undergraduate setting has not been one that encourages faculty to spend their time adjusting their teaching methods so that student learning improves (Biaocco & Waters, 1998; Caprio et al., 1997). Many colleges foster a research culture. Even though teaching is a concern, the relationship between the teaching culture and the research culture are not necessarily symbiotic (Barr & Tagg, 1998). In fact, there are sometimes political and social forces that get in the way. For example, faculty often have trouble getting funding to make instructional changes instead of following research pursuits. Administrators tell faculty to get outside funding if they want to try something new (Tobias, 1992).

Comfort Using Traditional Methods

It is common for undergraduate science faculty to have extensive experience in didactic teaching (Committee on Undergraduate Science Education, 1999). If faculty have been taught in didactic learning environments and employ primarily lecture techniques, it is often a difficult transition to the paradigm of science educational reform that is aligned with standards-based teaching (Committee on Undergraduate Science Education). To compound the difficulty in the paradigm shift, many of the classes that faculty members took when they were in undergraduate and graduate school were based on a didactic model of teaching in which knowledge was presumed to be transferring from the instructor to the student. Since they have not had training in education, they rely on their personal experiences to find models. As a result, many undergraduate science faculty have not adopted standards-based teaching methods.
Science Faculty Habits of Mind

Scientists are used to looking for definitive answers to problems. They sometimes approach teaching the same way. They think there must be some single answer that will fix all of the problems that prevent students from learning science. Tobias (1992) suggests that undergraduate science faculty should instead be finding multiple strategies to meet students’ needs. Since learning is a complex process and the needs of students are diverse, some strategies might work in one situation and not in another.

Training in Science, Not Necessarily Science Education

Most undergraduate science faculty have been trained as scientists and not science educators. They know how to do research because that is related to their training, but they have not had the opportunity to learn about pedagogy. Often faculty are unaware that they need to consider students’ learning styles and the conceptions that students bring from their cultural backgrounds. Others have never considered how to vary their instruction to meet the special learning needs of diverse student populations. Still others are unclear about how to make their courses student-centered.

Support for Adoption of Standards-Based Teaching

There is evidence that the undergraduate science faculty are beginning to use standards-based teaching methods. In recent years, Barr and Tagg (1998) have identified a paradigm shift that has begun with a change from a focus on instruction to one on learning. In the instruction paradigm, the purpose of college is to provide instruction. Productivity is measured in the cost per hour of instruction. In the learning paradigm, the
purpose of college is to foster student learning. It is a change, in line with the _NSES_ from a teacher-centered environment to a student-centered one in which the students actively construct their knowledge (Barr & Tagg; NRC, 1996).

Science faculty have started to write papers and report at conferences about how they have changed their teaching practices to be more student-centered (Glasson & McKenzie, 1997; Goldston, Clement, & Spears, 2002). They report that this supports their students learning but that it is a difficult transition to make. In some institutions, faculty are rewarded for integrating research about their teaching into their work. It has been predicted that by 2010, a student’s education from kindergarten through graduate school should be seamless (Rothman & Narum, 1999).

Tobias (1992) states that faculty who are working in successful reform-based settings speak passionately about the change. She found, in her 2-year study of undergraduate science programs, that the most successful programs are at 4-year and private institutions that do not have graduate students. These successful programs focused on the process of teaching and learning instead of only research. Tobias claims that the faculty who do not have to worry about tenure or promotion based on research are the ones who are making the change.

Colbeck, Cabrera, and Marine (2002) used survey methods to study tenure-track and tenured undergraduate engineering faculty in terms of the administrative and personal factors that influenced their use of lecture (traditional) or collaborative learning (innovative) teaching methods. The participating schools had been chosen a priori because of their emphasis on faculty use of “teamwork and design projects when teaching

40
undergraduates” (Colbeck et al., p. 4). The study investigated the relationship between faculty choice of teaching methods and demographic factors (rank, gender, and ethnicity); professional experience (industry, reform effort, funding, and publications); and motivational factors. The motivational factors were their goals for teaching, their skills, and their context beliefs. In the study, the faculty goals for teaching were defined as either the students learned teamwork and lifelong learning, design, and professional development, or they learned the fundamentals of engineering science. The faculty members identified their skills in terms of their abilities to solve ill-defined problems, to have effective formal communications, and to relate to others interpersonally. Colbeck et al. defined context beliefs as the faculty’s belief related to the potential rewards resulting from course innovations, grants, or publications and the faculty’s beliefs about the availability of resources such as clerical or administrative support, computer technology, library services, and faculty development.

Colbeck et al. (2002) found that the choices that the faculty made about their teaching practices were related to the faculty’s confidence about their performance. The study indicated that the faculty who were confident of their own interpersonal skills were more apt to use the nontraditional collaborative projects. On the other hand, if the faculty members were confident in their abilities to explain abstract concepts, they would be more apt to use lecture techniques. The lecture method was preferred by faculty who were not confident of their ability to solve ill-defined problems.
Characteristics of the Undergraduate Science Faculty Social System

Studies identify a struggle between the emphasis on research and the emphasis on teaching as a large problem for undergraduate faculty who are interested in their own teaching practices and their students’ learning (Rothman & Narum, 1999; Tobias, 1992). According to Paulson and Feldman (1998), the research culture is a dominant force in many undergraduate contexts, but the teaching culture is also a strong element. There is only a slightly symbiotic relationship between teaching and research. Paulsen and Feldman identify characteristics of undergraduate faculty cultures that support teaching such as (a) high-level and departmental administrators’ commitment and support, (b) faculty sharing values and a feeling of involvement and ownership, and (c) professional development.

Administration Participation

Paulsen and Feldman (1998) identify commitment and support from high-level administrators and department-level administrators as indicators of a culture that supports learning. It is important to note that this is also a common theme in the education change literature (Barr & Tagg, 1998; Fullan & Miles, 1992; Hall & Hord, 2001; Hord et al., 1987; Rothman & Narum, 1999; Tobias, 1992). If the administration does not support faculty spending time and energy on improving teaching practices, it is hard for the faculty to justify using time and energy that might otherwise be spent on research. Paulsen and Feldman state that for the teaching culture to thrive, administrators and faculty have to have shared values about teaching.
Faculty as Agents of Change

The second characteristic identified by Paulsen and Feldman (1998) is the involvement of faculty in the change process so that they can have a deep understanding of the importance of the change and feel a sense of ownership in effecting the change. The faculty members need to become active agents of change through their participation in planning for and implementation of improved teaching. Indications of this in the current study would be undergraduate science faculty learning about the NSES (NRC, 1996) and participating or leading professional development efforts to encourage these teaching methods in their departments or professional communities. Through this involvement, the faculty would develop shared values about standards-based teaching and would feel part of the change process. This could lead to a sense of ownership about learning environments that encourage standards-based teaching.

Teaching as a Focus for Employment and Faculty Rewards

Paulsen and Feldman (1998) state that if applicants for faculty positions are asked to demonstrate teaching or discuss pedagogy, it is an indicator that the undergraduate institution values excellent teaching. This sets the stage for the administrators and the faculty to have shared values about teaching. The shared value is further demonstrated if colleges and universities define scholarship in terms of teaching and service as well as research. If all three elements of scholarship are valued, then they all carry weight in the tenure and promotion system. Institutions that support the teaching environment also have rigorous peer and student evaluation of faculty members’ teaching practices. The hiring practices, the redefinition of scholarship, and the evaluation of teaching all send
the message to the faculty that their teaching efforts are valued and rewarded. This helps reduce the tension that often exists between the teaching and research cultures.

Faculty Discussion and Collaboration About Teaching-Related Issues

Paulsen and Feldman (1998) discuss how increased faculty collaboration helps the faculty reflect on their practices. In addition, it helps them recall the rewards they reap from teaching and increases their collegial camaraderie that helps prevent the isolation that often accompanies traditional teaching methods. Having focused discussions or other opportunities for the faculty to interact would increase the rate of diffusion of new ideas such as standards-based teaching (Rogers, 1995).

Professional Development Initiatives

Another indicator of an institutional environment that supports the teaching culture, according to Paulsen and Feldman (1998), is the presence of teaching centers or professional development programs. These professional development initiatives provide the faculty with needed support to facilitate the improvement of their teaching practices. The initiatives can also serve as a mode of communication and as agents of change for educational innovations.

Educational Digital Libraries (EDLs)

Rogers (1995) defines an innovation as something that is perceived as new by someone. Because the National STEM (Science, Technology, Engineering, and Mathematics) Digital Library (NSDL), a prime example of an Educational Digital Library (EDL), was launched in December 2002, it has not been available to the public
for very long. As a result, most people will perceive it to be new. Because the EDLs are a technology that supports STEM education, it can be considered a form of educational technology.

The roots of a STEM digital library began in 1999, when the National Research Council Committee on Undergraduate Science Education called for the publication and dissemination of STEM research and course materials. In response, the NSDL was created as a vehicle for disseminating high quality resources that are easily accessible (Zia, 2001). As the NSDL was conceived, several workshops were held to help identify challenges and tasks the NSDL would need to handle if the initiative was to be a success. The workshop participants identified user needs assessment as an important task. They felt that the faculty involved in a needs assessment should be at different stages in their academic careers and be drawn from a variety of postsecondary institutions. Questions surfaced such as: (a) Who are the potential users? (b) Would the faculty use the NSDL? (c) What support would they need to effectively use the digital resources in their courses (NRC, 1998)? These same questions are still being asked today.

Previous studies have investigated how digital libraries can be evaluated and how specific user needs were assessed as part of the evaluation. In the next section, background information about EDLs will be provided as well as a discussion of the evaluation of digital libraries and the use of educational technology to promote educational reform. In order to understand the relationships among undergraduate science faculty, standards-based teaching, and the EDLs, it is important to be familiar with examples of EDLs.
Examples of Educational Digital Libraries

Multimedia Educational Resource for Learning and Online Teaching (MERLOT)

The creation of the Multimedia Educational Resource for Learning and Online Teaching (http://www.merlot.org/Home.po) in 1997 by the California State University Center for Distributed Learning positioned it to be one of the forefathers of educational digital libraries. It has an extensive collection of links to online resources for undergraduate faculty and students in mathematics, science, and technology as well as links to art, business, education, humanities, and social studies. These resources range in size from entire websites to individual activities. Part of the strength of MERLOT is its emphasis on community. Individual members and faculty from member institutions have contributed to both the development of this digital library as well as the ongoing peer review of resources in its collection.

Visitors to MERLOT can use a basic search, advanced search, or browse lists of resources by subject term. Users can choose to limit search returns based on an advanced search query that makes use of up to 20 metadata fields. The resources in the MERLOT collection have been contributed by members of the MERLOT community, either the authors or fans of the resources.

From the MERLOT catalog record of a resource, the user can connect directly to the resource or link to the peer reviews, contact the authors, or locate other resources with similar topics. The catalog record has a description of the resource and other metadata such as technical format, rights, and primary audience. Member comments or peer reviews written by faculty serving on editorial committees are often associated with the
catalog record. Users can contribute “assignments,” descriptions of how a particular resource can be used, which can help other users envision the variety of ways that they themselves can use the learning resource. Each visitor to the MERLOT site can establish a personal collection and continually add resources to it.

*Digital Library for Earth System Education (DLESE)*

The Digital Library for Earth System Education (http://www.dlese.org/dds/index.jsp) also is a community-based project. Educators, students, and scientists work together to improve Earth systems teaching and learning at all levels. The development of this digital library began with funding from the Award to Facilitate Geoscience Education (NSF 97-174) from the Geosciences Directorate of the National Science Foundation.

DLESE provides access to collections of digital Earth systems resources for teachers and learners, such as lesson plans, images, data sets, assessments, and online courses. A subset of exemplary resources are in the DLESE Reviewed Collection (DRC). To insure that the resources are high quality, DRC best practices identify criteria such as scientific accuracy, information about pedagogical effectiveness, and the ease of use of the resource.

Users can find resources with the search or browse features that are described accurately and consistently. The DLESE descriptions are created by Earth system educators, scientists, and librarians to ensure accuracy and relevance to the users. The records have educational descriptors such as grade level and educational standard. Bibliographic descriptors include creator, technical requirements, and resource type.
Users can find resources by browsing the DLESE collection by subject, resource type, or grade level. The reviewed and thematic collections can also be browsed.

MathDL

MathDL (http://www.mathdl.org/) is a digital library that is funded by NSF, managed by the Mathematics Association of America, and hosted by Math Forum. MathDL provides access to both the *Journal of Online Mathematics and Its Applications (JOMA)* and a collection of digital classroom resources for undergraduate mathematics teaching and learning. Faculty can become part of the MathDL community by contributing resources, peer reviewing resources, or moderating discussions about resources.

The Digital Classroom Resources (DCR) record contains bibliographic (author and title), educational (intended uses and appropriate courses), and technical (software specifications) information about the resource. It also offers a review based on classroom teaching and peer review. Visitors also can link to a moderated discussion about the resource.

Communities for Physics and Astronomy Digital Resources in Education (comPADRE)

The Communities for Physics and Astronomy Digital Resources in Education (http://www.compadre.org/) is designed to help people who belong to or identify with the following institutions: the American Association of Physics Teachers (AAPT), the American Physical Society (APS), the American Astronomical Society (AAS), or the American Institute of Physics/Society of Physics Students (AIP/SPS). Users can find resources from collections focused on the different fields in physics and astronomy. These fields include: introductory astronomy, quantum physics, student resources, high
school teachers' resources, and public education. When users enter a query in the Physical Science Resource Center on the comPADRE site, they can limit their search by subject, author, and/or organization. It has bibliographic (such as author and cost), educational (such as intended levels and intended users), and technical information (such as format).

At this time, comPADRE is not as mature as some of the other mathematics and science educational digital libraries. Among the comPADRE development plans for the next few years are increasing the depth and breadth of the collections, building on the value of the records of the resources by including professional reviews, and establishing community interactions to promote advancement in physics and astronomy teaching and learning.

*BiosciEdNet (BEN)*

BiosciEdNet (http://www.biosciednet.org/portal/) is a project of the American Association for the Advancement of Science (AAAS) that provides access to life sciences resources for students from preschool through professional and continuing education. When visitors use a basic or advanced search or browse by subject area or resource type, they can open records that display bibliographic (author, publisher); educational (context); and technical information about the resource.

*The MicrobeLibrary*

The MicrobeLibrary (http://www.microbelibrary.org/) offers access to a peer reviewed collection of digital resources focused on the microbial world for undergraduate faculty and students in the life sciences. The resources in the MicrobeLibrary can also be accessed through BEN. It is linked to the American Society for Microbiology (ASM)
recommended core curriculum for introductory microbiology courses. It offers images, activities, articles from the *Focus on Microbiology Education* newsletter, and columns and reviews from the *ASM News*.

**The Learning Matrix**

The Learning Matrix (http://thelearningmatrix.enc.org) is a digital library collection for undergraduate mathematics and science faculty that was developed at the Eisenhower National Clearinghouse. Its goal is to support the extension of the implementation of the *NSES* for teaching into the undergraduate setting. It contains resources that have been selected for the collection by mathematics and science content specialists and described in bibliographic, educational, and technical terms. The resources range from entire websites to individual simulations, images, or articles. Educational fields that describe the difficulty, level of interactivity, and suggestions for use can help faculty in their selection and use of the resource. Users can link directly from the catalog record to descriptions of related resources. Users can use a basic or advanced search as well as a browse feature to locate and access resources. The advanced search allows the user to narrow their query by up to 14 different types of descriptors. The collection includes both resources for classroom use and faculty professional development.

**iLumina**

Faculty can find undergraduate teaching materials for chemistry, biology, physics, mathematics, and computer science in iLumina (http://turing.bear.uncw.edu/iLumina/index.asp). The resources in this digital library range in granularity from individual images and video clips to entire collections of
resources or courses. iLumina catalog records offer bibliographic, educational, and technical descriptions of the resources. Users can use a basic or advanced search feature or browse the resources described in the iLumina digital library. The advanced search allows users to limit their queries by descriptors such as subject, keyword, or level of interactivity. Users can browse by discipline, resource type, structure, media type, or contributor. The catalog record describes the resource in bibliographic, educational, and technical terms. Users also can see a description of different collections such as microscopy images, water mold videos, or calculus Maple worksheets. From the overview description of the collection, users can link to a list of all of the individual resources in the collection.

The Virtual Skeletons Project

The Virtual Skeletons Project (http://www.eskeletons.org/) allows visitors to access information about the bones of a human, gorilla, or baboon. The user selects a bone from one of the three organisms and then chooses to see a QuickTime movie about the bone, look at the origin or insertion points, or compare the bone to the same bone in a different organism. The user also can virtually manipulate the bone into other viewing positions.

National Science Digital Library (NSDL)

In December, 2002, the National Science Foundation (NSF) launched the main portal into the NSDL. This digital library was designed to transform “great piles of content” into “piles of great content” so that users could reliably find excellent resources. The resources were to be cataloged at a small enough level of granularity that users could reuse and repurpose them as part of their suite of tools to facilitate learning (Zia, 2001).
NSF wants to support standards-based learning by providing access to the very best curricular and professional development digital resources (National Science Foundation, 2000).

At the time that the idea for the NSDL was conceived, the amount of digital resources available on the Web was beginning to grow rapidly. These resources ranged from text explaining mathematics and science concepts and hard-to-find images to tutorials and simulations that gave learners more control as they explored new ideas. Individual teachers or institutions might have had access to small groups of the resources but they have been hard to find and difficult to access. The NSF created the NSDL so that the resources could be described and organized into focused collections. The information from the distributed collections can be searched so that users can find and access exactly what they want when they want it. Currently, the collections in the NSDL span a range of disciplines, formats, and intended end-user ages and roles.

The NSDL describes itself as

a digital library of **exemplary resource collections and services**, organized in support of science education at all levels. Starting with a **partnership** of NSDL-funded projects, NSDL is emerging as a **center of innovation** in digital libraries as applied to education, and a **community center** for groups focused on digital-library-enabled science education (National Science Digital Library, 2002, paragraph 1)

It could be asked how the collections are ensuring the high quality of the resources and how can the resources support STEM education. Many of the collections, such as the Gender and Science Digital Library (http://gsdl.enc.org/), the Learning Matrix (www.thelearningmatrix.enc.org), and the Eisenhower National Clearinghouse (http://enc.org/) are choosing science resources that have content and reflect pedagogy described in the **NSES** (NRC, 1996).
For the collections within the NSDL to be effective, they must be designed with the user in mind, but only a small number of studies have addressed the user needs in digital library development (Covi, 2000; McMartin, 1999; Salwasser & Murray-Rust, 2002). To understand user needs, it is important to have a thorough description of the intended users’ attitudes and practices related to the digital library. Since the user population of the NSDL includes undergraduate science faculty, questions need to be asked about their receptivity to student-centered, standards-based resources as well as the supports they need to make effective use of the NSDL.

The digital learning environment has been built through the work of five categories of projects funded by the National Science Foundation. These groups are Services, Targeted Research, Core Integration, Collections, and Pathways. The Services projects enhance the NDSL environment through the design of added-value features, such as the Instructional Architect (http://ia.usu.edu/app_user/) that helps users assemble digital lesson plans with learning objects found within the NSDL. The targeted research projects are investigating topics that range from the development of evaluation protocols for the NSDL to the incorporation of digital resources into online courses. The Core Integration projects weave the products of the other projects together into a functioning single unit. The Collections projects identify and describe outstanding digital STEM resources. The Pathways projects are designed to provide user-specific portals that support access to content and services. The current study focuses on how the collections in the NSDL meet the needs of undergraduate science faculty.
Technology Support of Education

Standards-based teaching and EDLs are reciprocally linked. Digital resources can support standards-based teaching with resources to help faculty develop student conceptual understanding, use inquiry methods, use textbooks as a reference, respond to student diversity, use computers, create a student-centered environment, and use multiple means of assessment. EDLs contain resources for direct student use as well as faculty professional development resources. Conversely, faculty who use standards-based teaching methods may search EDLs for resources for their students to use or for their own professional development.

Barbara Means (1994b) states that the school reform movement and technology in the classrooms were two of the most significant trends in education in the 1990s. She identifies school reform and technology as innovations that do not always occur together. “The key to the partnership lies in educators’ developing reformed sets of curricular and instructional goals and then using technology as a tool to support these goal” (Means, p. 4). The educators must be convinced that the technology will have a positive effect on education for a positive effect to occur. Means says that technology can act as a stimulus for educational reform because the implementation of technology is often accompanied by a financial investment. Frequently when there is money at stake, the decision-makers reflect on the value of what is being done. The result is that the innovations in educational reform and educational technology go hand in hand (David, 1994).

EDLs are just one component of an ever growing array of technology supports for education. As educational technology has developed, critics have stated that computers have not enhanced the education process. Ragsdale (1997) warns that the advantages of
technological advances in education are often accompanied by unintended side effects such as student use of the television, student misuse of educational software, and gender differences regarding the use of technology that result in differential achievement. He thinks that it is important to identify these potential problems in advance to limit the side effects.

Jane David (1994) states that the advantages of educational technology have not been realized because the wrong questions have been asked. As long as educators limit their use of technology to tasks that were already being accomplished in other ways, the full potential of the technology will not be used. The potential of technology will not be realized unless it is used to transform how teaching and learning occurred in the past. Instead of asking how to improve the effectiveness of current education practices, it should be asked, how can technology help transform education? Because designers are not creating the technology with education in mind, educational applications are often afterthoughts. Educators think of how they can replace an old technology with a new one, instead of considering what new tasks are unachievable with the old technology (Means, 1994b). Both the designers and the educators need to be considering the current unachievable tasks when evaluating the potential of educational technology.

David (1994) states that the reason that technology has not been used to transform education is because teachers have not had enough training about how to use computer applications. She lists the requirements for effective use of technology as professional development, access, technical support, and functionality (support the use for which it
was intended). Means (1994b) agrees that the education system needs to make provisions for technical professional development to help teachers understand how to use the computers as tools.

The current study is an example of how technology and educational reform can work synergistically. Standards-based teaching is a component of educational reform. EDLs use technology to help provide access to curricular resources and professional development that support the innovation of standards-based teaching, which may further support educational reform. The current study will help identify what provisions need to be made to help undergraduate science faculty use EDLs as a tool.

**Previous Evaluation of Digital Libraries**

Some work has already been done to determine if user needs have been met by digital libraries. The studies range from evaluating the user’s comfort with the digital library interfaces to the distribution of subjects covered in a digital library. The motivation for conducting these studies also varies. Some studies are done to evaluate the success of a digital library by monitoring usage patterns (Bishop, 1995; Bollen & Luce, 2002). Other studies are conducted to help digital libraries prioritize how they expend their resources by focusing on the aspects that are most important to the users (Choudhury et al., 2002). Still others emphasize the importance of considering user needs in all phases of the digital library design process (VanHouse, Butler, Ogle, & Schiff, 1996). Unfortunately, many digital libraries are constructed and maintained without considering the users. As Salwasser and Murray-Rust (2002) point out, many digital libraries are built with the philosophy that if the developers build it, the users will come.
Bishop (1995) called for an informal User Research Working Group to coordinate the collaboration of the Digital Library Initiative (DLI) projects, funded jointly by the National Science Foundation (NSF), the Advanced Research Projects Agency (ARPA), and the National Aeronautics and Space Administration (NASA). This working group shared information to synchronize the work of the members. Their work focused on the following: (a) how well the collection met users’ needs as well as users’ experiences with the digital library interfaces and usability, (b) what behaviors the users exhibit as they search the digital libraries and retrieve resources, (c) how the digital library affects users’ work, and (d) how the digital library impacts public policy. The 1995 Allerton Institute conducted by the Graduate School of Library and Information Science at the University of Illinois was an offshoot of the working group. The institute focused on issues ranging from digital library evaluation metrics to communications among digital library researchers, users, and developers.

Another approach to assessing user needs is to analyze document retrieval patterns from the digital library server. This approach allows the investigator to reconstruct the users’ thought processes as they moved from one document to another. The benefit of this approach is that the analysis can be done on an ongoing basis as opposed to the snapshot that comes from surveying user preferences (Bollen & Luce, 2002). A shortcoming of this approach is that it only assesses the activities and suggests preferences and needs of the current users. It does not take into consideration what potential users might need.

Salwasser and Murray-Rust (2002) conducted a needs assessment at the Oregon State University libraries to guide the design, content, and development of a natural resources
digital library. They used interviews to determine how easily the users could access the digital library and how well they could understand the process involved in the digital library. Most of their participants, who were citizens, policy makers, and scientists, indicated that they were either somewhat familiar or familiar with digital libraries and all had a good understanding of what digital libraries could feature.

One study used a combination of qualitative and quantitative methods to investigate the relationship between what educators think are quality indicators of resources within a collection as well the collection itself and their level of use of them in their classrooms (Sumner, Khoo, Recker, & Marlino, 2003). Participants were gathered in one of five focus groups clustered by grade bands (K-5, 6-12, and undergraduate grade bands). In the focus groups, the participants were asked to identify quality indicators that would be used to inform their digital library policies, priorities, and practices. The group reviewed 18 web sites that were selected from the DLESE and NSDL collections. They completed worksheets that asked for demographic data and computer and classroom experience. The worksheets also contained rubrics that the participants used to evaluate the content quality, advertising, scientific bias, and design and usability of the visited sites. The educators used the rubrics with a 7-point Likert scale and open responses to identify factors that positively and negatively influenced the evaluations of the websites. Then the entire group discussed the quality indicators related to characteristics and the researchers recorded the comments on a whiteboard as well as on audio tape. During the discussion, participants explained their attitudes related to the quality indicators and ways the quality indicators may affect classroom use. The data were analyzed for the individuals and the group. Four out of five groups identified resource quality as important and bias as
undesirable. All groups indicated disfavor with the design and usability of many of the
web sites and found distractions to be a design and usability flaw. There were mixed
messages in terms of the advertising on the sites. Participants mentioned that they did not
like advertising, but also mentioned that they did not mind it if the advertisements did not
distract from student learning. The authors believe that the study underscores the
importance of using a combination of qualitative and qualitative methods for digital
library evaluation. They also feel that it illustrates the value that EDLs can have for
teachers looking for digital resources (Sumner et al.).

Summary

This chapter provided the framework for the investigation of standards-based
teaching and EDLs as innovations, undergraduate science faculty as potential adopters of
these innovations, and the models that were used in the current study as lenses to view
the innovations and the adopters. It discussed innovation and change in terms of the
nature of innovation, characteristics of innovations that affect rates of adoption, and
successful strategies for the adoption process. The CBAM was reviewed and its three
components, Stages of Concern, Levels of Use, and Innovation Configuration, were
described. In addition, examples of the application of CBAM related to educational and
technological change were reviewed. The chapter contains an examination of the
educational innovations of standards-based teaching and EDLs. It outlined the
characteristics of standards-based teaching and discussed teacher roles in systemic
planning for standards-based teaching. Both obstacles and supports for the adoption of
standards-based teaching were presented. Examples of EDLs were provided and the role
of technology in the support of education was discussed. The chapter also provided
examples of previous EDL evaluation efforts.
CHAPTER 3
METHODOLOGY

Introduction

The purpose of this chapter is to describe the methods and procedures used in the current study. In this study, a contextually-based collective case study of undergraduate science faculty members was used to develop a grounded, descriptive theoretical model to examine their receptivity to and use of the innovations of standards-based teaching and Educational Digital Libraries (EDLs). This chapter will begin with a discussion of the reasoning behind the methodology selection. It will then move on to a description of the study sample and the surveys and protocols used to collect the data. This description will include the data collection methods, with an examination of all the study tools, including the researcher, the surveys, group meetings, semi-structured interviews, and document analyses. All quotes and examples preserve the language of the data sources. In addition, the chapter will describe the data analysis methods and the techniques used to ensure the trustworthiness and authenticity of the study. Finally, ideas for the utilization of and the limitations of the study are discussed.

To promote shared understanding and ease of communication, care was taken to maintain consistent terminology among all of the data collection methods. The exception to this rule was the use of the terms “student-centered” and “learner-centered,” which were applied interchangeably to reflect the language in current education documents. The
term “student-centered” was used regarding the Standards-Based Teaching Instrument and the term “learner-centered” was used in the semi-structured interviews and document analyses.

Methodology Selection

The objective of this study is to describe and develop a theoretical model about undergraduate science faculty’s adoption of standards-based teaching and EDLs. To date, information about undergraduate faculty and their use of standards-based teaching methods and EDLs is very limited. When little previous information is available, the stage needs to be set for future research and descriptive studies can provide this foundation. Surveys and qualitative research methods are often used in descriptive research (Fraenkel & Wallen, 2000). The purpose of the description is to help make sense of undergraduate science faculty’s feelings and practices related to the innovations of standards-based teaching and EDLs. Because qualitative research is designed to help make sense of the way that people interpret the world around them, qualitative research methods are appropriate for this study (Merriam, 1998).

The constructivist paradigm in qualitative research chosen for this study was appropriate for several reasons. With a constructivist paradigm, the reality is locally constructed from a subjective viewpoint. The aim is to understand the situation better and the researcher facilitates the reconstruction of the participants’ voices (Guba & Lincoln, 1994). Because I was building a theoretical model, my perspective, the local context, and giving the participants voice were important.
Because of my experience as an undergraduate science faculty member and EDL collections developer, I have a unique perspective with regard to undergraduate science faculty and their adoption of standards-based teaching methods and EDLs. The fact that I have had similar professional experiences and a learning curve that included initial resistance to standards-based teaching methods has allowed me to be an empathetic researcher. This was useful in my understanding the ways to approach the study and the meanings behind the data. My sympathetic perspective during the development of the theoretical model may help to strengthen the study.

In order to develop the theoretical model, I decided to develop collective cases, undergraduate science faculty in 2- and 4-year institutions, to investigate how their institution type and their discipline impact their reaction to different aspects of the change process as they adopt the two innovations. The decision to develop case studies was appropriate because this study will be particularistic, descriptive, and heuristic. It will be particularistic in that the research questions are focused on how the undergraduate science faculty are reacting to the change process. The study will be descriptive in that the case descriptions will depict the complexities of the adoption of standards-based teaching methods and EDLs by conveying each individual’s background information, professional environment, discipline, feelings of preparedness for and use of standards-based teaching methods, and concerns about EDLs. The study will be heuristic in that the study is designed to help the reader better understand undergraduate science faculty members’ feelings about and adoption of standards-based teaching and EDLs as well as why the participants might or might not be an adopter of and/or agent of change for each innovation (Merriam, 1998).
In addition, the decision to develop case studies was appropriate because the investigation of the research questions does not require control over behavioral events and focuses on contemporary events. This is a descriptive study about undergraduate science faculty members’ feelings about and use of two contemporary innovations. If the questions were focused on questions that began with what, where, or how much; if the behavior needed to be controlled; or if the study focused on historical events, other research methods such as archival analyses or experiments would have been selected (Yin, 1989).

Because the goal of the study is to develop a theoretical model, instrumental cases were integrated into a collective case study. Instrumental cases differ from intrinsic case studies in that the former is used to develop theory about the case whereas the latter is used to better understand the case. In instrumental case studies, the researcher is interested in how specific aspects of the theory are exhibited in the case. Since many of the issues were known in advance, it is appropriate to use pre-designed instruments (Stake, 1994).

The Study Sample

This study used a theory-driven process of assembling a purposive convenience sample of undergraduate science faculty to complete the three surveys. Since the study seeks information about faculty teaching life science, chemistry, physics, or geology at 2- and 4- year institutions, participants from those communities were invited to the group meetings. As the data from the group meetings and the surveys were analyzed, individuals were selected to participate in interviews. A theory-driven sample uses criteria that have been identified a priori. The participants can be chosen because of their
role in an organization (Johnson, 1990). In this study, participants were members of the science faculty at a 2-year undergraduate institution or a Midwestern 4-year research university, which were each selected because of their proximity to the researcher. All of the faculty in the sciences are housed in one Biological and Physical Sciences Department in the 2-year institution whereas each science discipline has its own department in the 4-year institution (i.e., Biological Sciences, Chemistry, Physics, and Geology).

Initially, the chairperson of each science department at each institution was approached by e-mail (see Appendix A). There was a mixed response to this approach. At the 2-year institution, all of the biological and physical sciences faculty are grouped into one department. The chairperson in that department gave the researcher permission to invite the faculty to the meetings and offered to arrange the meeting space, but did not want to extend the invitation himself. He felt that it would imply a job responsibility that was beyond the bounds of the faculty union contracts. Instead, I extended the invitation to the faculty and made additional contacts with known leaders in the department. The meetings that resulted were sparsely attended, with two people attending one session and one person attending each of two additional sessions.

In the 4-year institutional setting, three of the chairpersons (i.e., geology, chemistry, and physics) were not involved in the group meetings because they suggested that I contact someone else or because they did not respond at all. One chairperson who did respond provided tremendous support, extending encouraging invitations to the faculty and arranging for meeting spaces for the sessions. It can be noted that this chairperson also is involved in teaching the entry level courses in that department. In the remaining
three departments, faculty leaders in the department were contacted and they extended
the invitation to their colleagues. The faculty leaders served as liaisons between the group
participants and the researcher.

The sample self-selection process began when faculty chose to accept an invitation to
participate in group discussions about their teaching methods and EDLs. (See sample e-
mail invitation to group meeting in Appendix B.) Each faculty member only attended
one group meeting. The number of participants within each discipline who attended a
group meeting at each institution is listed in Table 3.1.

<table>
<thead>
<tr>
<th>Discipline</th>
<th>2-Year Institution</th>
<th>4-Year Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life science</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Chemistry</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Physics</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Geology</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>39</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>43</td>
</tr>
</tbody>
</table>

Table 3.1: Number of participants in group meetings identified by type of institution and
discipline.

Eight faculty, selected as a subset of those that attended the group meetings,
completed the surveys (i.e., the Demographics and Experience Questionnaire, the
Standards-Based Teaching Instrument, and the Stages of Concern Questionnaire)
distributed during the meetings. This subset was asked to participate in semi-structured
interviews. The sub-sample selection process was done to ensure one representative for
each of the science disciplines at each of the institutional types. Additional selection
criteria were the participants’ availability for the interview process and the completeness
of their responses in the surveys. An attempt was made to get a balance of males and
females, but because of availability and those willing to participate, only one female was
in the final group of eight. These eight faculty included one life science, chemistry,
physics, and geology instructor from both the 2-year institution and the 4-year institution.
Background information about the participants can be found in Table 3.2. This
combination of faculty provided descriptions that captured differences between faculty
members’ disciplines and the contexts of their work environments.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Rank/ Title</th>
<th>Tenured</th>
<th>Discipline</th>
<th>Years teaching higher education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-Year Institution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Associate Professor</td>
<td>Yes</td>
<td>Life science</td>
<td>20</td>
</tr>
<tr>
<td>Male</td>
<td>Assistant Professor</td>
<td>Yes</td>
<td>Chemistry</td>
<td>30</td>
</tr>
<tr>
<td>Male</td>
<td>Instructor</td>
<td>No</td>
<td>Physics</td>
<td>7</td>
</tr>
<tr>
<td>Male</td>
<td>Assistant Professor</td>
<td>No</td>
<td>Geology</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4-Year Institution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Professor</td>
<td>Yes</td>
<td>Life science</td>
<td>25</td>
</tr>
<tr>
<td>Male</td>
<td>Assistant Professor</td>
<td>No</td>
<td>Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>Male</td>
<td>Professor</td>
<td>No, retired</td>
<td>Physics</td>
<td>47</td>
</tr>
<tr>
<td>Male</td>
<td>Associate Professor</td>
<td>Yes</td>
<td>Geology</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 3.2: Interview participants’ background information.

Study Tools and Protocols

*The Researcher as Research Tool*

In a study in which data are interpreted to develop theory, the researcher is one of the
tools. Researcher bias could have a big effect on how the data are understood and what
inferences are made to develop the theory. As Valerie Janesick (1994) states, “There is no value-free or bias-free design” (p. 212). As I analyzed the data and developed the theory, my interactions with faculty as instructors, colleagues, and users of EDLs colored my view. Like Bauman (1997) and Carpenter (1999), I was very aware of the practical and ethical considerations of being both inside the system and out. I had been an instructor at a 2-year undergraduate institution, had worked with many of the participants on various projects, and was deeply involved in the development of digital libraries. It was important for me to find the appropriate balance between helping the participants to understand the innovations of standards-based teaching and EDLs while at the same time gathering information to help me understand their perspectives and use of these innovations. For this reason and to give a picture of my own conceptual continuum, I will briefly describe my educational and professional experience.

My undergraduate and master’s work was in zoology, specifically zooplankton ecology, at large Midwestern 4-year institutions. After I received my Master’s Degree, I worked in the Biological Sciences Department at my alma mater as a laboratory preparator. In this position, I worked with the biology faculty to plan and manage laboratory activities.

Two years later, I became adjunct faculty at a 2-year undergraduate institution and taught a variety of biology courses. At first, I taught undergraduate biology to inmates in a women’s reformatory and to the staff in a mental hospital, but after approximately 1 ½ years, I began teaching on the school’s main campus. As adjunct faculty, I had the same rights and many of the responsibilities of the full-time faculty and collaborated with both full-time and adjunct faculty. I was given a course description, the text, and the
laboratory schedule, but was allowed to conduct my classes any way I liked. I developed my own assessments and planned lectures, lessons, and activities.

After teaching for 15 years, I decided that I needed to have a better background in science education, so I returned to my alma mater for a doctoral program. During my doctoral studies, I could see my attitudes changing. I started the program not knowing about standards-based teaching. When I learned what it was, it took me a while to be convinced that it would work. Teaching theories such as constructivism and discovery learning seemed contrived and not likely to be effective. Slowly, I read enough and saw enough examples that I became convinced that standards-based teaching would be helpful on the undergraduate level.

During my doctoral studies, I began working at an organization that developed EDL collections. For the past 3 years, I have become immersed in the digital library world. I have helped design both the infrastructure behind and the user interface for digital library collections. As I have made these decisions, I have made assumptions about the potential users of our collections, many of whom are undergraduate science faculty. I have also made assumptions about the resources selected for the collections. One of these assumptions is that collecting resources that support standards-based teaching would help attract users interested in improving their instructional practices. Another assumption is that if EDL users are regularly exposed to standards-based resources, they will start adopting standards-based teaching methods.

As I developed the collective case studies and theories, I repeatedly reflected upon my personal experiences and assumptions related to undergraduate science faculty, their attitudes about and use of standards-based teaching methods, and their concerns about
EDLs. Instead of trying to set aside my perspective, I exploited it to give me an embedded viewpoint. I was aware that I would not be objective, but felt that my experiences gave me an advantage to better understand the cases and their environments as well as the innovations of standards-based teaching and EDLs.

**Surveys**

Three survey questionnaires were used in this study. The Demographics and Experience Questionnaire was used to gather background information about the participants. On the Standards-Based Teaching Instrument, the participants had the opportunity to identify their feelings of preparedness for and their frequency of use of a variety of standards-based teaching methods. The Stages of Concern Questionnaire was administered to identify the participants’ highest relative intensity concerns about EDLs.

**Demographics and Experience Questionnaire**

To create a rich description of the professional context of undergraduate science faculty, the Demographics and Experience Questionnaire was used to gather data for the background facet. These data included the participant’s gender, age, years of experience teaching at the undergraduate level, years of experience teaching science at the undergraduate level, academic rank, tenure status, principal scientific discipline, number of classes taught each year, and type of support from graduate assistant instructors. (See Appendix C for the complete instrument.)

**Standards-Based Teaching Instrument**

The participants’ responses to the Standards-Based Teaching Instrument were used to describe the participants in terms of their feelings of preparedness for and frequency of use of standards-based teaching methods. The items in the instrument were selected from
the Science Questionnaire (Teacher) Instrument of the *2000 National Survey of Mathematics and Science Education* (Horizon Research, 2001). The items in the original instrument were compiled from earlier national surveys and reviewed by panels of experts. The original instrument was revised, field tested, and revised again resulting in 44 items (Hudson, McMahon, & Overstreet, 2002). The reliability of the items were calculated by composite groups. The reliability (Cronbach’s Coefficient Alpha) of composite groups of items in the instrument are the following: Nature of Science Objective = 0.84, Science Content Objective = 0.60, Use of Traditional Teaching Practices = 0.71, Use of Strategies to Develop Student’s Abilities to Communicate Ideas = 0.79, Use of Computers = 0.91, Use of Laboratory Activities = 0.80 (Weiss, Pasley, Smith, Banilower, & Heck, 2003).

In the current study, 42 items regarding standards-based teaching methods were selected from the original instrument and re-configured into a format designed to be appealing to and efficient for use by the respondents. The criterion for the inclusion of items into the study instrument was the item’s relevance to standards-based, undergraduate science teaching. In order to determine the respondents’ preparedness for and implementation of the methods identified in the instrument, the selected items were changed from multiple choice questions to 42 stems and were placed in a center column with a Likert-scale of preparedness choices on the right and the implementation choices on the left. The preparedness choices were not adequately prepared, somewhat prepared, fairly well prepared, and very well prepared (scored 0-3 respectively), resulting in a range of scores from 0 to 126. The implementation choices were never; sometimes (e.g., once or twice a month); often (e.g., once or twice a week); and all or almost all science lessons
(scored 0-3 respectively), resulting in a range of scores from 0 to 126. This arrangement allowed the respondents to consider the stem in terms of both characteristics without having to repeatedly read the stem. The items in this section were clustered in sections about particular topics, such as the faculty members’ encouragement of students, use of the Internet in instruction, and assessment techniques.

In addition, the respondents marked yes or no to six questions about their professional development activities. These questions asked the participant if s/he had participated in professional development, mentored other faculty in terms of their teaching of science, taken science education courses, observed other faculty teaching as part of the participant’s professional development, met with other faculty to discuss science teaching, and attended a national or state science teaching association meeting. (See Appendix D for the Standards-Based Teaching Instrument.)

**Stages of Concern Questionnaire (SoCQ)**

The SoCQ was used to gather data about participants’ concerns in their adoption of EDLs. Even though the Stages of Concern (SoC) can be determined with using face-to-face conversations, open-ended questions, or the SoCQ, the SoCQ was selected because of its reliability, validity, and ease of use. This instrument was developed by a group at the Texas Research and Development Center to assess users’ concerns so that appropriate support could be provided to facilitate their adoption of the educational innovation. The instrument is based on research about teachers’ concerns (Hall et al., 1998).

Hall et al. (1998) describe the development and testing of the SoCQ, which began with 544 items that were written by the Concerns-Based Adoption Model (CBAM) research development staff. Of these items, 195 were incorporated into a pilot instrument
that was sent in 1974 to K-12 teachers and college faculty. The pilot instruments were used to study the innovations “teaming in elementary schools” and “instructional modules in colleges.” Of those questionnaires distributed, 359 were returned. The resulting data were used for both an item correlation and factor analysis. The researchers conducted follow-up interviews with a group of respondents. From the information garnered through these interviews, the researchers classified the participants in terms of their concerns. Expert judges correlated the interview classifications to the participants’ classifications based on the 195-item questionnaire. A 35-item questionnaire was created as a result of the pilot study. Following the pilot study, the questionnaire was then tested in cross-sectional and longitudinal studies with 11 different innovations over a 2-year period.

The 35 items on the instrument are designed to identify the respondents’ stages of concern about the innovation. The categories of stages of concern are awareness, informational, personal, management, consequence, collaboration, and refocusing (see Table 3.3). Because the stages are considered to be developmental but not necessarily sequential, a person’s path to complete adoption is not necessarily linear. A potential adopter could move from personal concerns to management concerns and then back to informational concerns.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Awareness</strong></td>
<td>Little concern about or involvement with the innovation is indicated.</td>
</tr>
<tr>
<td><strong>Informational</strong></td>
<td>A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about herself/himself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.</td>
</tr>
<tr>
<td><strong>Personal</strong></td>
<td>Individual is uncertain about the demands of the innovation, her/his inadequacy to meet those demands, and her/his role with the innovation. This includes analysis of her/his role in relation to the reward structure of the organization, decision making, and considerations of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td>Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.</td>
</tr>
<tr>
<td><strong>Consequence</strong></td>
<td>Attention focused on impact of the innovation on student in her/his immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.</td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td>The focus is on coordination and cooperation with others regarding use of the innovation.</td>
</tr>
<tr>
<td><strong>Refocusing</strong></td>
<td>The focus is on exploration of more universal benefits from innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.</td>
</tr>
</tbody>
</table>


**Table 3.3: Stages of concern about the innovation.**

The questionnaire has five separate items about each of the seven stages of concern (5 items X 7 stages of concern = 35 items). The respondents characterize how accurately the items describe them with Likert-scale responses. The responses range from 0 representing irrelevant, 1 representing not true of me now, 2-5 representing somewhat
true of me now, and 6-7 representing very true of me now. The respondent’s stages of concern profile is calculated by tabulating their scores (0-7) for each of the five questions about each stage of concern and converting the totals to percentiles of relative concern intensity based on a chart derived from the instrument validity studies (Hall et al., 1998). For example, if a respondent scored the five items about awareness concerns 4, 3, 5, 6, 2, they would have a sum of 20 which converts to the 98th percentile for relative intensity for that concern. The only modification of the SoCQ in this study from its original design is the replacement of the word “innovation” with the words “educational digital library” (see Appendix E). This modification was done with the permission of the Southwest Educational Development Laboratory. Similar modifications have been performed in other studies (Newhouse, 2001).

The 35-item questionnaire was subjected to a test-retest reliability check with higher education and elementary educators. There was a 77% response rate for the retest. The alphas for the coefficients of internal reliability for each of the seven stages of concern addressed in the questionnaire ranged from .64 to .83 (n = 830). The Pearson Product Moment Correlations test re-test (n = 132) ranged from .65 to .86 Based on these analyses, SoCQ is judged to be a reliable instrument (Hall et al., 1998).

As a validity check, the SoCQ results were compared to the results of an open-ended questionnaire assessing respondents’ stages of concern, a formal interview protocol, and a pre-SoCQ audio-taped evaluation. In all of these cases, although the results were encouraging, not all were significant for all of the Stages of Concern. Longitudinal studies have been conducted that indicate the validity of the SoCQ by demonstrating significant predicted changes in concerns as a result of an intervention (Hall et al., 1998).
Other studies in the literature support the validity of this instrument (Newhouse, 2001). For example, the conclusions from the work of Hall et al. are that the SoCQ “accurately measures Stages of Concern about the Innovation. In fact, the SoC Questionnaire appears to do an even better job than other measures and clinical judgments” (p. 10).

CBAM has two components in addition to the SoC. They are the Levels of Use and Innovation Configuration. These aspects of CBAM were not implemented in the current study because the focus was on the participants’ concerns.

*Group Meetings*

The group meetings were designed with three goals in mind: (a) to provide faculty with information about EDLs that could support their teaching, (b) to provide the faculty with a forum to discuss teaching methods and digital libraries, (c) and to gather data about the participants and distribute surveys.

As indicated in Table 3.4, the facilities in which the meetings took place varied from session to session. The March 16, 2004 session at the 2-year institution was held in the participants’ home department conference room and 1 chemist and 1 life scientist attended. The meetings for the physics and geology faculty in the 2-year institution took place in the faculty members’ offices. All of the meetings that took place in the 4-year institution were held in the participants’ home department conference rooms and participants continued to flow into the room after the session had started.
<table>
<thead>
<tr>
<th>Group</th>
<th>Date</th>
<th>Number of attendees</th>
<th>Meeting facilities</th>
<th>Survey completed at meeting</th>
<th>Standards-based methods discussion and Educational Digital Libraries demonstration</th>
<th>2-Year Institution</th>
<th>4-Year Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Science</td>
<td>3/16/04</td>
<td>2</td>
<td>Conference Room</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and Chemistry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td>5/5/04</td>
<td>1</td>
<td>Faculty Office</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Geology</td>
<td>7/7/04</td>
<td>1</td>
<td>Faculty Office</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Life Science</td>
<td>3/15/04</td>
<td>4</td>
<td>Conference Room</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>and Chemistry</td>
<td>3/17/04</td>
<td>5</td>
<td>Room</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Physics</td>
<td>4/20/04</td>
<td>9</td>
<td>Conference Room</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Geology</td>
<td>5/13/04</td>
<td>6</td>
<td>Conference Room</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>4/23/04</td>
<td>15</td>
<td>Conference Room</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 3.4: Group meeting dates and activities.

Internet connections were available in the conference rooms in the meetings that took place in faculty members’ offices at the 2-year institution and in the Physics and Geology Departments in the 4-year institution. In those meetings, the slides were projected from a PowerPoint computer program and the EDLs were demonstrated live. In the meetings for the life science and chemistry groups at both the 2-year and 4-year institutions, no Internet connection was available and the slides were transparencies that were projected using an overhead projector. I offered a tour of the EDLs using a simulation, but none of the participants took the tour.
Each session began with a 20- to 25-minute overview of the characteristics and features of EDLs and then moved into examples, including the National Science Digital Library and discipline-specific EDLs that could be helpful to the participants. The second component of the session was a 20- to 25-minute discussion of teaching methods associated with standards-based teaching in science including: (a) depth versus breadth of content, (b) student tasks, (c) inquiry, (d) role of the instructor, (e) use of scientific tools and equipment, (f) student-to-student interaction, (g) student assessment, (h) instructor’s conceptions of science, and (i) student confidence. The group and I discussed the meaning of each dimension. For example, the role of the instructor as a facilitator for student learning was compared to the role in which the instructor dispenses information. The authentic nature of student tasks, the variety of student assessments, and the importance of helping students build their confidence that they could become scientists were also discussed. In all sessions, I revealed my assumption that undergraduate science faculty would have a very accurate conception of science since they themselves are scientists. The participants shared how they incorporated standards-based methods into their classroom environment and used digital libraries.

In the third component, I distributed the surveys to the participants and gave a brief explanation of the sections and the Likert scales. The explanation of the surveys took approximately 5 minutes. It took participants between 10 and 20 minutes to complete all of the surveys. In the geology, chemistry, and physics sessions at the 4-year institution, the participants did not have time to complete the surveys during the meeting and were given the option of completing them at a later date. The participants returned the surveys
through campus mail or gave the surveys to a member of their group to return to me through campus mail. E-mail reminders were sent to encourage a higher return rate.

Each meeting lasted between 1 hour to 1 hour and 15 minutes. The entire session was audio recorded. Participant comments from the group discussion were recorded on an overhead to stimulate the conversation and let the participants see that their comments were noted. Refreshments were offered to the participants at all of the meetings.

_Semi-Structured Interviews_

Merriam states that, "Interviewing is necessary when we can not observe behavior, feelings, or how people interpret the world around them" (Merriam, 1998, p. 72). The questions for the semi-structured interview were designed to prompt participants to reflect upon the meaning of standards-based teaching, their current and future plans for implementing standards-based teaching, and their search for and implementation of educational digital resources. Questions used in the interviews originated in the change literature (see Table 3.5), surfaced from comments that participants made in the group meetings, and emerged from the answers of all respondents to the Standards-Based Teaching Instrument and the Stages of Concern Questionnaire. Participants were asked follow-up questions that helped them to clarify their answers and consider the questions deeply (Fontana & Frey, 1994).
<table>
<thead>
<tr>
<th>Question</th>
<th>Category</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does the term “educational digital library” mean to you?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How could or would you use standards-based methods in your teaching?</td>
<td>Comfort in using the innovation of standards-based teaching</td>
<td>Colbeck, Cabrera, and Marine (2002); Committee on Undergraduate Science Education (1999); Tobias (1992)</td>
</tr>
<tr>
<td>How could or would you use educational digital libraries in your teaching?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would you describe your classroom as learner-centered or teacher-centered?</td>
<td>Indicators of Adoption of Standards-Based Teaching</td>
<td>Barr and Tagg (1998), NRC (1996)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How did you first hear about educational digital libraries?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How inclined are you usually to change your teaching methods? Why or why not?</td>
<td>Five categories of accepting change</td>
<td>Rogers (1995)</td>
</tr>
<tr>
<td>Have you tried any of the methods that we discussed? Why or why not?</td>
<td>Characteristic of an innovation: Trialability</td>
<td>Rogers (1995)</td>
</tr>
<tr>
<td>Have you tried any of the educational digital libraries that we discussed? Why or why not?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continued

Table 3.5: Literature basis for interview questions.
Table 3.5 (continued)

<table>
<thead>
<tr>
<th>Question</th>
<th>Characteristic of an innovation</th>
<th>Rogers (1995)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can you see a difference between the methods on this list and traditional methods? Describe the benefits you see to using the methods on this list compared to traditional methods.</td>
<td>Characteristic of an innovation: Observability</td>
<td></td>
</tr>
<tr>
<td>Can you see a difference between educational digital libraries and traditional methods of finding digital resources? Describe the benefits you see to using educational digital libraries compared to traditional methods.</td>
<td>Rogers (1995)</td>
<td></td>
</tr>
<tr>
<td>How do these teaching methods compare to what you have now?</td>
<td>Rogers (1995)</td>
<td></td>
</tr>
<tr>
<td>How do educational digital libraries compare to what you have now?</td>
<td>Rogers (1995)</td>
<td></td>
</tr>
<tr>
<td>Do the methods on this list fit easily into your current methods and your approach to teaching? Do you think these methods are important to your community?</td>
<td>Rogers (1995)</td>
<td></td>
</tr>
<tr>
<td>Do EDLs fit easily into your current methods and your approach to teaching? Do you think these methods are important to your community?</td>
<td>Rogers (1995)</td>
<td></td>
</tr>
<tr>
<td>Who makes the decision about whether or not you use certain teaching methods-- you, your department, your university? Others?</td>
<td>Rogers (1995)</td>
<td></td>
</tr>
<tr>
<td>Who makes the decision about whether or not you use EDLs-- you, your department, your university? Others?</td>
<td>Rogers (1995)</td>
<td></td>
</tr>
</tbody>
</table>

Continued
Table 3.5 (continued)

<table>
<thead>
<tr>
<th>Question</th>
<th>Nature of the social system</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you wanted to share these methods (information about standards-based teaching) with your colleagues, who would you first approach? What would be the best way for you to share these methods?</td>
<td>Teachers are active participants in the systemic planning</td>
<td>Rogers (1995), Rothman and Narum (1999)</td>
</tr>
<tr>
<td>If you wanted to share information about EDLs with your colleagues, who would you first approach? What would be the best way for you to share these methods?</td>
<td>Faculty discussion and collaboration about teaching-related issues</td>
<td>McIntosh (2001)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>Successful change strategies for the adoption process</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>What additional resources could you use to help you try different teaching methods?</td>
<td></td>
<td>Barr and Tagg (1998); Fullan and Miles (1992); Hall and Hord (2001); Hord, Rutherford, Huling-Austin, and Hall (1987); Paulson and Feldman (1998); Rothman and Narum (1999); Tobias (1992)</td>
</tr>
<tr>
<td>What additional resources could you use to help you try different EDLs?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>Professional development initiatives</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do the research and teaching cultures interact in your department?</td>
<td>The social culture</td>
<td>Biaocco and Waters (1998); Caprio, Dubowsky, Micikas, and Wu (1997); Hall and Hord (2001); Paulsen and Feldman (1998); Tobias (1992)</td>
</tr>
</tbody>
</table>

The interviews of the faculty at the 2-year institution took place in the following locations: (a) the life scientist interview was in her home department conference room, (b) the physicist interview was in his office, and (c) the chemist and the geologist interviews took place at two different times in vacant departmental classrooms.

The interviews for the life science, chemistry, and physics faculty at the 4-year institution took place in their offices. The geologist from the 4-year institution met with
me in a conference room at his workplace. The interviews of all of the participants were completed in approximately 1 hour and 30 minutes and were audio-taped.

Document Analyses

The current study makes use of public, online records as an easily accessible source of data. Merriam (1998) considers documents to be a non-intrusive source of data that were produced independent of the research study. It is recommended that the documents be considered with an open mind so that patterns can emerge. It is important to determine authenticity by considering questions about the documents such as their integrity, their source, and the bias and intent of the makers. It is also important to consider if there are other documents that might have additional pertinent information. When selecting documents, it is essential to choose items that have relevance to the research questions and are easily available. In the current study, ethnographic document analyses are used. Since the documents analyzed in this study are web pages, Merriam suggests that they be considered to be the equivalent of offline documents.

The documents analyzed from the 2-year institution included the institution’s mission, vision, and goals as well as the Department of Biological and Physical Sciences’ mission and goals. The documents analyzed from the 4-year institution included the institution’s vision, purpose, and goals, as well as the tasks outlined in the academic plan. Since the life science faculty at the 4-year institution reside in the College of Biological Sciences, and the chemistry, physics, and geology faculty reside in the College of Mathematical and Physical Sciences, the missions of each of these colleges were
analyzed. In addition, the mission for the Introductory Life science Courses Program was
analyzed. Missions for the individual Chemistry, Physics, and Geology Departments
could not be located.

These documents can be considered authentic for several reasons. First, since all of
these documents are available as web pages on each of the institutions’ websites, it can be
assumed that they are all intact and complete as of the date of retrieval. Second, the
source of each document is assumed to be the institution, the college, the department, or
the program based upon their location on the website. Third, it is assumed that the
statements reflect the particular biases of the sources, which can be used to describe the
relative importance that each group places on standards-based teaching and EDLs. The
websites for both institutions were thoroughly searched for additional documents that
could be relevant to the current study, but none were located.

Analyses of the Data

This study uses what Stake (1994) refers to as a collective case study in which several
individuals are studied to advance the understanding of a larger collection of cases. In
this study, the cases studies are developed to better understand faculty from different
disciplines in 2-year and 4-year higher education institution environments in terms of
their adoption of standards-based teaching and EDLs. The methods used to construct case
studies require frequent reflection by the researcher and ongoing interpretation and
recoding of the data. A constant comparative approach was used as I looked at each
aspect of the data to see how they naturally fit together instead of identifying how they
would fit together a priori (Merriam, 1998).
The objects of this study are collections of instrumental cases. In this study, the theory was related to the undergraduate science faculty’s feelings of preparedness for and use of standards-based methods and their concerns about adopting EDLs. Since many of the issues were known in advance, I took advantage of two pre-designed surveys, the Standards-Based Teaching Instrument adapted and modified from the National Survey of Science and Mathematics Education: Science Questionnaire (Horizon Research, 2001) and the Stages of Concern Questionnaire (Hall et al., 1978, 1998).

**Surveys**

**Demographics and Experience Questionnaire**

Demographic and experience data and survey responses were used to develop the background facet of the 8 participants’ case studies regarding their professional experience and their feelings and concerns related to standards-based teaching and EDLs. The demographic data from the Demographics and Experience Questionnaire included the participant’s type of institution, academic rank/title, tenure status, years of teaching science on the undergraduate level, and discipline. These data were combined with interview data to develop descriptions of the participants’ backgrounds.

**Standards-Based Teaching Instrument**

The scores from the Standards-Based Teaching Instrument provided rich descriptions about how the 8 faculty members in the case studies felt about their preparation for using standards-based teaching methods and their use of these methods. Items from the Standards-Based Teaching Instrument were grouped into seven categories (see Table 3.6). Following literature recommendations, the selection of the categories were designed to thoroughly reflect the faculty members’ feelings related to preparedness for and use of
standards-based teaching methods as well as meeting the following criteria: (a) mutually exclusive, (b) clearly understandable, and (c) identifiable as different types of standards-based teaching methods (Merriam, 1998).

<table>
<thead>
<tr>
<th>Standards-Based Teaching Category</th>
<th>Item on Standards-Based Teaching Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop student conceptual understanding</td>
<td>Take students’ prior understanding into account when planning curriculum and instruction</td>
</tr>
<tr>
<td></td>
<td>Develop student’s conceptual understanding of science</td>
</tr>
<tr>
<td></td>
<td>Provide deeper coverage of fewer science concepts</td>
</tr>
<tr>
<td></td>
<td>Make connections between science and other disciplines</td>
</tr>
<tr>
<td>Use inquiry methods</td>
<td>Lead a class of students using inquiry strategies</td>
</tr>
<tr>
<td></td>
<td>Manage a class of students engaged in hands-on work</td>
</tr>
<tr>
<td></td>
<td>Manage a class of students engaged in project-based work</td>
</tr>
<tr>
<td></td>
<td>Have student’s work in cooperative working groups</td>
</tr>
<tr>
<td>Use textbooks as a reference</td>
<td>Use the textbook as a resource rather than the primary instructional tool</td>
</tr>
<tr>
<td>Respond to student diversity</td>
<td>Teach groups that are heterogeneous in ability</td>
</tr>
<tr>
<td></td>
<td>Recognize and respond to student cultural diversity</td>
</tr>
<tr>
<td></td>
<td>Encourage students’ interest in science</td>
</tr>
<tr>
<td></td>
<td>Encourage participation of females in science</td>
</tr>
<tr>
<td></td>
<td>Encourage participation of minorities in science</td>
</tr>
</tbody>
</table>

Table 3.6: Categories assigned to the Standards-Based Teaching Instrument items.
<table>
<thead>
<tr>
<th>Use computers/Internet</th>
<th>Use computers for drill and practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Use computers for science learning games</td>
</tr>
<tr>
<td></td>
<td>Use computers to collect and/or analyze data</td>
</tr>
<tr>
<td></td>
<td>Use computers to demonstrate scientific principles</td>
</tr>
<tr>
<td></td>
<td>Use computers for laboratory simulations</td>
</tr>
<tr>
<td></td>
<td>Use computers to ask students questions for tests and quizzes</td>
</tr>
<tr>
<td></td>
<td>Use the Internet in your science teaching for general reference</td>
</tr>
<tr>
<td></td>
<td>Use the Internet in your science teaching for data acquisition</td>
</tr>
<tr>
<td></td>
<td>Use the Internet in your science teaching for collaborative projects with classes/individuals in other institutions</td>
</tr>
<tr>
<td>Create a student-centered environment</td>
<td>Introduce content through formal presentations</td>
</tr>
<tr>
<td></td>
<td>Pose open-ended questions</td>
</tr>
<tr>
<td></td>
<td>Engage the whole class in discussions</td>
</tr>
<tr>
<td></td>
<td>Require students to supply evidence to support their claims</td>
</tr>
<tr>
<td></td>
<td>Ask students to explain concepts to one another</td>
</tr>
<tr>
<td></td>
<td>Ask students to consider alternative explanations</td>
</tr>
<tr>
<td></td>
<td>Allow students to work at their own pace</td>
</tr>
<tr>
<td></td>
<td>Help students see connections between science and other disciplines</td>
</tr>
</tbody>
</table>
Table 3.6 (continued)

<table>
<thead>
<tr>
<th>Use multiple means of assessment</th>
<th>Conduct a pre-assessment to determine what students already know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Use assessments embedded in class activities to see if students are “getting it”</td>
</tr>
<tr>
<td></td>
<td>Review student homework</td>
</tr>
<tr>
<td></td>
<td>Have students do long term science projects</td>
</tr>
<tr>
<td></td>
<td>Have students present their work to the class</td>
</tr>
<tr>
<td></td>
<td>Give predominantly short answer tests (e.g., multiple choice, true/false, fill in the blank)</td>
</tr>
<tr>
<td></td>
<td>Give tests requiring open-ended responses (e.g., descriptions, explanations)</td>
</tr>
<tr>
<td></td>
<td>Grade student work on open-ended and/or laboratory tasks using defined criteria (e.g., a scoring rubric)</td>
</tr>
</tbody>
</table>

Scores ranging from 1-4 were associated with the responses in the Likert scales for both preparedness for and frequency of use. The scores from the individual items within each categorical group were averaged, and a profile was constructed for each participant based on their averaged scored for each category of standards-based teaching. Because the extreme scores were of greatest interest, the averaged scores were adjusted based on quartiles as shown in Table 3.7. In terms of the participant’s feelings of preparedness, the number 1 was used to represent the lowest quartile indicating feelings of being unprepared, the number 2 was used to represent the middle two quartiles indicating feelings related to being partially prepared, and the number 3 was used to represent the highest quartile indicating feelings related to being totally prepared. Similarly, in terms of the participant’s frequency of use of each category of standards-based teaching, the
number 1 was used to represent the lowest quartile indicating that the category was not used, the number 2 was used to represent the middle two quartiles indicating that the category was intermittently used, and the number 3 was used to represent the highest quartile indicating that the category was regularly used.

<table>
<thead>
<tr>
<th>Range of average score</th>
<th>Quartile</th>
<th>Adjusted score</th>
<th>Preparedness</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 – 1.65</td>
<td>Lowest</td>
<td>1</td>
<td>Unprepared</td>
<td>Not used</td>
</tr>
<tr>
<td>1.66 – 3.35</td>
<td>Middle two</td>
<td>2</td>
<td>Partially prepared</td>
<td>Intermittently used</td>
</tr>
<tr>
<td>3.36 – 4.0</td>
<td>Highest</td>
<td>3</td>
<td>Totally prepared</td>
<td>Regularly used</td>
</tr>
</tbody>
</table>

Table 3.7: Adjusted scores related to the standards-based teaching profiles.

New profiles based on the adjusted scores were generated and used to construct the individual case descriptions. In addition, all of the items on the survey that related to the participant’s professional development activities were used describe the participant’s professional background. During the cross-case analyses, transparencies of the standards-based teaching profiles were created and compared to look for trends across groups of participants based upon institution type and/or discipline. The trends were then reported in the group analyses.
**Stages of Concern Questionnaire (SoCQ)**

The results of the Stages of Concern Questionnaire (SoCQ) were used to construct individual stages of concern profiles. The data were from the participant’s scores on the SoCQ that were calculated by adding scores for the items on the seven stages (categories) of concern. Table 3.8 identifies the items on the SoCQ with the stages of concern. The raw scores were converted to percentiles based on a conversion chart and the percentiles were used to graphically represent individual profiles to be used in group analysis (Hall et al., 1998). Although Hall et al. state that either high-stage scores or high-stage and second high-stage scores can be used in the analysis, the greatest insight into the participant’s concerns about the adoption result from a complete profile analysis. With only 8 participants in this study, I chose to present a complete profile analysis on each individual and then focus on the highest and second highest scores of relative intensity of concern.

<table>
<thead>
<tr>
<th>Stages of Concern</th>
<th>Stages of Concern Questionnaire Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness</td>
<td>I don’t even know what the EDUCATIONAL DIGITAL LIBRARIES is.</td>
</tr>
<tr>
<td></td>
<td>I am not concerned about the EDUCATIONAL DIGITAL LIBRARIES.</td>
</tr>
<tr>
<td></td>
<td>I am completely occupied with other things.</td>
</tr>
<tr>
<td></td>
<td>Although I don’t know about the EDUCATIONAL DIGITAL LIBRARIES, I am concerned about other things in the area.</td>
</tr>
<tr>
<td></td>
<td>At this time, I am not interested in learning about the EDUCATIONAL DIGITAL LIBRARIES.</td>
</tr>
</tbody>
</table>

Continued

Table 3.8: Stages of concern associated with the items of the SoCQ.
Table 3.8 (continued)

<table>
<thead>
<tr>
<th>Category</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informational</td>
<td>I have very limited knowledge about the EDUCATIONAL DIGITAL LIBRARIES.</td>
</tr>
<tr>
<td></td>
<td>I would like to discuss the possibility of using the EDUCATIONAL DIGITAL</td>
</tr>
<tr>
<td></td>
<td>LIBRARIES.</td>
</tr>
<tr>
<td></td>
<td>I would like to know what resources are available if we decide to adopt</td>
</tr>
<tr>
<td></td>
<td>the EDUCATIONAL DIGITAL LIBRARIES.</td>
</tr>
<tr>
<td></td>
<td>I would like to know what the use of the EDUCATIONAL DIGITAL LIBRARIES</td>
</tr>
<tr>
<td></td>
<td>will require in the immediate future.</td>
</tr>
<tr>
<td></td>
<td>I would like to know how the EDUCATIONAL DIGITAL LIBRARIES is better</td>
</tr>
<tr>
<td></td>
<td>than what we have now.</td>
</tr>
<tr>
<td>Personal</td>
<td>I would like to know the effect of reorganization on my professional</td>
</tr>
<tr>
<td></td>
<td>status.</td>
</tr>
<tr>
<td></td>
<td>I would like to know who will make the decisions in the new system.</td>
</tr>
<tr>
<td></td>
<td>I would like to know how my teaching or administration is supposed to</td>
</tr>
<tr>
<td></td>
<td>change.</td>
</tr>
<tr>
<td></td>
<td>I would like to have more information on time and energy commitments</td>
</tr>
<tr>
<td></td>
<td>required by the EDUCATIONAL DIGITAL LIBRARIES.</td>
</tr>
<tr>
<td></td>
<td>I would like to know how my role will change when I am using the</td>
</tr>
<tr>
<td></td>
<td>EDUCATIONAL DIGITAL LIBRARIES.</td>
</tr>
<tr>
<td>Management</td>
<td>I am concerned about not having enough time to organize myself each day.</td>
</tr>
<tr>
<td></td>
<td>I am concerned about conflict between my interests and my responsibilities.</td>
</tr>
<tr>
<td></td>
<td>I am concerned about my ability to manage all that the EDUCATIONAL</td>
</tr>
<tr>
<td></td>
<td>DIGITAL LIBRARIES requires.</td>
</tr>
<tr>
<td></td>
<td>I am concerned about time spent working with nonacademic problems related to the EDUCATIONAL DIGITAL LIBRARIES.</td>
</tr>
<tr>
<td></td>
<td>Coordination of tasks and people is taking too much of my time.</td>
</tr>
</tbody>
</table>
Table 3.8 (continued)

| Consequence | I am concerned about students’ attitudes toward NSDL.  
|             | I am concerned about how the EDUCATIONAL DIGITAL LIBRARIES affects students.  
|             | I am concerned about evaluating my impact on students.  
|             | I would like to excite my students about their part in the EDUCATIONAL DIGITAL LIBRARIES.  
|             | I would like to use feedback from students to change the program.  
| Collaboration | I would like to help other faculty in their use of the EDUCATIONAL DIGITAL LIBRARIES.  
|             | I would like to develop working relationships with both our faculty and outside faculty using the EDUCATIONAL DIGITAL LIBRARIES.  
|             | I would like to familiarize other departments or persons with the progress of the EDUCATIONAL DIGITAL LIBRARIES.  
|             | I would like to coordinate my effort with others to maximize the EDUCATIONAL DIGITAL LIBRARIES’ effects.  
|             | I would like to know what other faculty are doing in this area.  
| Refocusing | I know of some other approaches that might work better.  
|             | I am concerned about revising my use of the EDUCATIONAL DIGITAL LIBRARIES.  
|             | I would like to revise the EDUCATIONAL DIGITAL LIBRARIES’ instructional approach.  
|             | I would like to modify our use of the EDUCATIONAL DIGITAL LIBRARIES based on the experiences of our students.  
|             | I would like to determine how to supplement, enhance, or replace the EDUCATIONAL DIGITAL LIBRARIES.
Semi-Structured Interviews

Each interview lasted approximately 1 hour and resulted in approximately 20 pages of transcript. The data were coded and analyzed in terms of the participants’ responses regarding their feelings related to adopting standards-based teaching and the EDLs as well as their implementation of the two innovations. The concepts explored in the interview questions provided an a priori framework that was supported and augmented by the other data sources. The codes were determined as they emerged from the data. A checklist matrix was constructed based on an a priori framework (see Table 3.9) of the characteristics related to the adoption and diffusion of standards-based teaching and EDLs. The matrix facilitated data comparison between the 2- and 4-year institutions. A similar matrix was constructed to compare life science, chemistry, physics, and geology faculty. An interpretive rubric was used in the assignment of the codes (see Appendix F).

The data were reviewed to identify characteristics related to the variables influencing the rate of each innovation’s adoption. A holistic analysis of the adoption and diffusion data for the two innovations was conducted to determine whether or not the participant would be a potential adopter of and/or agent of change for each innovation. If the majority of the participant responses were positive regarding the innovation’s (a) complexity, comfortability, trialability, observability, relative advantage, and compatibility with the participant’s existing practices; (b) the participant’s inclination to change; and (c) the participant’s control of the adoption decision, then the participant would be considered to be a potential adopter. If the participant is a member of a complex social network of undergraduate faculty and uses communication channels to gather and share information with colleagues, then the participant would be considered a potential agent of change.
Table 3.9: Checklist matrix to categorize semi-structured interview data.

<table>
<thead>
<tr>
<th>Category</th>
<th>Standards-based teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation’s complexity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort using innovation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicators of adoption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructivism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication channels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceptance of change category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation’s trialability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation’s observability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation’s relative advantage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation’s compatibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of innovation decision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature of the social system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successful change strategy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional development initiatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social culture</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Document Analyses*

During the document analyses, the documents were retrieved from the institutional, college, department, and program websites. The content of the documents was grouped and analyzed using the aggregated categories from the Standards-Based Teaching
Instrument. Additional topics addressed in the web-based documents include (a) extra-institutional collaborations, (b) degree preparation, (c) educational programming, (d) institutional quality, (e) institutional improvement, (f) high quality faculty and staff, (g) discipline specific content, and (h) create and disseminate knowledge. These were not used in the document analyses.

The responses from the surveys were triangulated with the coded data from the interviews and document analyses. The evidence from all of the data sources were used to construct the individual and collective cases. Each case consists of participant background information, the standards-based teaching facet of the case, and the EDL aspect of the case. The information for the participant background information came both from the Demographics and Experience Questionnaire, the data from the group meetings, and the interview data. The standards-based teaching facet of the case was constructed by creating a standards-based teaching profile from the responses on the Standards-Based Teaching Instrument and the data from the group meetings, the interviews, and document analyses. The EDL aspect of the case was constructed by creating a SoC profile based on the SoCQ and the data from the group meetings, interviews, and document analyses. Approximately 20% of the transcripts from the interviews were used as direct quotes in the cases. As recommended by Merriam (1998), individual case (within-case) descriptions were created and then cross-case analyses took place. The cross-case analyses were conducted for the following characteristics: institution type, discipline, and locus of control. The cross-case analyses looked for patterns resulting from complete agreement within the groups as well as agreement among the majority of the group. The agreement majority for the characteristic of institution type was considered to be 3 out of
4 faculty, for discipline it was considered 2 out of 2, for faculty central to the locus of control it was 2 out of 3, and for faculty peripheral to the locus of control it was 3 or 4 out of 5. The collective case studies were used to develop descriptive theories to provide insight into the similarities and differences among institutions and disciplines related to the faculty members’ feelings about and use of standards-based teaching and EDLs (Miles & Huberman, 1994).

**Trustworthiness and Authenticity**

Guba and Lincoln (1994) explain that trustworthiness and authenticity are two sets of criteria for judging constructivist qualitative research. They state that the proposed trustworthiness criteria are “credibility (paralleling internal validity), transferability (paralleling external validity), dependability (paralleling reliability), and confirmability (paralleling objectivity)” (p. 114). In the following sections, I will outline how I have fulfilled these criteria.

**Credibility**

Credibility is a check to make sure that the results make sense, that alternative explanations have been explored, and that the researcher provides enough rich description that the reader can make an evaluation (Miles & Huberman, 1994). In the current study, I have extensively used evidence from the participants. Pieces of evidence collected through qualitative means have been triangulated. As I was immersed in the data for an extended period of time, I searched for alternative explanations for the patterns that emerged. The categories used to code the qualitative data were drawn from pre-existing theories and research in the literature and patterns that emerged from the data.
Triangulation is a method that enhances the credibility of the study (Merriam, 1998). Fielding and Fielding (1990) compare triangulation to surveying the landscape. If only one landmark is used, the person can only locate himself along one dimension. As more landmarks are used, the person is better able to locate himself/herself at the intersection of many dimensions. This increases the person’s confidence in his/her position. The same is true with qualitative research. The more data sources that are used, the better the research has surveyed the object of the study (Fielding & Fielding). They point out that a problem with using multiple methods is that it might multiply the errors. They suggest that instead of just having multiple data sets, it is important to link them to reduce the validity threats in each.

In the current study, the researcher triangulated the data by linking and integrating the data from the surveys, group meetings, interviews, and documents to develop a theoretical model. The researcher was immersed in the data searching for alternative explanations for the patterns that emerged. The categories used to code the qualitative data were drawn from pre-existing theories and research in the literature.

Transferability

Transferability indicates that the research has applicability or importance beyond the context of the study setting. To support transferability, Miles and Huberman (1994) suggest that researchers are careful to make their processes and analyses clear so others can see how their studies compare. The researcher should make it clear how the theory is transferable and make suggestions to others on ways to apply the results in future studies. The transferability can be working hypotheses or user generalizations that allow the readers to discern how the study applies in their own situations (Merriam, 1998).
This study provides two aspects that are transferable. First, it offers a protocol that others could use to investigate the same questions with other samples. Second, it offers a theoretical model. I have richly described both. The fact that multiple cases were described allows the reader to see several people’s perspectives on standards-based teaching and EDLs. As other investigations deepen our knowledge of undergraduate science faculty’s adoption of standards-based teaching methods and EDLs, the better the model will be. The better the model, the more effectively professional development can be designed to support the faculty adoption process.

Dependability

Dependability is a criterion to make sure that the research was performed with diligence and care. Indicators of dependability include well thought out research designs that are customized to research questions, repeated quality checks throughout the investigation, member checks, peer review, and an audit trail (Merriam, 1998; Miles & Huberman, 1994). The research design in this study was carefully crafted to reflect and respond to the research questions. Throughout the research process, I conferred with experts in qualitative and quantitative research to ensure quality. I asked the 8 interview participants to give me feedback about the resulting case studies as member checks and made adjustments in the individual case study profiles as requested. I asked colleagues to review the work and provide reality checks as I designed the current study and performed data collection and analysis. The methods used and decisions made in the current study are described in great detail in this chapter so that others can follow the audit trail and understand the origin of the study results.
Confirmability is a standard of the quality of the conclusions of the qualitative study that is similar to external validity in a quantitative study. Even though there is no claim about objectivity in a qualitative study, it is important that the conclusions that the researcher draws are based on the evidence in the data and not the researcher’s preconceived notions and biases. This can be supported if the researcher (a) provides explicit explanations of the methods used to gather and analyze the data so that others can replicate the study, (b) illustrates how the conclusions are based in the data, (c) supplies the data so that others may decide for themselves if the conclusions are reasonable, (d) demonstrates self-reflection about the assumptions and biases that may influence the researcher’s interpretation of the data, and (e) explains how alternate and opposing conclusions were considered during the study (Miles & Huberman, 1994).

The goal of this methodology is to lay out a rich description of the data collection and analysis strategies. It is hoped that with Chapter 3 as their guide, other researchers can replicate this study. It is assumed that different study contexts will result in slightly different results. The conclusions are based on a snapshot in time of the current participants. Even if the same procedures were followed with exactly the same participants, most likely there would be differences in their positions in the process of change. That being said, the procedures provide a model for other researchers to get other snapshots in time. The more snapshots available to the research community, the stronger the collective-case theory.

The relationship between the data and the conclusions should be clear. The data from the surveys have been presented in graphic form throughout Chapters 4 and 5. The
checklist matrix of the interview data shows a connection between the evidence and the concepts being investigated. The data have been displayed throughout Chapter 4 and 5 to enable the readers to determine for themselves if the conclusions are valid.

The process of selecting a protocol for data collection and data analysis involved a great deal of self-reflection. I asked myself questions such as, do the data collection tools answer the questions being investigated, how do my educational and professional experiences impact my analysis, and do those experiences clarify or cloud the analysis? I searched for and considered alternate and opposing explanations throughout the iterative process of data analysis.

Utilization

Utilization of the study is to ensure that somebody cares that it was done. Even if a study is trustworthy, its value will be questioned if it is not useful. Indicators of utilization are the accessibility of the findings to the people who would benefit, the ability of the users to change, and the catalytic properties of the study (Miles & Huberman, 1994). The results of this study will be distributed to the higher education community through organizations such as the Society for College Science Teaching. The results will also be distributed to the digital library community, both through the National STEM Digital Library (NSDL) communications portal and through digital library publications. These communities are important because they can further study the theoretical model proposed and provide the professional development support needed for undergraduate science faculty members’ adoption of standards-based teaching and EDLs. The results of the current study are designed to facilitate change in several ways. It is intended that the theoretical model will help people increase their understanding of the needs of the
undergraduate science faculty. It is also intended to help the participants have a better understanding of standards-based teaching and EDLs. Finally, it is intended to support systemic change so that faculty get the support that they need to easily adopt the aspects of the innovations that are most beneficial to them.

Limitations

My perspective as a researcher could be considered a double-edged sword. I have more insight into the issues related to undergraduate science faculty members’ feelings about and use of standards-based teaching and EDLs than most people, which may strengthen the study. I also have assumptions based on my experiences that might make me miss other ways to analyze or explain the data. This limitation was controlled by inviting peers and experts to provide their perspectives related to the study as it was ongoing.

The participants in this study are all full-time undergraduate science faculty. Their time is of a premium and it was a concession for them to attend the group meetings, complete the surveys, and participate in an interview. It would not have been possible for me to have gotten any more time nor extended exposure with them. This limitation was lessened to some degree by my extended exposure to their data.

The surveys were limited in a number of ways. The survey data relies upon respondent self-reporting and subsequent interpretations rely upon the researcher drawing reasonable conclusions. Since much of the data in the Standards-Based Teaching Instrument requires the participants to respond in a relativistic way, there could have been great variation from person to person. For example, one participant might feel partially prepared to use inquiry methods because s/he understands the complexity of these
methods and realizes that s/he has much to learn. Another participant, who is less aware of the complexity of the methods, might respond that s/he is totally prepared with much less background or preparation.

The Likert scale on the SoCQ that is required by the Southwest Educational Development Laboratory (SEDL), who manage the permission for use of the questionnaire, allows the respondent to choose within a range for a specific response. For example, a respondent might mark a 6 or a 7 to say “Very true of me now.” Although the instrument designers do not consider this to be an egregious limitation because the scores on the individual profiles are considered relative to one another, this is an area of improvement for further research. The designers’ reasoning is if a respondent is prone to mark a low score they will most likely mark their score low in a consistent fashion. Even though that might be true, in future studies, I recommend having one choice for each score.

When the responses to the Standards-Based Teaching Instrument were analyzed, the responses were aggregated into top, middle two, and bottom quartiles. This adjustment of the data might have been a limitation because some of the specificity could have been lost. The advantage of doing this aggregation was that the extremes were more obvious. I made the research decision that the benefits from this aggregation outweighed the potential limitations.

There were no reliability tests for the data from the Standards-Based Teaching Instrument and the Stages of Concern Questionnaire specific to the study sample. This is a result of the sample having only 8 participants.
An inherent limitation of the interview data is that they are also self-reported. Without supplemental evidence, the analysis relies on participants’ perceptions of the questions and their self-reflections on their practice. In addition, the use of multiple data sources resulted in inconsistent data. Both of these limitations rely on the researcher drawing reasonable conclusions.

The ethnographic document analyses are limited in three ways. First, they are limited because the documents were not created specifically for this study. The documents were analyzed to identify aspects of mission/goal statements, visions, goals, and an academic plan that relate to standards-based teaching. If the documents did not mention aspects of standards-based teaching, it was assumed that the document creators did not consider those aspects to be important enough to include. Since the document creators did not anticipate this use of the documents, this assumption should be considered carefully. Second, the document designers did not intend the documents to be specifically used for science educators. Since the documents are general, it is not possible to discern if the exclusion of support for standards-based teaching methods, such as the use of inquiry, is a reflection of institutional values or due to the nature of the documents. Third, the online nature of the documents makes them susceptible to frequent changes. Since these documents are not archived online, accessibility for future research might be limited.

The final limitation is the transferability of the study. It would not be possible to predict how all undergraduate science faculty would feel about the innovations based on the collective case studies. The parts of the study that are transferable are the methods used to develop the cases and the grounded theoretical model, which can be considered a starting point for future research.
CHAPTER 4
INDIVIDUAL CASE-STUDY ANALYSES

In this chapter, the data are used to create individual case descriptions for the faculty in the current study. The goal of these descriptions is to advance the understanding of undergraduate science faculty as potential adopters of standards-based teaching and EDLs by examining their feelings, use, and concerns related to both innovations. The following 8 case descriptions were created from a synthesis of the data from the Demographics and Experience Questionnaire, the Standards-Based Teaching Instrument, the Stages of Concern Questionnaire (SoCQ), the group meetings, the individual semi-structured interviews, and the document analyses.

Structure of the Case Descriptions

Each case description contains four facets to create a multi-dimensional depiction of each faculty member. The first facet is faculty background information. The next two facets are profiles of the faculty in terms of feelings about and use of standards-based teaching and their concerns related to EDLs. The last facet is a diffusion summary that highlights the distinguishing characteristics of the faculty in terms of their adoption of standards-based teaching and EDLs and their potential as an agent of change to diffuse each of these innovations.

The background information facet for each faculty member includes an overview of the faculty member’s science teaching experience at higher education institutions,
participation in professional development opportunities, and the nature of the faculty position within the department and institution. The data for the background information were gathered from Demographics and Experience Questionnaires, the interviews, and the ethnographic document analyses.

The standards-based teaching facet of the case description portrays the faculty member in terms of his/her standards-based teaching profile as well as the faculty member’s role in the diffusion of standards-based teaching as an innovation. Each profile depicts the faculty in terms of feelings of preparedness for and frequency of use of standards-based teaching methods. The profiles were based on adjusted scales with scores from 1-3 for feelings of preparedness ranging from unprepared to totally prepared and frequency of use ranging from not used to regularly used (see Table 4.1). The description of the faculty member’s role in the diffusion of standards-based teaching as an innovation was developed based on the synthesis of responses to questions on the Standards-Based Teaching Instrument and comments during the semi-structured interview.

<table>
<thead>
<tr>
<th>Adjusted score</th>
<th>Preparedness</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unprepared</td>
<td>Not used</td>
</tr>
<tr>
<td>2</td>
<td>Partially prepared</td>
<td>Intermittently used</td>
</tr>
<tr>
<td>3</td>
<td>Totally prepared</td>
<td>Regularly used</td>
</tr>
</tbody>
</table>

Table 4.1: Definitions of the adjusted scores used in the standards-based teaching profiles.

The EDL facet of the case description portrays the faculty based on their Stages of Concern profile in terms of adopting EDLs and their role in the diffusion of EDLs as an
innovation. The Stages of Concern range from 0 to 6 and indicate awareness, informational, personal, management, consequence, collaboration, and refocusing concerns (see Table 3.3). The explanation for the calculation of the relative intensity for each of the stages of concern can be found in Chapter 3 in the section called Stages of Concern Questionnaire (SoCQ). The description of the faculty member’s role in the diffusion of EDLs as an innovation was created based upon the responses in the semi-structured interview.

The diffusion summary component of the case descriptions combines all of the data from the Demographics and Experience Questionnaire, the Standards-Based Teaching Instrument, the Stages of Concern Questionnaire, the group meetings, and the interviews. The data are related to the literature to help depict each faculty member in terms of his/her role as a potential adopter and/or agent of change. Each summary provides a synthesis and interpretation related to the faculty member.

**Cases at 2-Year Institution**

The following 4 case-study descriptions are of science faculty at a 2-year institution. The cases are presented separately to illustrate the individual characteristics of the faculty. They are grouped into this section as an organizational tool so the faculty teaching in a specific discipline at the 2-year institution will not be confused with faculty teaching the same discipline at the 4-year institution.

*Life Science Faculty at the 2-Year Institution (LS-2)*

**LS-2 Background**

LS-2 was a tenured Associate Professor teaching life science at a 2-year institution. She had 20-years experience of teaching science at higher education institutions.
known her for at least 15 years. Her focus was on teaching anatomy and physiology to
nursing students, but she has also taught a range of introductory life science and natural
science classes to both majors and non-majors.

LS-2 has not participated in professional development related to teaching practice,
has not attended a national or state science teaching association meeting, and points out
that she does not have any training in education. In fact she said, “Boy, you know I have
never had an education class per se. EVER.” She continued, “So I guess that makes me a
phony.” She has mentored and observed other faculty in terms of teaching science and
has met with other faculty on a regular basis to discuss science teaching issues.

I interpret from her responses and my personal interactions with her that LS-2 cared
deeply for the students at the 2-year institution. She indicated that the student population
at the 2-year institution has special needs. She said that most of the students are
nontraditional, meaning that they are not typical of students who attend undergraduate
institutions. In the following passage, she explained her impressions of the nontraditional
students’ lives, and how the complexity of their lives makes it challenging to do well in
school.

As a group, they are so over-committed. They have so many other things going on
in their lives and they try to smash so much into so little time. I had a student
yesterday, she’s got two little kids, she’s pregnant, she’s in the nursing program,
and wants to take pathophys online. And I was like, Ach! Gee, do you need a
hobby, too? Maybe, sleep? That could be your hobby this quarter, because I am
looking at you and I am thinking it ain’t happening. So they do. They try to smash
everything into one particular quarter and they can’t [succeed at everything].
She also mentioned that many of the students are the first in their families to attend college.

Here we are reaching an audience that might otherwise not come to college, at all, ever. I’m mentoring a little girl now who is the first generation to friggen graduate from high school much less go to college. And she wants to complete her Ph.D., and I am like, this is so exciting. Think of what she could change for her family and her community, a group of African Americans. They never graduated high school. You know, she has not only graduated high school, she finished her Associate’s Degree and she wants to complete a Ph.D. It’s so cool. And I love seeing people like that who come through here.

Her comments indicate that she had great admiration for the students working hard to get an education, and she had great empathy for those who don’t have the intelligence or tools to pass the courses. She referred to one student about whom she said, “… he could have been my son. You know. He was just so cute and so goofy and so lazy and he failed twice. And it broke my heart, but he failed.” She continued, “and he didn’t just fail, he FAILED. God love his heart, he failed. For the second quarter in a row. Oh my word.”

**LS-2 Standards-Based Teaching Profile**

LS-2’s standards-based teaching profile is illustrated in Figure 4.1. It is notable that LS-2’s responses on the Standards-Based Teaching Instrument indicate that her feelings of preparedness lagged behind her frequency of use in three categories and did not surpass her frequency of use in any category. In fact, her feelings of preparedness and use were equal in four of the seven categories. She felt partially prepared to implement the methods in all of the categories of standards-based teaching; however, she regularly used textbooks as references, responded to student diversity, and created a student-centered environment. In terms of developing student conceptual understanding, use of inquiry
methods, use of computers and the Internet, and the use of multiple means of assessment, LS-2 indicated that she intermittently used these standards-based approaches. For example, she stated in the interview that she does not do formal pre-assessments of what her students know because most often she does not expect them to know anything about the course topics and so she does not think pre-assessment was a good use of class time.

![Figure 4.1: LS-2 standards-based teaching profile](image)

Even though she responded on the Standards-Based Teaching Instrument that she allows students to work at their own pace, she indicated in the interview that there was a set amount of content that needed to be “covered” in the courses. Her responses on the Standards-Based Teaching Instrument indicated that she regularly used methods to create
a student-centered environment which was confirmed by her interview comments that described how students enjoyed talking about their families’ ailments in physiology class.

I interpret from both the instrument responses and the following quote that she strives to strike a balance between class discussions about real-world applications of the concepts that they are studying and getting through all of the course objectives.

They wanted to ask all kinds of different questions about themselves and their loved ones. … So, after an entire day of asking questions, really good questions, interesting questions about everyone’s cousin’s niece’s grandma, and their disease processes, we wasted a whole day. We had to cover three objectives in that day. We covered half of one. It was like, OK, I love your questions but we are going to have to speed up a little bit, so save your questions about your cousin’s niece’s grandma for after class or during class break ’cause we have to cover a certain set of material.

When asked in the interview to define the term standards-based teaching, LS2’s responses all related to content.

To the best of my knowledge it would mean teaching a particular set of objectives to a given level of competency. So for example in my classes, which are primarily designed for nursing students, I would teach the objectives outlined for that particular course, such that the student could pass, say for example a proficiency exam, which we’re very much targeting towards all of the courses within our discipline.

It is my job as the instructor to find out what the standards are for that class; to make myself completely familiar with what it is that I am expected to teach; to evaluate the textbook to see how it is [and any other ancillaries that come along with it] to see how it is going to help me do that; and then to put together my syllabus and lesson plans in such a way that I can effectively teach those standards and reach as many people as I possibly can. You know, with the goal being, Gee it would be nice if I taught everybody, but you know …. I mean one can’t ask for miracles, can one? And have everyone achieve a competency that meets those standards.

I interpret her comment about not asking for miracles to mean that she can try her best, but there are always going to be students who will not succeed, no matter what methods she uses.
LS-2 describes her class as learner-centered, but that means that she was willing to answer their questions.

Because, even though I have a certain set of objectives that I have to meet; if I take a look throughout the room and I see a bunch of faces, where everybody’s going, “Huh?” then it’s time to stop. It’s time to slow down. It’s time to allow questions. It’s time to ask questions of my own and make sure that everybody is up to speed. You can tell just by watching faces. You can also tell by watching, is that person meeting your eyes? If they’ll look back when you look at them, they understand what you are saying. If they look off to the side, it’s like, don’t ask me a question ’cause I don’t understand and I don’t want to look stupid. So don’t ask me a question. I want to be invisible. So I try as much as I possibly can to make it learner-centered.

I interpret this to mean that she defines learner-centered as the instructor responding to the student cues about whether or not they understand the content. She thought the instructor still has the most responsibility for student learning. In her opinion, when the instructor detects that the students are having problems in LS-2’s learner-centered environment, the instructor slows down and tries another explanation in the formal presentation.

In the interview, LS-2 indicated that she learned about teaching methods from colleagues, mentors, and readings.

But in conversations with peers, that’s to me the best way to learn about teaching and teaching techniques. What works for you, what works for other people. And so for example when talking with colleagues, I have learned about pretty much all of these topics [dimensions of standards-based teaching]. That is pretty much my only way. That and what I can pick up in my own readings—journals, the NABT [National Association of Biology Teachers], the HAPS [Human Anatomy and Physiology Society] journal, occasionally attending conferences. I don’t get to as many as I would like to. Reviewing materials for various publishers you know, ’cause they will always ask you questions [such as] ... what you feel about if this particular resource addresses students who are visual learners. And when I first saw that phrase I thought, what the hell are you talking about? And that led me to pursuing further about different learning styles and stuff like that, websites, stuff I picked up more or less on my own.
LS-2 indicated on both the Standards-Based Teaching Instrument and the interview that she extensively used didactic methods, such as lecture. I interpret several of her comments to mean that she does this because this is a technique that she feels prepared to use; it helps her get through the course objectives quickly, and she feels that is how other aspects of the world work. She said in the interview that she used assessment techniques that help her students prepare for licensing examinations and future careers.

It’s because to my mind, that’s still how the real world works. You know, you can talk about, for example having nursing students do journals about how they feel about a particular assignment, but the fact is, at the end of the program, they have to take [a standardized] test.

So using alternative methods isn’t effectively preparing them for real life. Except for writing papers. I’ll still have my students write papers.

When the data related to LS-2’s attitudes toward students are aggregated and interpreted, it is clear that she thinks it is important to help boost the students’ confidence. She indicated that she thought that many of her students had come from family and school experiences that made the students believe that they could not succeed. She tried to do what she could to counteract the students’ attitudes by using praise.

The sign in my office says it all. And I don’t even know the exact wording of it. I bought that thing when I first went full time and plastered it up. It says that the most important tool for success is the belief that you can succeed. And the people who come in here are so beaten down, and they have such little confidence. And they’re like puppy dogs in the way that they lap up praise and the way that you can boost their self confidence. So I will tell them all of the time how smart they are, how competent they are, that they can do this. Wow! You did a great job! … But, yeah they have been so beaten down, and if you can make somebody believe that they can succeed, they’ll surprise you sometimes.
She said that she could distinguish the difference between standards-based teaching and traditional methods of teaching.

When you look back and you think of the people that you recall that were really good teachers—you loved their class; you looked forward to going to it; you were sorry when it was over. You probably should, you know one of these days when you get around to it, write that person a letter and say you changed my life. They all … [used the methods listed as the dimensions of standards-based teaching].

I mean … role of the instructor, student tasks, building confidence, isn’t that all [the] Socratic method? That sucker was a long time ago. … [The best teachers] were fundamentally people that cared about their students and about their students’ learning and wanted to get people excited about their subject.

Her comments suggest that she thinks that the core of great instruction is faculty caring about their students personally, caring about students’ learning, and striving to excite their students about the content. Since she does not appear to perceive a difference between standards-based methods and traditional methods, she does not appear to perceive a benefit to using standards-based methods. When asked if the methods fit into her current practices, she said,

Some do, some don’t. As I mentioned, student-to-student interaction does not fit well into some of the classes that I teach simply because of time constraints. Now other classes, it works well. For example, anatomy, if you are there in the laboratory you present a certain set of structures to learn that day. You show the students where they are. You show them again and again and again. And then I say to the students, since they are stuck there for the 2 hours anyway, Look you people can’t leave early. So now start quizzing each other. Show each other where those things are. And Mary I want you to quiz Sandy and Sandy you go quiz Brian. And don’t any of you people let your lab partners leave until they know where all of the parts are. So they are teaching each other and teaching themselves at the same time. So depending upon the class and the limitations, every one of those works. You just continue to evolve as you go along.

One may conclude from the following quote that LS-2 is very careful not to force her techniques on others. She shares when asked to share, but does not feel comfortable making suggestions to others.
I am not going to come and proselytize [to] you. If you ask me … I will sit there and tell you. I love to be asked my opinion, but I won’t offer it. I won’t offer it. If you are sitting around in a group of colleagues and exchanging ideas about here’s what I did at this point in time or I tried this and it worked well, or I tried this and it flopped, that sort of thing.

She was hesitant to share her stories with others through professional journals because she did not believe she has anything original to say and did not have the time to write it.

I guess I’ve just not thought of anything that I would consider novel. You know and if it has to be peer edited, does it have to be novel enough to be where people would go “Oh,” or “Ugg,” or “Been there, done that, done that a million times.” So that is what has discouraged me from ever attempting it.

During the interview, LS-2 indicated that she was open to changing her methods, but considered time to be a huge barrier. When asked about the relationship between the research and teaching cultures, she replied that there was no research culture in her department. This means that research may not be taking up her time to prepare for teaching, but rather her teaching and other tasks, such as committee and service work, may take up so much time that she can not find the time to make the changes. She does not want to waste class time on techniques that might not work. She does not seem to have a lot of time to investigate which techniques to prepare for or use. She repeatedly mentioned the problem of lack of time.

**LS-2 EDLs Profile**

Figure 4.2 illustrates LS-2’s profile created from her responses to the SoCQ. It shows that her greatest concern was related to awareness of EDLs, with her informational concern about EDLs being secondary. This can be interpreted to mean that EDLs are a relatively new idea to her and she is a non-user. She may welcome more exposure and more information to help her clarify her notion of EDLs.
Figure 4.2: LS-2 stages of concern profile related to her adoption of EDLs

During the interview, her comments indicated that her understanding of EDLs was limited. She had done a little searching in EDLs after our initial meeting, but was not a regular user. LS-2 perceived a link between what publishers were doing and what EDLs were doing. She heard about EDLs from me. If she could fit in time among her normal instructional, service, and committee responsibilities, LS-2 may search for digital resources using EDLs. She could discern the difference between EDLs and traditional methods of finding educational resources as well as comprehend the potential of EDLs. She indicated that she would expect the EDLs to be powerful tools to help her quickly find educational resources.
Speed in terms of, hey I don’t have to go to the library, look under subject, write down all of those Dewey decimal thingies, and then go back to the stacks, and look for the books, and go through the index. [Figure out if it] is … really in there, [if] is it useful, that sort of thing. With these digital libraries, with much fewer keystrokes, I can find precisely what I am looking for. If it’s a video I am looking for, there it is. If it is a picture, a graphic, an illustration, something like that; if it’s articles. I do see them as a very powerful and fast resource.

LS-2 looked for resources that were educationally helpful and scientifically correct.

I continue to look for things to substitute real people or real animals for something that is going to be equivalent, and it gets annoying because they sometimes don’t do that very well at all. They’ll throw something together and have very, very big errors in the theory; it doesn’t match what the research tells you should happen under any particular set of circumstances.

When that happened, she did not necessarily reject the resource, but rather would try to fix it.

I went and tweaked it. I put it in the lab book and I went and tweaked it so that the point was made, that as blood pressure changed, glomerular filtration rate stayed constant. I sent off a message to the developer saying this is wrong and you are pissing me off here. So fix it. I still don’t think that they fixed it. So I continue to evolve trying to get as much media stuff as I can get.

LS-2’s statements seem to indicate that she does not idly sit by and approach her teaching passively. She actively reviews the resources that she is going to use with her students, adjusts them for her own use, and lets the developers know about the problems so that they can fix it for others. She said that she would like the resources in the digital libraries to be readily available without having to pay to get access. She indicated that she could see the importance of having resources that require a fee available in digital libraries, but would prefer that a filter separate those from the ones that were freely available.

**LS-2 Rate of Innovation Diffusion**

LS-2 was a faculty member who spent many years teaching science at the undergraduate level. The data suggest that LS-2 felt partially prepared to use the methods
in all of the standards-based teaching categories. The categories of methods that she regularly used included using textbooks as a reference, responding to student diversity, and creating a student-centered environment. It is not surprising that she finds textbooks an easy tool to use since they are fundamental in traditional undergraduate learning environments. Considering her concern about her students’ special needs, it was not surprising that she regularly uses methods that recognize and respond to student diversity and their environment. She was in the early stages of adoption of EDLs, with her primary stage of concern being awareness and her secondary being informational.

Table 4.2 summarizes LS-2’s responses related to the diffusion of the standards-based teaching and EDLs as innovations. It indicates that standards-based teaching was an innovation that was complex enough that she did not yet have a clear understanding of what it encompassed. This level of complexity may slow her rate of diffusion of standards-based teaching. In addition, LS-2 did not feel comfortable using standards-based teaching methods, did not perceive a clear difference between them and traditional methods, and consequently, did not think that there were advantages to using standards-based methods. In terms of EDLs, LS-2’s responses about all the variables that influence the rate of diffusion were positive. The synthesis of all of the data leads to the conclusion that LS-2 is not likely to be an adopter of standards-based teaching but may be a future adopter of EDLs. Because of her reluctance to share her ideas with others, she is not likely to be an agent of change for either innovation.
<table>
<thead>
<tr>
<th>Rate of Diffusion Factor</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Comfort in using the innovation</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Teacher-centered vs. learner-centered</td>
<td>Learner-centered</td>
<td></td>
</tr>
<tr>
<td>Source of information about the innovation</td>
<td>Colleagues, mentors, and readings</td>
<td>The researcher</td>
</tr>
<tr>
<td>Willingness to accept change</td>
<td>Positive with hesitations</td>
<td>Positive</td>
</tr>
<tr>
<td>Trialability</td>
<td>Positive with hesitations</td>
<td>Negative</td>
</tr>
<tr>
<td>Observability</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Relative advantage</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Positive with hesitations</td>
<td>Positive</td>
</tr>
<tr>
<td>Types of innovation - decisions: optional, collective, or mandated by authority</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Sharing ideas in the community</td>
<td>Colleagues through one-on-one</td>
<td>Colleagues through one-on-one</td>
</tr>
<tr>
<td>Current support to facilitate adoption</td>
<td>Materials supplied by publishers</td>
<td>Nothing identified</td>
</tr>
<tr>
<td>Desired supports to facilitate adoption</td>
<td>Time</td>
<td>Freely available resources or a filter that separates them out</td>
</tr>
<tr>
<td>Research and teaching cultures</td>
<td>No research</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2: LS-2 responses related to the diffusion of standards-based teaching and EDLs.

Based upon her responses, it appears that LS-2 is a committed teacher who has a clear vision of what she thinks her role should be. There appears to be three things that drive her practice: (a) her students’ needs in terms of content and emotional support, (b) her personal experiences in the classroom both as a teacher and a student, and (c) her time
restrictions. She appears to be mixing traditional didactic methods with an enormous amount of care for her students and their learning. This was a method that worked for her as a student and seems to fit into her time restrictions as an instructor.

From both my personal collegial experiences with her and my interpretation of the data, I believe that LS-2 feels that there is a job to do and she wants to do it well. LS-2 suggests that the students at a 2-year institution have different needs than the students at a 4-year institution. She feels that her best way of teaching them is to stick with traditional methods that she thinks would best prepare them for the high stakes tests that are required to enter their chosen professions.

LS-2 would welcome any suggestions that would help her, but she did not want to complicate the matter with jargon or baseless theories. When she thinks about instructional resources to use in class, she thinks about what she gets from the publishers because that is the focus of the department and that is a comfortable approach for her. She is interested in becoming more aware and would welcome additional information about how to insert more standards-based teaching methods into her teaching and effectively use EDLs. If she had more time, she believes that she will be able to investigate different options in greater depth.

Many of her responses suggest that she is treading water until she gets to a situation in which she has more time for professional development. She participated in educational change on a person-by-person basis, but had not attended a state or national science teaching association meeting. She did not do faculty presentations because she did not want to force her ideas on anyone. She did not contribute to the science education community because she did not think that she had anything new to say about teaching,
and even if she did, she wouldn’t have the time to say it. She feels that she is doing the best that she can with her available time and resources.

*Chemistry Faculty at the 2-Year Institution (Chem-2)*

**Chem-2 Background**

Chem-2 has been teaching at various higher education institutions for 30 years. I have known him for at least 15 years. As a tenured Assistant Professor, his focus at the time of the current study was chemistry, but he also taught natural science and physics.

He said during the interview that he viewed himself as different from his colleagues at the community college in that he was more “Socratic” in his approach to teaching. He was comfortable with that difference. He reported on the Standards-Based Teaching Instrument that he has participated in professional development activities related to teaching practice, has mentored other faculty to help them improve their practice, and has attended national or state science teaching association meetings. He has not taken any formal college or university courses in the teaching of science and has not met regularly with other faculty to study or discuss science teaching issues.

**Chem-2 Standards-Based Teaching Profile**

Chem-2’s standards-based teaching profile is illustrated in Figure 4.3. Chem-2 indicated that he felt partially prepared to develop student conceptual understanding, use inquiry methods, use computers and the Internet, and use multiple means of assessment, which are all methods that he intermittently used. He felt totally prepared to use textbooks as a resource and create a student-centered environment, both of which he did intermittently. He also felt totally prepared to respond to student diversity, which he did regularly. It is of note that his score about implementing methods to respond to student
diversity is the highest of all of his use scores and is equal to his preparedness for this dimension. This could be related to the fact that he taught at a community college with a nontraditional student population.

![Figure 4.3: Chem-2 standards-based teaching profile](image)

His comments during our interview seem to indicate that he is unaware of teaching standards. When he was asked what the term “standards-based teaching” means, content, as in the course syllabus, came to his mind.
I assume standards-based—we must have some sort of standards. So how would that differ from any other type of teaching, I really don’t know. I mean we always have a syllabus and a course description that tells you what you are supposed to do, but I don’t know what standards-based teaching would mean.

When asked if his class was learner-centered he said, “Yes, sometimes. Primarily learner-centered, but I am generally Socratic. I would have to say that I do a lot of questioning and answering in my class, probably more than most science classes.” Chem-2 heard about different teaching methods from his mentors and specifically mentions the work of Lillian McDermott.

Actually, some of these [methods] are obviously related. In fact, the first three seems to be a grouping—that is to say that depth vs. breadth of content, student tasks, and inquiry. It must have been 10-15 years ago that I went out training with Lillian McDermott out in Washington—Seattle—University of Washington. I’ve always been impressed with the type of stuff that she did, which obviously—you give them things to do. It’s an inquiry-based method that she—she’s come up with this inquiry-based physics, which I think is excellent for people who are going to be teaching physics or science in any sort of sense.

So this “depth vs. breadth of content”—the whole idea with McDermott’s program is to make sure that they really understand things that may not actually appear to be that complicated, but make sure that they actually understand. And with this inquiry-based thing, you give the students things to do. You give them tasks [and] then they solve them in various ways with inquiry-based teaching.

He didn’t learn it all from Lillian McDermott, but she helped him put it together.

Some of these inquiry things …. I was just having my students involved with because I thought it was a good thing. And then I went off and I found out that there are other people who think that it is a good thing, and they are getting world-wide recognition for it. But it is the same general type of thing.

Chem-2 said that he used the Socratic method, encouraged students to collaborate, and occasionally asked students to seek out answers on their own. He said that many of the methods listed on the dimensions of standards-based teaching were used by Plato, which make them traditional methods. He did see a difference between his application of the Socratic method and didactic methods that he thought his peers used.
You get them to realize that they can do the stuff by questioning … There is a
danger actually in [using the] Socratic Method. I can remember one of the
comments when I taught physics … on the students’ evaluations was, “My
instructor never answers any of my questions. And either I have to answer them
myself, or he gets somebody else in class to answer them. So what does he do?”

So the role of the instructor in this inquiry-based system is that you do as little
as possible … [while] getting them to understand what to do. What you do to get
them to understand … is you ask them questions. And those can be more pointed
or less pointed depending on the students. Even when I taught physical chemistry,
it was just amazing what you could do by just giving students general directions on
how to do something, something that is very simple. And I really think that my
students learned a lot more with the labs … we did that were simple tasks for them
to come up with solutions for. Like, gee, how will I check for this? Here’s some
equipment. Play with it.

But, it is also time consuming. … You do a whole lot in a sense. … You have to
figure out what they are doing, and then give them as little help as possible. But
[you have to] make sure that they don’t get frustrated and … that they were able to
complete the task that you assign them, [while not standing] over top of them …
all the time telling them what to do. At some point, [you can] discreetly observe
them and figure out what is going on …. I’ve been teaching for a long time, so I’m
able to deal with things that are not necessarily expected. I can actually give them
general directions, and sometimes they come up with different ways of solving
things, which is fine. However, I have to be able to evaluate, ok, this will work, or
ok, you would think this would work, but there are certain problems. But they will
figure that out when they actually try to do it, and then they will have to modify it.
Because you don’t want to jump in and say, “Ok, this isn’t going to work because
of such and such and such and such” even though you are thinking, this is a good
idea, [and] I know that there are certain problems that are going to occur, but they
will figure it out.

Chem-2 said that he felt comfortable making the students responsible for learning
some of the material outside of class time. This was different from the other faculty from
the 2-year institution with whom I talked. They felt that they needed to “cover” all of the
material in class.

If you have problems with it, talk to me about it, ask me questions, but I’m not
going to necessarily deal with class time because there is a good chance that you
can figure this out without me, and if you can’t, then well, we’ll work on it, but
that’s an important thing to be able to do. Part of that is probably the fact that I’ve
done it for so long that I’ve gotten to the point that I can figure out the stuff that
students are more likely to be able to figure out on their own.
Chem-2 was not interested in change for change sake. He was willing to try minor modifications, but he felt that he was already determining what his students needed and how best to help them. Any change from that would have been counter-productive in his mind.

I don’t know how to … not do the best I could for the students. I mean, you have to look at what they need. I do realize that there are other things that are done. I mean, there are people who think that one of the major things in class, and particularly in lab, is to get students almost to conform. Conform might be too strong a word, but to be able to follow written directions and do these things. I really couldn’t bring myself to do that because I do feel that there are other possibilities in there, and I am not a good one at setting rules …. I really am kind of attached to the idea that there are lots of ways of doing things. I guess that is [my approach] and I’m not going to change it. However, in the little sense, what I am saying is I am going to change things.

In the interview, Chem-2 said he would continue to adjust his teaching methods to best meet the needs of his students and found a relative advantage to the dimensions of standards-based teaching that we discussed in the interview. He said, “Well, getting them to have some understanding that will stick with them, I think this is much better.” He cited time as the additional resource that he needed to modify his methods. He found that it was easy for him to fit the teaching methods we discussed into his current teaching methods.

His comments during the interview indicated that he saw a turning point at which students should be expected to learn facts and when they should be expected to understand concepts. He thought that it was appropriate to expect recall of facts in some introductory science classes, but felt that it was important for upper level students to
achieve understanding of concepts. Even in his introductory chemistry classes, he tended to expect his students to think and understand at an earlier point in his course compared to his colleagues.

There are important facts to know. At what point do you switch over from knowing facts to really doing some sort of more fundamental exploration of what is going on? [That is when] you [as a student] have to … understand things and try to put facts together and then create questions to be answered somehow. But you don’t necessarily [learn them] from looking [them] up in a book. There is always that question. Where do you switch over from basically getting people to fundamentally learn facts to fundamentally getting them … to think?

He realized from his own experience as a student in an introductory physics course that it was much easier to do well if he understood the concepts than if he tried to learn the isolated facts.

When I took physics, we were required to hand in a piece of paper about this size with our name on it, and we could write anything else we wanted on this piece of paper. … I mean, what did I put on my piece of paper? … F = MA ….

Chem-2 said that the people who did well in the class realized that everything was related to that simple relationship. The people who were learning the isolated facts filled up their sheets with writing, but didn’t understand the fundamental relationships.

When he had a new idea to share, Chem-2 first went to the Department Chairman. After he had passed it by the Chairman, Chem-2 said that he actively worked with colleagues in their classrooms, which was contrary to his responses on the Standards-Based Teaching Instrument. On that instrument, he indicated that he did not regularly meet with other faculty to discuss teaching methods. Combining the two data sources, it was interpreted that he did not regularly work with colleagues in their classrooms, but would do so on occasion. Chem-2 thought his greatest support for standards-based
teaching was academic freedom and the greatest limitation was inadequate class time. He reported that there was no research culture in his department, so his time and focus for teaching was not limited by conducting research.

**Chem-2 EDLs Profile**

Chem-2 has been involved in digital library development for several years. Chem-2’s SoCQ profile (see Figure 4.4) indicates that his greatest concern was management, which indicates that Chem-2 was concerned about how to manage and coordinate the tasks related to EDLs with the other aspects of his teaching. He mentioned on the open-response questions of the SoCQ that standardization of the sections within courses was important in his department, and he wondered how EDLs will affect the need for that standardization. His SoCQ profile indicates that, to a lesser degree, he also had additional awareness, informational, and personal concerns. This means that additional information about EDLs may help him become more aware of EDLs and enable him to better understand what they involve and how they will affect him.
Chem-2 appears to have a better understanding of EDLs than most of the other faculty in the study. Even though he had more experience and found it easy to try them, he did not actively use EDLs. When he looked for digital resources, he turned to the materials from the publisher because these resources were convenient.

What do I typically use as far as things to help students …? Predominately it is stuff that the textbook publishers push, which … they have their own axe to grind, of course. … It is much easier to go with what is with your textbook manufacturer, typically.

He planned to use digital libraries the next time he was evaluating a new textbook for the department. Even though his interests in curricular materials centered on the textbooks, he liked EDLs as a source of resources that the publisher was not trying to sell.
We have publishers who push things on you. And it is nice to have someplace to go that is not a publisher that is dealing with these same types of things that the publishers are pushing, but you realize that the publishers are pushing all different things. And you know, you wonder, why do they think this is the best of all possible ways of doing something? Is it because this is what they are doing and they want you to buy their book? Probably. It is nice to have someplace to go for a larger view of things.

It appears that Chem-2 views the materials from publishers as convenient, but with their own agenda.

Chem-2 would have shared what he had learned about EDLs with his Department Chairman. He said that the school had plenty of computers in the computing labs and in the individual classrooms. He said, “We have tremendous computer access on this campus. I am just amazed when I go other places and compare our computer support to what they have at other places. Boy, do we have computers.” He said that the additional support that he would have enjoyed would have been lab techs. “Could we use the equivalent of a lab tech looking at what [students] are supposed to learn in these courses? That might be an idea.” He said that it would have been nice to have someone combine the content and technology for him.

A lot of those people seem to know a lot about the technology, but it would be nice if you had someone who was good at the technology and what you want to actually teach in your course, which—I mean—that is what I see with lab techs. They know what is going on with your course, and they have some understanding how to prepare the basics of what they do.

When asked how he would like to be supported in his use of EDLs, Chem-2 said, “Evaluations are always a good thing to have there, but they seem to have those.” He repeatedly stressed that EDLs gave him a source other than publishers for educational resources. He said that publishers had a vested interest in getting faculty to use their products, whereas the EDLs did not.
Chem-2 Rate of Innovation Diffusion

Chem-2 was a faculty member who had many years experience teaching at the undergraduate level at his current 2-year institution. Chem-2 felt that his long teaching career allowed him to anticipate problems and find solutions that a less experienced instructor would not be able to do. The data indicate that Chem-2 felt totally prepared to use the textbooks as a reference, respond to student diversity, and create a student-centered environment. Although he felt prepared for three standards-based teaching methods, he only regularly used methods to respond to student diversity. This is not surprising because he considers the student population at his institution to be non-traditional with various backgrounds and aspirations. He felt partially prepared and intermittently used all of the other categories of standards-based teaching. Chem-2 was in the middle stages of adoption of EDLs, with his primary stage of concern being management and his secondary concerns being awareness, informational, and personal.

Table 4.3 summarizes Chem-2’s responses related to diffusion of standards-based teaching and EDLs as innovations. Even though his statements about standards-based teaching seem to indicate that the innovation might have been too complex for him to have a clear understanding of it, extended discussions indicate that he understands standards-based teaching quite well. For example, the Standards-Based Teaching Instrument responses indicate that Chem-2 did not give his students responsibility for their own learning, and yet his interview responses indicate that he gave them a great deal of room to use a variety of methods to solve problems and learn concepts outside of class. He seems to approach science and science teaching from a very philosophical perspective. He models his own thinking after Socrates and Plato and encourages his
students to do the same. He stated that he thought there was great value in standards-based teaching and would have been willing to use any of these methods as long as they improved student understanding. The mixed messages that he conveyed through his responses could slow his contribution to the rate of diffusion of standards-based teaching.

<table>
<thead>
<tr>
<th>Rate of Diffusion Factor</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Comfort in using the innovation</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Teacher-centered vs. learner-centered</td>
<td>Learner-centered</td>
<td></td>
</tr>
<tr>
<td>Source of information about the innovation</td>
<td>Experts in the field</td>
<td>Participation in a EDL project</td>
</tr>
<tr>
<td>Willingness to accept change</td>
<td>Somewhat, but not change for change sake</td>
<td>Positive</td>
</tr>
<tr>
<td>Trialability</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Observability</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Relative advantage</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Types of innovation - decisions: optional, collective, or mandated by authority</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Sharing ideas in the community</td>
<td>Department Chair and colleagues</td>
<td>Department chair and colleagues</td>
</tr>
<tr>
<td>Current support to facilitate adoption</td>
<td>Class time</td>
<td>Lab techs</td>
</tr>
<tr>
<td>Desired supports to facilitate adoption</td>
<td>Freedom in the classroom</td>
<td>Evaluations</td>
</tr>
<tr>
<td>Research and teaching cultures</td>
<td>No research</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.3: Chem-2 responses related to the diffusion of standards-based teaching and EDLs.
With regard to the diffusion of EDLs, Chem-2 had not used them even though he understood what they were and was comfortable using them. He was not apt to integrate technology into his teaching unless he perceived a great advantage to doing so. He understood digital libraries, knew what they could do for him, but did not regularly use computers or Internet-based resources in his teaching.

All of the other variables that influence Chem-2’s contribution to the rate of diffusion are positive for both innovations. He was open to both standards-based teaching and EDLs as long as they did not adversely affect his students or get in the way of managing all of the work he had within the department, such as working on college committees and choosing textbooks. He considered that his most important communication channel about both innovations was his Department Chairman. The culture of the department did not encourage him to discuss the innovations with his colleagues, but gave him the option of whether or not to adopt the innovation. He viewed himself as different from the others in the department, and so was not apt to think his colleagues would be interested in his methods. The synthesis of all of the data suggests that Chem-2 may be an adopter of the innovations, but would not likely be an agent of change for either innovation.

Physics Faculty at the 2-Year Institution (Phys-2)

Phys-2 Background

Phys-2 had 7-years experience teaching science in higher education institutions and was currently an untenured physics instructor on a tenure track at a 2-year institution. His professional development experiences were limited in that he was never a participant in professional development related to teaching practices, did not take formal college courses in the teaching of science, never met with a group of other faculty on a regular
basis to study and discuss science teaching, and never attended a national or state science teaching association meeting. He had served as a mentor to other faculty and had observed other faculty as part of his own professional development.

Phys-2 did not respond to my general invitations to participate in a group discussion. I contacted him after talking to his two colleagues who attended the departmental group meeting. They suggested that he might be a good person to contact. When I approached him, he willingly agreed. We met in his office two times, once for what would have been a group meeting (it was just the two of us) and once for his interview. He answered the questions I asked him carefully and reflectively. He would often bookmark on his computer the sites that we discussed and would often murmur comments to himself as though he was making mental notes to come back later to try different ideas.

I interpret his reluctance to volunteer to participate along with statements that he made during the interview to imply that Phys-2 is isolated, but he is willing to collaborate when others actively invite him to join. I do not think he would have felt comfortable joining the group meeting without someone else bringing him along. On the other hand, he was very welcoming of any information I had to share with him. The fact that he took many notes during our discussion makes me believe that he may further investigate the ideas that were new to him.

*Phys-2 Standards-Based Teaching Profile*

Phys-2’s Standards-Based Teaching Profile is illustrated in Figure 4.5. His adjusted scores indicate that the use of textbooks as a reference was the only method that he felt totally prepared to use and the only standards-based teaching method that he regularly used. Phys-2 felt partially prepared and intermittently used methods to develop student
conceptual understanding, use inquiry, respond to student diversity, use computers and the Internet, create a student-centered environment, and use multiple means of assessment.

![Standards-Based Teaching Category](image)

**Figure 4.5: Phys-2 standards-based teaching profile**

Phys-2’s responses during our interview indicated that he did not have a clear understanding of the term “standards-based teaching.” When asked to define it, he said, “I guess it means adhering to some set of standards determined by some sort of research
or educational body. Using that as a guide for your curriculum as well as your lectures
and exams and so forth.” In terms of his current use of standards-based teaching methods
as he defined them, he said,

We haven’t. I suppose we could. We are talking about our department having
standardized syllabi. That to me does not seem the same as standardized teaching,
though. I’m not sure. I suppose there would have to be some sort of push for it for
us to take the trouble to adopt some standardized teaching approach. We have to
become familiar with some set of standards and get interested in it and have some
discussion.

As he talked, he was working through the idea of how he could use standards-based
teaching even though he and I had discussed those methods in our previous “group”
meeting. This indicates that even though we discussed standards-based teaching methods
before, he did not consider them in terms of his own practice but rather from a theoretical
perspective. When he considered implementing them, he talked about having
departmental standardized tests and standardized teaching methods, not taking standards
from an educational body and using them as a guide himself. In addition to being
unfamiliar with the science education definition of standards-based teaching, Phys-2 was
not sure of the meaning of the terms related to the dimensions of standards-based
teaching.

In our interview, Phys-2 mentioned that he considered himself and his institution
hemmed in by the curriculum.

The curriculum at this time is set and we would have to meet within our discipline
and hammer out what our new curriculum is supposed to look like. … And then
get that approved by the chairman, and I don’t know how much higher it needs to
be approved. We’re constrained somewhat because we can’t depart too drastically
from what [the 4-year institution] does because our courses transfer or are
supposed to transfer.
This leads me to believe that Phys-2 does not feel that there is much room to make drastic changes in his approach to teaching because if he changes things too much, the courses may not transfer. If the courses change in status and do not transfer to the 4-year institution, it may be catastrophic for the 2-year institution. The 2-year institution relies heavily on the tuition dollars paid by students who plan to transfer the credits to the 4-year institution.

Phys-2 indicated during the interview that he was skeptical of educational fads. His comments also indicated that he did not have training in education and was not always aware of teaching techniques. For example, when we talked about one method, he said, “I don’t know if that indicates that it is a current buzz word or if it is finally breaking through my consciousness.” In another example, when we were talking about supporting student confidence, he said that that he hadn’t been considering his teaching from the point of view of building student confidence. He explained that he offered homework that made students feel comfortable, and considered that he may not have been paying as much attention to student confidence as he should. This may be an indication that he is open to other methods and reflective about his current methods.

The decision about whether to adopt standards-based teaching and EDLs were both Phys-2’s option. He indicated that he had the leeway to control how he taught and how he prepared to teach. This was consistent with the responses of the other faculty from his department.

He described his classroom as teacher-centered because,

I decide what’s going to go on in a given class and give lectures that are where I am talking, give demonstrations and so forth. Not much of what happens in the class strongly relies on student initiative, I guess.
His responses consistently reflect a didactic, traditional approach to teaching while trying to develop student understanding of the concepts. On his Standards-Based Teaching Instrument, he reported introducing the content through formal presentations and asking open-ended questions with a frequency ranging from almost all to all of his classes. His assessments were also traditional. He never conducted pre-assessments, embedded assessments, or had students present their work to the class.

Phys-2 was very concerned with student assessment in terms of both student success and department success. His comments indicate that he thought that accurate assessment was challenging.

I think the way that we use assessment here for that program is a more specialized use of the term. I think that assessment in general means how do you tell what you’re teaching the students, what do they actually learn from what they’ve done in your class. ... I think it is a problem of how do you really figure that out with any confidence that you have a really good objective measure of what students learn. The students take tests, they get nervous, you know they misinterpret the question. What are you measuring? I don’t know.

He learned of most of the dimensions of standards-based teaching during graduate school. He tried new techniques each quarter to make improvements for himself and his students. As he looked through the dimensions of standards-based teaching, he could see many more that he currently was using in some way. He could perceive the difference between the methods on the dimension’s list and traditional methods.

Seems like traditional methods were pretty much—the instructor lectures and demonstrates, the students do homework, take notes, take exams, and do labs, and that’s probably a caricature of it. But the things on this list are so much more focused on the quality of the experience for the students and asking them to participate in learning in a different way than traditional methods.

He perceived an advantage to standards-based methods. In the following passage, Phys-2 characterized standards-based teaching as providing a more active role for the students,
allowing more opportunities for student/faculty interactions, and greater flexibility for both the students and the instructor.

I guess the primary advantage to me would be a more active role for the students, although I am not sure that all students see that as an advantage. And I guess also, I mean, breaking out of some of the rigidity. I mean, a classroom that cares a lot about these things allows a lot more interchange between the student and the instructor—a lot more flexibility. I don’t really like being an enforcer of discipline.

After reviewing each of the dimensions of standards-based teaching with me, Phys-2 said that he did do many of the techniques to some degree and felt that they fit well into his current teaching methods. He sensed that the standards-based teaching methods were important to a “very committed and active minority” of his colleagues in the undergraduate physics education community who were actively involved in promoting these methods. Even though he stated clearly that he made the decision about whether or not he used standards-based teaching and EDLs, the limitations of having to comply with departmental standardization and the requirements from the local 4-year institution had an impact on how he approached his teaching and the freedom he felt to explore new innovations.

The nature of the social system in his department put him in a position to promote change, mostly with the adjunct faculty. As he has done in the past, it seems that he would have shared what he learned about standards-based teaching with adjunct faculty through seminars and faculty inservice-day presentations. He would have liked to get support from professional development workshops and seminars because he felt that they would give him a chance to see theory translated into practice. When asked what supports would help him use standards-based teaching methods, he cited the campus’ Teaching Learning Center as a place that provides good support for building websites, making
recordings, and integrating things into existing websites. I interpret this to mean that he feels that these technological supports would also help him implement some of the standards-based teaching methods.

When asked about the interaction between the teaching and research cultures in his department, Phys-2 responded that there was no research culture in the department. This indicates that research tasks may not be limiting Phys-2’s time or focus that he has available for his teaching. Other commitments, such as committee and service work, may be preventing him from spending more time adjusting his teaching methods.

**Phys-2 EDLs Profile**

Figure 4.6, illustrating Phys-2’s SoCQ profile, shows that he was mostly unaware of EDLs and would have liked additional information about adopting them. According to the SoC analysis, this indicates that he may benefit from information about the advantages of EDLs over what he has as well as information about what resources and requirements are required to adopt EDLs. His profile also showed a peak related to the management concern, which implies that he worries about how he could organize his academic and nonacademic tasks and responsibilities so that he can effectively use EDLs.
Figure 4.6: Phys-2 stages of concern profile related to his adoption of EDLs

When Phys-2 and I discussed EDLs during the interview, it appeared that he understood what was available in EDLs even though his introduction to them was in our initial “group” meeting. Between our two meetings, he searched through some EDLs to find resources that he subsequently used in his classes. Even though the resources he found were mostly text based and too advanced for his students, he said he was very inclined to use them.

Phys-2 felt that EDLs will be a good tool because they will help him find the resources that he needs to help his students understand the physics concepts. He said, “I like to have interactive [applets] or simulations that I can show students in the classroom
or find things that I can point them to because I think that does something different than reading a textbook.” The following indicates that he thought it was important to have educational resources in a variety of formats.

Well, I think it’s a different approach to the brain, plus, I think it is a little more engaging. … I think it is a change of routine in the classroom and some of the courses I teach are 3-hours long and you can’t just talk the whole time. Plus if you have things that you can point students to, then they can take charge instead of passively taking something in. I mean video presentations are fine, but they just watch them. If you can have something that you can interact with, you know change values of the mass or the force and see what happens, then you can—it’s like doing virtual experiments. I think it gives people—I think it has the potential to give people a better feel for relationships between physical entities.

It was interesting that he appears to greatly value the interactive nature of the digital objects while describing his own teaching approaches as very didactic. The convenience of EDLs over traditional methods of finding education resources was a big advantage to him.

I guess the digital libraries allow you to kind of do it on your own from your office. You don’t have to attend a conference. You don’t have to do all of the organizing. I mean, it’s not very expensive. You miss out on the interactions with other people. I mean you don’t have people to bounce ideas off of. But it is certainly very convenient, I think.

Phys-2 stated that he would share information about EDLs though departmental seminars. He said that he would invite both full-time and adjunct faculty to the seminars. He liked the seminar format because, “[It is] something where you actually see what’s there, rather [a format in which] you are told if you follow this link you might find some interesting stuff. I think that [the format] has a better chance of finding something where you might also get people interested in it.”

When asked what additional supports he would like, Phys-2 indicated that he fantasized about one site that searches through all of the other sites. He was thrilled when
he heard that the NSDL.org was designed to do exactly that. He cited time as a chronic problem for him exploring standards-based teaching and EDLs. “I wish I had more time to explore the various things that are available with the digital libraries or other methods of teaching. There is just so much you can spend your time on.”

*Phys-2 Rate of Innovation Diffusion*

Phys-2 was a faculty member who was early in his teaching career at the 2-year institution. The data suggested that Phys-2 felt totally prepared to use the textbooks as a reference and used this method regularly. He felt partially prepared and intermittently used all of the other categories of standards-based teaching. It was not surprising that he finds textbooks an easy tool to use since they are fundamental in traditional undergraduate learning environments. He was in the early stages of adoption of EDLs, with his primary stage of concern being awareness and his secondary being informational and management.

Table 4.4 summarizes Phys-2’s responses related to the diffusion of standards-based teaching and EDLs as innovations. It indicates that standards-based teaching was an innovation that was complex enough that he did not yet have a clear understanding of what it encompassed. This level of complexity may slow his contribution to the rate of diffusion of standards-based teaching. However, all of the other variables that influence the rate of diffusion were positive for both innovations. The synthesis of all of the data points to the conclusion that Phys-2 has the potential to be an adopter and an agent of change for both innovations.
Table 4.4: Phys-2 responses related to the diffusion of standards-based teaching and EDLs.

Phys-2’s exposure to standards-based teaching and EDLs gave him enough awareness to be interested in both innovations. He needed additional information about both in order to use them better to support his teaching. He has the potential to serve as a good
communication channel because he is interested in learning more and then sharing his experiences with others. He was open to participating in professional development programs that gave him a practical view about how he could use both innovations. He had a history of sharing information with his colleagues in departmental settings.

The data indicate that he approaches his teaching from a very reflective and analytical point of view, but he is aware that analyses of student learning could be misleading. He was very interested in improving student learning. I inferred from the data that language may be a barrier to his learning about standards-based teaching methods because he is not familiar with the meaning of many terms used in science education settings. The data seem to show that Phys-2 is very interested in changing his classroom to be more interactive and flexible and that he has found resources in EDLs that could help him implement those changes. I think the fact that he finds overlap between the innovations of standards-based teaching and EDLs may have a synergistic effect on his adoption of both. More information and exposure to both innovations and the language used to discuss them may help his adoption and diffusion of standards-based teaching and EDLs.

Geology Faculty at the 2-Year Institution (Geo-2)

Geo-2 Background

Geo-2 was an untenured Geology Assistant Professor who was on a tenure track and has had 2-years experience teaching science courses at a higher education institution. He did not respond to any of the invitations to come to a group meeting. His name was suggested by the chemistry and life science faculty who did come as well as a geologist in the department who did not want to participate herself. The geologist contacted Geo-2
and asked to be a participant. The first meeting, which would have been a group meeting, was just the two of us and took place in his office.

Geo-2 indicated on the Standards-Based Teaching Instrument that he had been a participant in professional development related to teaching practices, observed other faculty as part of his own professional development, and mentored other faculty in terms of teaching science. He said that he had met with other faculty on a regular basis to study and discuss science teaching methods. He had not attended a national or state science teaching association meeting. Geo-2 said that he had not taken a formal college course in the teaching of science, but in the interview he clarified that he had taken one undergraduate education course.

*Geo-2 Standards-Based Teaching Profile*

Geo-2’s standards-based teaching profile is illustrated in Figure 4.7. With regard to methods to develop student conceptual understanding, use inquiry methods, use textbooks as a reference, respond to student diversity, and use multiple means of assessment, Geo-2’s adjusted scores indicate that he felt partially prepared, and that he reported that he used these methods intermittently. It is of note that Geo-2’s responses indicate the largest gap between his feelings of preparedness for and his actual use of methods related to creating a student-centered environment. In fact, of all of the standards-based teaching categories, he felt totally prepared to use methods to create a student-centered environment, but he only used those methods intermittently. Geo-2’s adjusted scores indicate that he felt unprepared to use computers and the Internet, which is, not surprisingly, a standards-based teaching category that he did not use.
During the interview, when Geo-2 reviewed the dimensions of standards-based teaching, he said that he used most of the methods on the list. He was unfamiliar with the term “standards-based teaching.” When asked to explain the term he said, “I would think that standards-based teaching means chairs, chalkboard, chalk, overheads …. Just your basic teaching set-up. No electronic devices, just chalk talk as it were.”

In the following passage from the interview, Geo-2 explained why he described his class as learner-centered.

It is more of a discussion. You can go to many other places and listen to people stand up there and preach about this that or the other thing. I ask a lot of questions and there is a lot of discussion that goes on in my classes.
I interpret this to mean that he distinguishes his approach from others who strictly lecture. It seems as if he thinks that the presence of class discussion was a key determinant of learner-centeredness. I also interpret this to mean that he does not have a deep understanding of what the science education community associates with learner-centered environments. For example, he did not mention the students’ responsibility for their own learning. This could indicate unfamiliarity with the term or unfamiliarity with the concept.

Geo-2 was the only faculty member who said that he had an education class. The class he took dealt mostly with general educational issues such as “paddling.” He felt that he was introduced to the teaching methods described in the dimensions of standards-based teaching through personal experience as a student in undergraduate and graduate school. Geo-2 modeled his lecturing techniques after one of his undergraduate professors.

When asked how inclined he was to change his teaching methods, he replied

It would have to be fairly convincing for me to completely change …. Every other quarter, I completely redo my notes and redo my overheads and things to try to keep up to date. And I found myself adding more, I guess, electronic-type visual stimulation to my classes—more fancy color overheads, more slides, more audio-visual type things, movies … and PowerPoint kinds of things. I have been trying to catch up. So I guess, subconsciously, I have been doing it in some way. But I haven’t made an honest effort to thin out [my methods] and completely change over yet.

He said that the reason he had not changed more was that he did not have time to review his options.

When I asked him if he saw a difference between traditional methods and the methods on the standards-based teaching list, he said, “I think the traditional method in higher education is the guy or the professor [who] comes in with a piece of chalk and just
starts talking and if you don’t get it, tough.” Geo-2 indicated that the standards-based teaching methods fit well with his teaching methods and felt that 90-95% of his colleagues would have found them valuable and usable as well. Even though Geo-2 indicated that the decision about teaching methods was his, he said that the institution tries to give some guidance during orientation.

Well, the college tries to give guidelines as to what you should do at an orientation-type thing for new instructors. But you can’t teach geology and English the same way, I don’t think. So, although the college thinks that they are [giving guidance], I think the instructors actually do it themselves. As bad as that sounds …. They have people come in and give a 5- or 10- minute summary of what their good teaching methods are. Someone who teaches French. I really don’t have any interest in what they are saying about teaching French because it is completely different. No offense to them.

If Geo-2 shared information about different teaching methods, he said that he would share it with all faculty at an inservice day. He said, “I would have a workshop type scenario. And if it’s like me, nobody would show up. I mean that would be the best way to do it in an interactive type of situation. Maybe in a computer lab.”

Geo-2 never attended a faculty inservice day himself. He said that he would prefer to use the time for other aspects of his job.

I go to the morning , you know, the big [departmental meeting], and then they usually have these [workshops] after lunch. And so I just go to my office and do work. Lock the door. … I have been to workshops at meetings and things, which is probably completely different, so no. I am guilty of not going. So I guess I can’t really answer honestly. … I don’t go because I have other things to do that have priority, [such as] grading papers [or] working on manuscripts. You know, a free 3 hours in the afternoon is a Godsend, so I just take that time and work on a publication, rather than have office hours and try to get something done. … Well yeah, it’s not really that I am not interested. It is that I would rather do other things with the 3 hours.

His responses indicate that he thinks that presenting the ideas in an inservice workshop may be a good way to share ideas, but he feels that he can not be sure since he, himself,
has never attended one. His decision to not attend the inservice meetings was not because
he did not think that they were valuable, but rather because he would have preferred to
spend his work time accomplishing other tasks.

When asked what additional resources he would like to help implement standards-
based teaching methods, he said that he could use more time as well as more visual
methods and referred to the resources that we had previewed in EDLs the week before.

I have an image bank that I am still yet to look at that I got from some book
people. Where you type in volcano and it has pictures of all of these things. And
actually the volcano thing that we looked at last week was very cool, and we just
talked about volcanoes [in class], but I completely forgot about it. … If I get the
quarter off to put these things together it would be nice.

The fact that Geo-2 repeatedly brought up EDLs while answering questions about
standards-based teaching could be interpreted in two ways. The first interpretation is that
he is blurring them together in his mind. We discussed both innovations during our
meeting the previous week and he may not have been separating the two constructs when
answering questions about standards-based teaching. Another interpretation could be that
he sees EDLs as a means to implement standards-based teaching. The latter interpretation
is a sophisticated analysis of the relationship between standards-based teaching and
EDLs. Geo-2 was not familiar with the terms, standards-based teaching or EDLs, before
our meetings. Because of his unfamiliarity with both innovations, I believe that the
former interpretation is more likely.

When asked about the interaction between the teaching and research cultures in his
department, Geo-2 responded that there was no research culture in the department. This
indicates that research tasks may not be limiting Geo-2’s time or focus that he has
available for his teaching. Other commitments, such as committee and service work, may have been preventing him from spending more time adjusting his teaching methods.

**Geo-2 EDLs Profile**

Geo-2’s SoCQ profile indicates that his greatest concerns were informational followed by awareness (see Figure 4.8). This verifies that he was completely new to EDLs, as he had said in the interview and initial meeting. This profile suggests that his concerns may be met best by more exposure to EDLs and hearing more information about what they can do to support him.

![Figure 4.8: Geo-2 stages of concern profile related to his adoption of EDLs](image)

When asked in the interview to define digital libraries, Geo-2 said the following.

*It is a collection of information I guess, trying to remember what we talked about last week. It’s a collection of information—web sites and places you can get things*
by typing in keywords and things like this that help students individualize. And it’s available to everybody or in theory it is. So I don’t know if it would replace textbooks, but it is a good crutch, I guess. … It’s a good help … I don’t know, does it have text?

His references to websites and materials for students indicate that he has a general idea of what is in EDLs. His confusion about whether or not there was text in EDLs supports the interpretation that more information may help to clarify his ideas. I am interpreting his response to mean that the concept of EDLs is not so complex that he would avoid adopting it as an innovation, but rather his notion of them is incomplete.

The first time Geo-2 heard about digital libraries was during his discussion with me the week before. Even though he knew we were going to talk about them again, Geo-2 had not reviewed any of the EDL collections that we had discussed because he had not had enough time. He was somewhat inclined to use EDLs in the future. He said, “I think they are a valuable tool. And if I could, I would. And I plan on it in the future. I don’t know completely if I would veer away from textbooks.” Geo-2’s conception that EDLs are potential replacements for textbooks does not correspond with developers’ current plans for the use of EDLs. He referred to EDLs as a crutch twice in our conversation, which may imply that he views them as educational supports that people lean on when they need help.

Geo-2 cited low cost and accessibility as two advantages to using EDLs.

One, is for the students; it’s free, well free in quotes. They don’t have to spend $97 for a textbook, when they can just go … and you can do it anywhere—well if you have a computer. And I think the main thing is that everybody has access to it. And these days, even the most illiterate computer people can go and click. … Most people know how to use the Internet.
As he said in the following passage, Geo-2 felt that EDLs fit well into his current methods.

I show a lot of pictures anyways. And a lot of models. A lot of overheads and a lot of photos. And from what I saw last week, that would be great. The digital libraries would be nice for putting all of that together.

The data suggest that Geo-2 may share the EDLs with his colleagues at an inservice day where he could demonstrate the EDLs. Geo-2 reflected on the use of EDLs in geology labs.

I think it would be good in lab, so I don’t want to say to move the geology lab to the computer room. But maybe for a couple of labs or maybe even on the overhead thing [in lecture], incorporate some of these working models and have people watch these short videos and things, and [have the students] answer questions from that. [Having] the geology lab become more electronic would be a plus.

With regard to institutional support, Geo-2 said, “Well I know [my institution] is gung ho for ground-breaking methods of teaching and this, that, or the other thing, so I am sure that they’re on board. And I am sure that a lot of people use this, and I just don’t, yet.”

*Geo-2 Rate of Innovation Diffusion*

Geo-2 was new to teaching at the 2-year institution. The data suggest that Geo-2 felt unprepared to use and did not use computers and the Internet in his classroom and totally prepared to create a student-centered environment. This seems to indicate that he may have problems implementing a technology-rich innovation such as EDLs, but was prime to incorporate some standards-based teaching methods into his practice. He was in the early stages of adoption of EDLs, with his primary stage of concern being informational and his secondary being awareness.
Table 4.5 summarizes Geo-2’s responses related to the diffusion of standards-based teaching and EDLs as innovations. It indicates that both innovations were complex enough that he did not yet have a clear understanding of what either one encompassed.
This level of complexity may slow his contribution to the rate of diffusion of standards-based teaching and EDLs. However, all of the other variables that influence the rate of diffusion were positive for both innovations. The synthesis of all of the data suggests that Geo-2 has the potential to be an adopter of the innovations, but, at the time of the current study, he would not have been a good agent of change for either standards-based teaching or EDLs.

In order for Geo-2 to become an adopter, he needs clarification of what the innovations are and how he can implement them. He has not yet developed a clear picture of standards-based teaching or EDLs. This causes his responses to the questions to be a little ambiguous and vague. He said that he did not have enough time to investigate different techniques. It seems that additional experience may help him better assess his own teaching methods. Since he had not yet taken advantage of the inservice days at his institution, he was not able to use that format to learn about new ideas and share his ideas with his colleagues. In order for Geo-2 to adopt either standards-based teaching or EDLs, he may need more exposure and experience related to the use of these innovations. A faculty inservice workshop may be a good venue for this exchange.

Cases at 4-Year Institution

The following 4 case-study descriptions are of science faculty at a 4-year institution. The cases are presented separately to illustrate the individual characteristics of the faculty. They are grouped into this section as an organizational tool so the faculty teaching a specific discipline at the 4-year institution will not be confused with faculty teaching the same discipline at the 2-year institution.
Life Science Faculty at the 4-Year Institution (LS-4)

LS-4 Background

LS-4 was a tenured Professor with 25 years of teaching in higher education institutions. He was an active participant in professional development related to teaching practices and mentored other faculty in terms of science teaching. In addition, he observed other faculty as part of his own professional development, met with other science faculty to discuss science teaching issues, and attended state or national science teaching association meetings.

The 4-year institution has a College of Biological Sciences which is led by a dean and is subdivided into several departments. Within the college, all of the introductory life science courses were staffed and coordinated in one program, which was directed by LS-4. In addition, LS-4 was a faculty member within one of the life science departments within the college. Many of the faculty in the college took turns teaching introductory classes within that program. In his capacity as Director, LS-4 created and maintained the learning environment for both the students and the other faculty who taught introductory life science courses. He was responsible for facilitating the faculty’s understanding and implementation of the teaching techniques that he thought were important for the program.

His colleagues in the department thought he was willing to try things that they were not willing to try. For example, in the group meeting for the current study, one colleague said,

My guess is that if you go around to all 25 of us in this department, LS-4 may be very close to unique. Most of us [think] PowerPoints are better than overheads which are better than writing on the chalk board.
I interpret this to indicate that many of the faculty in the department use didactic teaching techniques and, left to their own devices, would stick to the teaching tools that they always use.

Compared to the other departments investigated in the current study, it appears that the LS-4’s has more administrative support. It is of note that the Chairman of LS-4’s department was the only department head from the 4-year institution to help me set up group meetings. That Chairman sent out e-mail invitations on my behalf and encouraged the faculty to participate. I interpret this Chairman’s level of participation as important in setting an example for his faculty. I take his actions to mean he was sending a message to his faculty that he thinks discussing teaching methods and educational innovations are a valuable use of faculty time.

*LS-4 Standards-Based Teaching Profile*

LS-4’s standards-based teaching profile is illustrated in Figure 4.9. The two categories in which there was a disparity between LS-4’s feelings of preparedness and his frequency of use were responding to student diversity and the use of computers and the Internet. He regularly responded to student diversity, even though he only felt partially prepared to do so. He felt partially prepared to use computers and the Internet; however, this was a standards-based teaching category that he did not use. With regard to methods to develop student conceptual understanding, use inquiry, and use textbooks as a reference, his profile indicates that LS-4 felt well prepared for each and that these were
categories of methods that he regularly used. He felt partially prepared and intermittently used methods to create a student-centered environment and use multiple means of assessment.

Figure 4.9: LS-4 standards-based teaching profile

When asked in the interview what standards-based teaching means to him, LS-4 discussed content standards that were identified by the course curriculum and what the students were supposed to know coming from high school into the course, which was determined by the state. As the following quotes illustrate, LS-4 gave science teaching enough thought that he started to integrate his ideas about teaching content, teaching process skills, and the methods for teaching science.
It means two basic things. At the level of my college instruction we should, to some extent we do, have some kind of expectation for what our classes are supposed to do.

I use standards-based in my teaching in two very increasingly explicit ways. One is standards that I expect to accomplish with my students. … I now hand out a précis of my class. A précis, it’s a brief summary of the entire class. In this case, it is a chart with rows that indicate day-by-day progression of the labs and the lectures and columns that indicate what is going to be accomplished during that lecture, during that lab lecture pair, or whatever. The content standards are there. … The process standards are there as well.

He considered his classes to be learner-centered for many reasons, but realized that there was room to make them more so. An example of LS-4 shifting the responsibility to the students can be found in his lab data sheets. He felt strongly that the students needed to figure out the best way to record and analyze the data so that they can better understand what was being recorded and analyzed. LS-4 thought that students learn a valuable lesson by struggling how to best present their data so that it communicates what they want related to the experiment.

Half the experiment’s done when you design the data sheet. We don’t do that. So one of the things that I want to have done, but I have to get these other things done first, is we are removing all data sheets from our lab manuals. My goal is to have the student directions on what to do in a lab down to a page or two. They are going to use Excel. It’s in the [the software package sold by the university.] … You are going to get a bachelors in science from the [this university] and not know how to use a spreadsheet?

He indicated that the learner-centeredness of a class was in the eye of the beholder.

I can point to a number of things that I have done, both as instructor of my own class and as Director of the [Undergraduate Biology Education Program], that [are] meant to focus on the students. The laboratory exercises are all student-centered. They are all discovery-based. They all build some hypotheses, think of some ways that you can differentiate between the hypotheses, design the experiment, fall flat on your face. If that is what you are going to do, that’s OK. There are no points associated with being right because sometimes we don’t know what right is. We use a learning cycle approach. … If you had a committee of
student-centered experts come in here and look at my class, they’d say that I wasn’t. But if you had a committee of my peers come in they’d say, “No, I could never do that. He’s crazy.”

The comment that his peers would consider him crazy can be interpreted to mean that he perceives his approach as different from theirs. The entire passage implies that LS-4 thinks that he has not adopted and implemented learner-centered methods as completely as education experts have, but he considers himself farther along in the adoption process than his colleagues.

LS-4 has thought about teaching for most of his life. He remembered hearing about standards-based teaching methods from a colleague at another institution. He also learned about the methods through reading *NSES* (NRC, 1996) and professional reading throughout his career.

I got into these some when the faculty line for a biology educator at my old institution was transferred into my then Department of Zoology. I was already thinking—I have been teaching since I was 8-years old, so I had been thinking about it a lot. He really helped me come up with a lot of these and then much more of these came from reading the *National Science Education Standards*. A lot of that other information was coming out in the mid 90s.

It seems that LS-4 perceives the difference between standards-based teaching methods and traditional methods. He considers the former to work much better. For example, he said people used PowerPoint presentations to be progressive, but he thought they were still using traditional methods. He said, “A 40-minute-lecture that’s just ‘here it is. My PowerPoint slides are on the web’ is pretty bad. There are a lot of people who think that is pretty good.” He thought that standards-based methods were better because students had the tools to continue to learn science after they left his class. He said,
It’s the old, if you give a person a fish, they can eat for a day. If you teach them to fish, they can eat for their life. I think if you can show them how we think, they can think that way, too.

LS-4 said that he was inclined to change his teaching methods. When asked why, LS-4 responded, “I want to be better.”

LS-4 was becoming increasingly intolerant of people who challenged his attempt to improve student learning by using standards-based methods.

There is an accumulating body of evidence. Data that this works. … I was at a workshop this weekend … where I was the radical and they were all reductionist biologists and they all kept challenging me and in a fit of anger I said, “Where the hell is your data? Show me! You know, I know TIMSS, do you guys know TIMSS? It says you haven’t been doing a Goddamn thing for the last 50 years. You want to see me document everything. I can just document some of what I am telling you, but tell me that rote memorization works. Well, students get As. Well yeah, but I said go back and retest them 10 days later.” So why do it? It felt better, and trust me, I was good at the old methods. I used to give good lectures. Damn, I gave good lectures. I still get to carry that through. It’s not that hard. Usually the data that we have for our teaching methods is [that] it felt right to me. This felt right to me.

This indicates his understanding of the difference between standards-based teaching and traditional methods as well as his understanding of expectations and efforts to document the effects of different teaching methods. I also interpret his comments to mean that he finds it wearisome to have to repeatedly defend his standards-based approach to teaching.

LS-4 did not think that many of his colleagues valued standards-based teaching. He said that he tried to make it easier for them to use the techniques so that they could carry out his overall plan for the course.

My job as Director of the [Undergraduate Biology Education Program] is to mentor it for [the faculty] and to lower the bar. And I think we are making some headway there. I think what you hear from a lot of my colleagues is, “Yeah, yeah, yeah, that’s nice and good, but the fact of the matter is I have 15 minutes to get ready for the lecture. That’s as much time as I can give it.” But what you can do in those 15 minutes, if you listen real carefully and do what I have arranged for you
to be able to do. And you go in there and act the part of the professor and connect this with the lab, you can get away with that and be more effective. I can show you that. So I don’t think that they think it is as important as I do, but then again, it is my job description to make it important and to make it easy for them. I think we are doing that.

He pointed out that he did not force anyone to use specific techniques, but he made it clear to the faculty that their lives would be easier if they did what he suggested. The following quote illustrates how he facilitated their use of standards-based teaching methods.

One, I get to structure it so, [Faculty Member], if you want to come in and teach for me, that’s great. Now look, we’ve got this lab on cell division. It’s a pretty cool lab. Go in and take a look at it. It’s got students looking at root tips. It’s got all of those things that you love to do as a geneticist and everything else. And the TAs know how to do this. Everybody knows how to do this. You don’t have to do a thing with one exception. You can’t lecture on mitosis before they do the lab. … The lab is not a verification lab. The lab is a discovery lab. You will ruin the lab if you go in and say, “And now in lab you are going to see this.” So if you do that, you can’t use this lab. You are going to have to write your own. You know what happens? They do it.

Many of his comments led me to believe that he thinks the other faculty would not use standards-based methods on their own, but would prefer more prescriptive, cookbook-style approaches.

LS-4 was an agent of change for standards-based teaching within his program and department. He had developed a support network on campus so that he could solve problems and find sources for professional development on campus. Examples of his supports on campus include the office in charge of professional development for faculty and the office that supports the use of computers in teaching and learning. His comments imply that LS-4 feels that it is part of his job to share ideas and information with other faculty and staff. The resource that may help him most to implement and share ideas
about standards-based teaching would be time. He felt that he already had a very strong support system in the institution. He said that the administration realized that they hired him to improve the quality of the Undergraduate Biology Education Program, and so they were willing to help him do that.

From my perspective, LS-4 is hesitant to say that the competing demands from the research and teaching cultures in his department have an effect on people’s adoption of standards-based teaching methods. In the following two quotes, I interpret LS-4 to be saying that faculty need to find a way to balance the various demands of their jobs and to realize that there is not enough time to do everything.

Research and teaching, I think, are very badly misunderstood. For myself, the pressure to perform basic research, to get science publications out there, to get grants, to find new things, to have graduate students, to have post docs is enormous. It’s staggering. It’s all internally generated, too.

I mean I tell my graduate students, I will not spend enough time with you. I don’t spend enough time on my teaching. I don’t spend enough time on my research. I don’t spend enough time with my family. I don’t spend enough time with my dog. I don’t spend enough time exercising, reading books on the outside, and anything else. I mean welcome to life. What we need to do is recognize those constraints, stop bitching about them and ok you only have 15 minutes, let’s shut up and get going. I’ll tell you give me 15 minutes. That’s more than nothing.

**LS-4 EDLs Profile**

LS-4’s profile on the SoCQ indicated that his concerns about EDLs were greatest in the areas of awareness, information, and management (see Figure 4.10). According to the SoC analysis, his awareness concerns indicate that he did not know much about EDLs, but the fact that he would like more information could mean that he was interested enough from what he knew to want to learn more. His management concerns could be interpreted as a natural extension of his leadership within the Undergraduate Biology
Education Program. He may need some guidance about how he can organize his academic and nonacademic tasks and responsibilities so that he can effectively use EDLs.

![Stage of Concern](image)

**Figure 4.10: LS-4 stages of concern profile related to his adoption of EDLs**

His interview responses indicated that he understood what EDLs were enough to explain what they were and how they could be adapted in his teaching environment. He thought of them as

- electronic or digitally available resources usually over the net. Sometimes with gates for access. I conjure up a similar picture as what I conjure up in terms of what infinity’s all about when I think of the size of the thing.

He has thought about them enough to consider their use in his context. He linked the concept of EDLs to textbooks and considered a way to leverage them pedagogically and commercially. For example, he said

162
What I would really like to do, and I don’t know if the book companies haven’t figured this out is – I am using ABC publishing company college text, if you used ABC publishing company in high school, we’re building in reverse an e-portfolio telling this e-publishing company to keep their account active and where they went to …. We are going to go back and get them in college. Tremendous pedagogical and, not that I am interested in it, commercial power there.

This passage illustrates LS-4’s interest in developing and implementing a continuous, coordinated K-16 curriculum by expanding the methods and resources that are used in the K-12 environment.

LS-4 did not remember when he first heard about EDLs, but he tried several and felt comfortable looking for and accessing resources through them. Even though he had heard about MERLOT, which was an EDL, he went back to look through it after his participation in the group meeting in which we discussed MERLOT. His motivation for doing this was that I corrected his misconception about MERLOT during the life sciences group meeting. He said that MERLOT was for K-12 and limited to a specific state. I told him that it was for undergraduates, for all disciplines, and all states. He said in our interview,

Yeah, you hit me over the head with MERLOT so I went and looked at MERLOT and now I am getting ready to submit stuff. So yeah, I’ve tried MERLOT. I’m a learner man, I’m a learner. I have to practice what I preach.

This can be interpreted to mean that he actively responds to new information about EDLs.

He said that he was inclined to use EDLs because he would like to find materials for student remediation so the students could bring themselves up to the level of understanding indicated in the state standards documents.
I think they are going to be a fantastic place to find these remediations.

I think it is very important to mentor the students to figure out what they don’t understand and go learn it. And to do that, we have to find, and I think we have to vet now the resources that we send them to. I don’t want to send them just to Google.

LS-4 compared EDLs to Google when asked if he can discern a difference between EDLs and other ways of finding educational curriculum materials. He said that Google was limited because

It is only as good as the sum of all of the stuff that’s in it. And so it’s not good enough. Five years ago, going to Google was pretty smart. Now I am very concerned that we are missing a whole level of information that college graduates ought to get.

LS-4 has heard people extol the virtues of distance education which leads him to be concerned about EDLs in that context.

They scare the hell out of me when you talk to people who say we can do everything with digital education, with distance learning. Some places that’s the only recourse that you’ve got. I am too imbued, and maybe this is a complete bias, but I am too imbued with the university model to abandon the one-on-one teaching with my students. But they have as much of a role as a model or a bird guide or a book or anything else. I sure use them.

He felt that EDLs were important to his community. His comments suggest that he may be happy to share information about EDLs with his on-campus network, which he cited as an important support system at the 4-year institution. When asked what resource would help him with EDLs the most, he replied, “Time.”

**LS-4 Rate of Innovation Diffusion**

LS-4 was a faculty member who had long experience teaching science at the undergraduate level. The data suggest that LS-4 felt totally prepared to develop student conceptual understanding, use inquiry methods, and use textbooks as a reference and he
used these methods regularly. He was also a regular user of methods that helped him respond to student diversity, although he felt partially prepared to do so. The use of computers and the Internet was the category of standards-based methods that he did not use. He felt partially prepared and intermittently used all of the other categories of standards-based teaching. He was in the middle stages of adoption of EDLs, with his primary stage of concern being awareness and his secondary concern being informational and management.

Table 4.6 summarizes LS-4’s responses related to the diffusion of standards-based teaching and EDLs as innovations. All of the variables that influence the rate of diffusion were positive for both innovations. The synthesis of all of the data points to LS-4 as a potential adopter of and agent of change for both innovations.
### Table 4.6: LS-4 responses related to the diffusion of standards-based teaching and EDLs.

<table>
<thead>
<tr>
<th>Rate of Diffusion Factor</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Comfort in using the innovation</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Teacher-centered vs. learner-centered</td>
<td>Learner-centered</td>
<td></td>
</tr>
<tr>
<td>Source of information about the innovation</td>
<td>Colleagues and professional reading</td>
<td>He couldn’t remember</td>
</tr>
<tr>
<td>Willingness to accept change</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Trialability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Observability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Relative advantage</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Types of innovation - decisions: optional,</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>collective, or mandated by authority</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharing ideas in the community</td>
<td>Colleagues through participation in his program</td>
<td>On campus network</td>
</tr>
<tr>
<td>Current support to facilitate adoption</td>
<td>Support by administration and campus support network</td>
<td>Campus support network</td>
</tr>
<tr>
<td>Desired supports to facilitate adoption</td>
<td>Time</td>
<td>Time</td>
</tr>
<tr>
<td>Research and teaching cultures</td>
<td>Research takes time, but so does everything else</td>
<td></td>
</tr>
</tbody>
</table>

LS-4 has the potential to be an important agent of change. He is in the position to introduce new teaching ideas to faculty and encourage them to use them. He is very open to improving science teaching in the Undergraduate Biology Education Program and is always looking for innovations that may improve the learning environment. He has in-depth experience with standards-based teaching techniques. He has a well-developed
network of colleagues within the department, the institution, and the science education community through which he can share information. To support his adoption of standards-based teaching and EDLs, he needs an easy way to continue to get information; ideas for managing the implementation of the two innovations in his program; and time to take care of the instructional, administrative, and research aspects of his job.

Chemistry Faculty at the 4-Year Institution (Chem-4)

Chem-4 Background

Chem-4 was a chemist who was an Assistant Professor with 5 years of teaching experience in higher education institutions. He had a tenure-track position, but was not yet tenured. On the Standards-Based Teaching Instrument, Chem-4 indicated that he had been a participant in professional development related to teaching practices and he met with a group of other faculty on a regular basis to study and discuss science teaching issues. He had not mentored other faculty in terms of science teaching, taken formal college/university courses in the teaching of science, observed other faculty teaching science as part of his own professional development, nor attended a national or state teaching association meeting. The Department of Chemistry at the 4-year institution was divided into divisions, such as the Organic Chemistry Division and the Analytical Division. A social system that enabled collaborative problem solving about teaching issues was evident from the camaraderie during Chem-4’s division group meeting.

When I met Chem-4 for our interview, I noticed that his recently published research papers were posted in the hallway and a guitar sat in the corner of his office. When I asked him about the guitar, he said that he was in a local band, and he found that the
guitar helped make the students less nervous when they came to see him. This indicates that he is interested in presenting himself both as a professional and as an approachable instructor.

Chem-4 Standards-Based Teaching Profile

Chem-4’s Standards-Based Teaching Profile is illustrated in Figure 4.11. It is of note that with regard to responding to student diversity, Chem-4 responded that he felt partially prepared even though he implemented this standards-based method regularly. I am interpreting this to mean that he feels he could use more preparation to effectively respond to student diversity. In terms of the use of inquiry methods, Chem-4 felt unprepared, and in fact, did not use inquiry methods. This leads me to wonder, if he has greater preparation for this instructional technique, would he use inquiry more often? With regard to developing student conceptual understanding, using computers and the Internet, creating a student-centered environment, and using multiple means of assessment, Chem-4 felt partially prepared and intermittently used these methods. In contrast, Chem-4 felt totally prepared to use textbooks as a reference, and regularly did so.
During our interview, Chem-4 defined standards-based teaching to be everyone in the department teaching the same topics. His conception of standards-based teaching was very tightly tied to assessing the students to see what teaching methods worked.

Oh, I don’t know. I have never thought about a definition. To be honest, I don’t have a definition. I would assume if somebody had said standards-based teaching to me, this is an established curriculum with a set of standard assessment tools that may apply across more than one class, across different instructors so that you could assess differences between different teachers, but all for the same course. Is that close?

Similarly, his description of student inquiry was different than that described by the NRC (2000), which states that classroom inquiry is apparent when learners investigate scientific questions by developing and evaluating alternative evidence-based explanations and then justify and communicate their explanations.
Chem-4 considered inquiry to be students asking him questions that he had them answer themselves. The questions did not lead to a deeper understanding of the content, but rather were factual.

I would have students ask me questions that I didn’t know the answer to. And rather than say next week I will come back with the answer, I’ll tell them I want you to come back next class period with the answer to your question and tell the rest of the class [because] I don’t know. And why am I going to waste my time? Why don’t you figure it out and let us know? And these weren’t concepts based, someone would ask me why is a method named after this person and I would be like, well, why don’t you figure out and tell the rest of the class?

He did not mention the teaching standards in the *NSES* (NRC, 1996). When asked how he implemented his idea of standards-based teaching he said,

I think right now in terms of my teaching, it would be valuable to have a set of assessment tools in addition to the sort of standard exams that we give. You know, aside from multiple choice tests, it would be nice to adopt, I mean we have adopted a curriculum within our division for undergraduate education that we all try to adhere to. But there is a lot of flexibility in terms of how much depth we go into topics and often one person may spend more time on one subtopic. We don’t assess across the division what the students learn. So it might be nice to have a standard set of evaluations at the end to evaluate the students coming in before taking the class and to assess the students after they have taken the class to see whose methods are doing a better job at instructing the students and are the students actually learning the material. Are we spending the right amount of time on the subjects that are more difficult?

When asked in the interview, Chem-4 said he considered his classroom to be teacher-centered.

Oh! I don’t know! Um I would have to say that it is probably more teacher-centered because the only interactions outside of lecture are when students enter your office and then I would say that office hours are more learner-centered. And laboratories are learner-centered. In the course, I try to get students to participate, but given the breadth of material and the time, you can’t digress into group discussions of any topics.

As he looked through the list of the dimensions of standards-based teaching, Chem-4 said that he learned about most of the techniques by using the teachers he had throughout
his years as a student as models. He never had heard of the methods as part of standards-based teaching. He made it clear that he didn’t have any training in education and was looking to a recently hired lab preparator and more experienced colleagues to introduce him to these techniques.

He was very inclined to try new teaching methods. He was concerned that when he tried something new, he did not have a good way of measuring its effects. He tried things because they seemed intuitively to be better methods, not because the methods were research-based or recommended by a national standard or a colleague.

I am always trying to find a better way to get the students involved in the class. You know, I try to ease test anxiety in the upper division classes, we don’t have timed exams. That is one of the biggest concerns that students have and we have students with learning disabilities. I’d say the most common learning disability is the issue with taking timed exams, so they end up taking untimed exams out of classes. So … I run a democracy. I let them vote if they want a timed or untimed type of exam. This is usually just in graduate courses. Otherwise the potential for academic misconduct would be too great, but we have been doing that for a couple of years. So we try some different things out, but it is more intuition based than it is standards based.

Chem-4 was clear about what he wanted to accomplish in his teaching.

I guess the goal when I teach is not so much to have them master the science, but it is to get them to a point where they feel that they can master the science on their own. Because when the class is over, they may retain some percentage, but if they leave the class and they are able to be a better scientist, they are able to work independently, to work things out on their own, then they are going to be much better off later on, I think. I think that is the most important role of science is to train independent investigators, people who can think critically about science and not so much retain information.

Chem-4 understood that his lack of training in education limited the methods that he tried. He stated that the university employed faculty because of their contribution to the research world and not because of their abilities or background in teaching.
Education is something we are thrown into. We learn that we either have a knack for it or we don’t. And I don’t consider myself having a knack for it, so, if I truly have an interest in it, I think I have to learn how to do it. At the same time, you have to continue your quest for world dominance in your field. So these are conflicts of interest, right? So you just have to pick a balance and one of the things that I think we do in this department, I hope we do, is to hire somebody who is a really competent chemical educator, and [who] can actually bring some concepts (maybe the watered down versions) that we can try and improve the education in general at [this university]. We have a good program because I think a lot of people really do care about their teaching methods, but I think they learn by trial and error. And I think few people are actually able to go out and pull out tried and true methods or standards and incorporate those. Partially because I don’t think they know where to look.

According to Chem-4, his department was very concerned about research and excellent teaching. However, he said, “I think that you can’t do both extremely well. I think that there is a give and a take.” He said that the fact that his department regularly won teaching awards stemmed from the faculty’s love of research and enthusiasm about their content. He cited the work that a colleague does with K-12 students as a great example of how the instructor’s enthusiasm for the content was infectious and positively impacted both his research and his teaching.

The department’s won many awards in teaching and I don’t think that it’s because we are great teachers trained in science education. I think it is more about that people are very enthusiastic about science. And that enthusiasm carries over into their teaching. Students become interested. You win teaching awards by getting students excited about coming to your class. That excitement carries over into learning also. So I think that if you have a love for science, you are going to do well in research and that love for science can carry over into your teaching, if you enjoy the teaching aspect of it.

Once he reviewed the dimensions of standards-based teaching, he could see a difference between these methods and traditional methods, which he identified “as standing in front of the class and then giving multiple choice tests.” He returned to the ideas of assessment and “technique” evaluation when he was considering the advantages
of one “technique” over another. He was very interested in seeing how his teaching
helped students advance their understanding and he did not think that traditional methods
allowed for that. He would have liked to do pre- and post-tests and used methods that
help prepare students to be scientists, which he defined to be “independent investigators.”

If you could accurately assess every student in your class, where they are in terms
of their critical thinking, and you could, at the end of the class, assess if you have
done the job to bring them along that curve, that’s a valuable piece of information.
And I don’t think that we do that with traditional teaching. I think we assess what
their final grade is. We don’t care where they came in. It is only catch up, get the
final grade at the end, and go from there.

When I asked Chem-4 what he thought the final grade represented, he said,

I think the final grade represents their devotion to getting that final grade.
I think it makes no difference; they are done at the end. Grades are competitions.
It’s a race. … It’s the tortoise and the hare, right? You have the hare, they fly
through, they get the great grades, they can go and they can take a break and you
know really smart students might only have to do half of the class. They can ace a
couple of exams and they can coast the rest of the way out, get their B, and go.
That’s all they care about. Then you’ve got some students that want those As.
They’ve got jobs and they may not even really care about the material. But they
work and work and work, they get the As and they go on to the next class and get
an A and they may not retain any information. They figured out how to take the
exams and they figure out the techniques. I mean if you talk to the students, they
say all you have to do is study this guy’s old exams and you’ll be able to make the
As. That’s the trick. You know, they don’t learn the material. And then you have
got the people who are generally interested in the material and they may get so
bogged down in the learning that they don’t take the exams well. So I don’t think
the grades accurately reflect which person is going to come out of that class and be
the best person in that field.

The standards-based teaching methods seemed to fit well into Chem-4’s desire to
advance student understanding. On the other hand, they do not seem to fit well in that he
does not feel competent to implement them. He is interested in taking small steps and
having people spoon-feed him the way to implement the techniques. He is concerned that if he tries some of the techniques, his inexperience with them may cause more harm than good.

The environment in Chem-4’s department allowed him to choose whether or not he implemented different teaching methods. When he tried something new, he was most apt to share it with the division leader and the lab technician. From both his comments in the group meeting and Chem-4’s comments during the interview, it seems that the division leader had experience working with standards-based methods and created a program in which the faculty from the 4-year institution supported science on the K-12 level. During the interview, Chem-4 said that he felt comfortable using the division leader and the technician as resources for pedagogical information and a sounding board for him as he tried out new methods. He also looked to the literature for new teaching ideas. Chem-4 further said he would be best supported by an educational specialist, who would first be able to identify assessments to help him know how well his students were learning with his current methods and then give him ways to correct his areas of weakness.

Chem-4 EDLs Profile

Chem-4 was just learning about EDLs. The prominent peak on the informational concern on Chem-4’s SoC profile suggests that he knew enough about them to care about how they work, but he needed additional information about what EDLs were and how to use them (see Figure 4.12). The second highest peaks of awareness and management concerns indicate that he may benefit from additional exposure to EDLs and that he has some additional concerns about how using them will fit in with the other aspects of his job.
Figure 4.12: Chem-4 stages of concern profile related to his adoption of EDLs

The innovation of EDLs was simple enough for Chem-4 to understand at a novice level. His first introduction to them was through the initial group meeting in the current study. He had not tried searching for any resources using EDLs because he did not have the time nor the need to do so. Since his first introduction to EDLs, he had not had a teaching assignment but Chem-4 was very excited to use them to prepare for his future undergraduate classes. He felt that the resources in the EDLs were not appropriate for graduate courses in which the students should be reviewing and analyzing research papers. He was very inclined to use EDLs to find resources that could help him develop new teaching methods.
Chem-4 has not used EDLs enough for him to determine if there is a difference between them and traditional methods of finding and accessing resources. He thought they could have been beneficial if they did a better job than Google.

’Cause if you can Google it faster than you can go in and go to a page and search whereas as opposed to you can hit three words in Google and hit go and get a hundred references, I think that is going to make it or break it. Right now, if I am looking for something—an animation for ion motions, you know and electric fields, I’ll type ion motion electric field in Google. I will get a hundred thousand hits. I’ll go through and I’ll find Java applets. It’s very easy to do. So for one of these libraries to work, it’s going to have to be able to find information quicker and I think it has to be more intelligent. It has to sort of think what are the other things that might go along with this. You know, like on Amazon.com [it] says, “the people who view this page also viewed these pages.” So it is going to have to be more intelligent about providing the information than web search engines. And go beyond the web to some degree.

This seems to indicate that Chem-4 feels that EDLs fit well into his practice if they do a better job than the tools he is currently using to find educational resources. The resources he said he looked for most often were lecture notes, animations, and JAVA applets.

If the libraries can take what’s so wonderful about the web and somehow make it more intuitive in terms of preparing information for someone who is doing a course, then you are going to rake in the users like crazy.

Chem-4 would have liked the EDLs to include evaluations to lead users to resources that would best suit their needs or resources that they might not have thought about using without a referral system.

The people that viewed this resource also found the following interesting. You have reviews—this person said …, “I used this in the class and it was great and blah, blah, blah.” Or, “I used this and it wasn’t.” The Amazon model is very powerful because before Amazon.com if you wanted to read a book, you just went there. Now if you want to read a book, you go to Amazon.com, you see the book, you also see that these are books that are complementary and then you can read reviews and it allows you to sort of follow a path that might take you somewhere that you might never have originally intended to go. And you might discover something more interesting that you want to incorporate by doing that.
Chem-4 said that the key to the success of EDLs was providing people with precise search results without users having to sort through long lists.

If it is just type in *mass spec* and you get a whole bunch of links for mass spec, that’s not so interesting. Let’s say you click on *ionization techniques* and it shows you animations of *electrospray*. … These are just examples from mass spec. And then it takes you to links with people’s lecture notes on electrospray. If it brings the next 15 searches that you would have done to you without you having to do those searches, and it does a better job of it, then people are going to go all crazy for this.

He used Google as a reference point and felt that EDLs would have to do better than Google if they were going to have widespread adoption.

*Chem-4 Rate of Innovation Diffusion*

Chem-4 was a faculty member who was early in his teaching career at the 4-year institution. The data suggest that Chem-4 felt totally prepared to use textbooks as a reference and he used this method and methods to respond to student diversity regularly. He felt unprepared to use inquiry methods, and so he did not use inquiry methods. It is not surprising that he felt totally prepared to use textbooks as a reference and used them regularly since they are fundamental in traditional undergraduate learning environments. He was in the middle stages of adoption of EDLs, with his primary stage of concern being informational and his secondary stages being awareness and management.

Table 4.7 summarizes Chem-4’s responses related to the diffusion of standards-based teaching and EDLs as innovations. This table indicates that standards-based teaching was an innovation that was complex enough that he did not yet have a clear understanding of what it encompassed. This level of complexity may slow his contribution to the rate of diffusion of standards-based teaching. However, all of the other variables that influence the rate of diffusion were positive for both innovations. The synthesis of all of the data
suggests that Chem-4 has the potential to be an adopter of both innovations, and that he has the potential to be an agent of change for both innovations.

<table>
<thead>
<tr>
<th>Rate of Diffusion Factor</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Comfort in using the innovation</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Teacher-centered vs. learner-centered</td>
<td>Teacher-centered</td>
<td></td>
</tr>
<tr>
<td>Source of information about the innovation</td>
<td>Other instructors as models when he was a student</td>
<td>The researcher</td>
</tr>
<tr>
<td>Willingness to accept change</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Trialability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Observability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Relative advantage</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Positive with hesitations</td>
<td>Positive</td>
</tr>
<tr>
<td>Types of innovation - decisions: optional, collective, or mandated by authority</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Sharing ideas in the community</td>
<td>Colleagues through one-on-one interactions</td>
<td>Colleagues through one-on-one interactions</td>
</tr>
<tr>
<td>Current support to facilitate adoption</td>
<td>The literature</td>
<td>Nothing identified</td>
</tr>
<tr>
<td>Desired supports to facilitate adoption</td>
<td>An educational consultant</td>
<td>Evaluations and a search better than Google</td>
</tr>
<tr>
<td>Research and teaching cultures</td>
<td>Research and teaching coexist—teaching does not come naturally</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.7: Chem-4 responses related to the diffusion of standards-based teaching and EDLs.

Chem-4 is a potential adopter of both standards-based teaching and EDLs if he is given enough support and information. His comments suggest that he would like to take a scientific research approach by using assessment to see if the standards-based teaching
methods improve his students’ understanding of chemistry. He views his lack of education training and teaching aptitude as problems and would like faculty support to overcome them. There were many standards-based teaching methods that he did not feel prepared to use and that he did not regularly use, such as inquiry methods, but he may consider them if he has enough support. Even though he felt that the research and teaching tasks compete for his time and attention, he seems to be willing to put effort into excellent teaching.

The nature of the social system in his division provided an open mechanism for the innovations to be diffused through the division leader and the individual division members. Chem-4 had specific ideas about how EDLs could be better than Google. To implement these ideas, he suggests that developers of EDLs need educationally important metadata and referral systems so that users can find what they want and discover resources they have yet to imagine.

*Physics Faculty at the 4-Year Institution (Phys-4)*

**Phys-4 Background**

Phys-4 was a physicist who was a Professor at a 4-year institution. He had 47 years of experience teaching science at higher education institutions. He came out of retirement to work, as he said, “for fun.” One of the implications of him coming out of retirement was that his current position was not part of the tenure system. Although he had never taken any formal college courses in teaching science, he had been a participant in professional development related to teaching practices and has mentored other faculty in terms of teaching science. He met with colleagues to discuss science teaching issues and attended national or state science teaching association meetings.
Phys-4 Standards-Based Teaching Profile

Phys-4’s standards-based teaching profile is illustrated in Figure 4.13. His adjusted scores indicate that he felt totally prepared for the inquiry category of standard-based teaching methods and regularly used inquiry methods. His profile illustrates that he felt partially prepared to implement all of the methods in the other categories, which includes developing student conceptual understanding, using textbooks as a reference, responding to student diversity, using computers and the Internet, creating a student-centered environment, and using multiple means of assessment. Of those, he regularly used methods to develop student conceptual knowledge, use textbooks as a reference, and respond to student diversity. In addition, he intermittently used computers and the Internet, created a student-centered environment, and used multiple means of assessment.

Figure 4.13: Phys-4 standards-based teaching profile
During the interview, Phys-4’s responses to questions indicated that he did not necessarily understand the vocabulary associated with standards-based teaching, but he deeply understood how to implement the techniques. For example, when he was asked to explain what standards-based teaching methods means to him, Phys-4 said, “Absolutely nothing. I don’t even know what the phrase means,” yet it was clear that he had worked to have a learner-centered classroom. His comments indicated that he thought that the more active the students were in their own learning, the more learner-centered it was and the better they would learn.

This is a course that was invented by a previous expert in physics education … and he set it up … to be very interactive, even though there is a lecture. The lecture, recitation, lab format—he worked very hard to make all three interactive. ... The philosophy was the work the students do helps them to learn, the work the professor does, does very little.

During the interview, when Phys-4 reviewed the methods listed on the dimensions of standards-based teaching, he indicated that he heard them throughout his 47 years of teaching. He said that he learned about them from colleagues (including Lillian McDermott), professional reading, and trying things on his own. He attributed the learner-centeredness of his classes to previous faculty who worked to make them that way. I interpret this to have been a huge support, since he entered a pre-designed environment that already supported his learning goals for his students.

His responses in the interview seem to show that he sees himself constantly evolving, and he stated that the change process was not necessarily easy. Even though he found it to be difficult and in spite of his retirement and re-entrance into the profession, he continued to change because he said that the new methods better support student learning.
I am in the process of [changing], over the last decade or maybe more, [and] I have come to fully realize that lectures are not effective.

I have tried the … model … [of forcing] the lectures to be interactive and I am finding a greater success in conceptual understanding as opposed to plug and chug performance. I am changing.

He realized that his old lecturing techniques were not working as well as he would have liked when he noticed that his students didn’t perform any better on assessments than students of other faculty, who he evaluated to be mediocre instructors.

One time, it started many, many years ago, maybe 30 or 35 years ago. … My first experience was in the old days [when] I used to get 3 ½ out of 4 or higher [on] student evaluations of lectures. There was another guy teaching the same course who hardly ever got more than a 2 or 2 ½. So I was a very good teacher, [and I] knew that he was a very terrible teacher. But we had joint tests and our students got the same scores. So I realized right then that the lectures were not effective. As I moved in later years towards physics education and more and more teaching and education research, I thought well let’s try some new methods. I have tried various avenues.

Phys-4 continued to explain in the interview that he changed his teaching methods and was faced with the fact that it was hard to implement inquiry methods. As the following passage indicates, his switch to inquiry methods caused him to have more interactions with students. More interactions with students gave him more opportunities to say or do something that could negatively impact them. He indicated that he needed to monitor his behavior more when he used inquiry methods.

I started out with a different style in ’91 when I did physics by inquiry. [Over my life, the student evaluations of me] averaged … 3.5 out of 4. My grading in the first physics by inquiry class was 2.7 out of 4. And my reaction to this was I don’t need this, a few curse words. I am never going to do this again. To hell with this and then I realized what was going on. When you contact people once or twice a lecture, all you have to do is once in a while toss out a joke and you are a great person. When you contact people 10 times a day, 10 times a session, you have to be very, very careful how you interact with them.

Because, even helping 10 times and doing something damaging once … as soon as you alienate … one person forever with some damaging remark, you have
alienated [the entire student collaborative] team and any other team that happened to be close to that team. Just by saying the wrong thing to the wrong person once. If you had a tough day, you had a fight with somebody, the work isn’t going well, you got a proposal turned down, and you just lose it for just a little bit of time. … You cannot lose it. You can never lose it.

So what I found out is that this idea of closeness is the same closeness as a psychologist to his patient. You have to be very careful of what you do and you have to be [reflective about] what you are doing as well as doing it. So every time you talk to somebody, you let a second or two go by and then say [to yourself] will this offend? Will this hurt their confidence? That is a very hard style to learn, especially if you are ebullient and what comes in your head comes out your mouth. It is not easy.

This level of self reflection indicates to me that Phys-4 has great dedication to improving his teaching so that his students can successfully learn. Even though it has been difficult, he said he was willing to continue to change. He indicated in the interview that the longer he used these methods, the easier it was for him to use them.

It has taken me over a decade now to change my style. … It is easy now. The thing that is not easy is … the longer you are a professor, the closer you are to God and the more likely you are to offend people and you have to work backwards to the beginning and now you are not a professor anymore—you are a graduate student and you are learning. That is hard for a lot of people. It is hard for me.

I interpret this to mean that he has to change his mindset and approach from being the authority-style teacher to the learner-style teacher. His comments indicate that he had been engrained to be a fount of information while he taught, as opposed to being a facilitator and co-learner with his students as they learned. This is a very sophisticated view of standards-based teaching.

Even though he has had to struggle, Phys-4 said in the interview that he has persevered and continued to strive to include student interaction in all aspects of his teaching. An example of the interactive nature of Phys-4’s lectures was the students’ use
of voting machines to answer questions. The students used the voting machines as self
assessments to help them gauge their understanding.

We give them short problems to do in class, during the lecture. For several years, I
have used voting machines in non-science classes and now I have them in the
science-based classes, where the students in lecture vote on problems that are
presented on a slide and submit answers. … Students don’t learn if they think they
know it, so they have to do something that forces them to have an impasse, so this
is some of the student work as part of the lectures.

Another aspect of his current teaching practices that Phys-4 mentioned as important
was the support of student confidence. He said that it was key to successful student
learning. The following passage illustrates his dedication to protecting student
confidence.

[Student confidence] is a must. It is just like playing football. If the students don’t
have any confidence that they can win, they have a much greater probability of not
winning or not learning. So it is very important when you show students that they
don’t understand something, you do not destroy their confidence. So I think
whatever technique you use, they have to be so ingrained that they don’t feel
threatened by it.

In the following quote, Phys-4 discussed his concerns about assessing how well the
teaching techniques work. He mentioned that he has seen how trends in education have
been treated like fads in society. He realized how hard it was to do controlled
experiments to evaluate teaching techniques because students were not all the same. This
caused him to look hard at how best to evaluate a method.

Education is never going to be hard science. All electrons are the same, all
students are not. You can try to do it, but you can’t. This idea of assessment to see
if your pizzazz really works is really important so I am getting more interested
when trying a new technique using assessment. For example, the voting machine.
It is only used in 1 of 3 classes and I have tried a few things. Now I am going to
try on a religious basis to use the voting machine in one class and not in others.
And if all things are equal, I can assess if the voting machine has done anything.
Phys-4 considered the similarities and differences between traditional and standards-based teaching methods. His responses indicate that the level of student activity and interaction between the instructor and the students are central to developing student understanding. I interpret his comments to mean that he thinks that with more student activity, it would be easier for the student to take charge of his/her own learning. His comments also indicate that the more comfortable the students are with the instructor, the easier it may be for them to actively participate.

There are similarities and differences. But at least in the lecture format, the tradition [was] when I went to school, the lecturer lectured and you took notes. And that was it and there was essentially no student participation. Some students are bold enough to ask questions, most students are not. So what you find is that the questions come from a very small number of students and there is potentially no interaction at all.

So the level of interaction between the instructor and the students is the big difference that you see between the traditional and the methods on that list.

The other thing that I think is very important in this--I have no proof, this is not science, the very first thing that an instructor has to do if a class is the size of 100 or less is learn everybody’s name. So what I do is take pictures of the whole class and effectively do the flip-name mentally and I just go over and over again, face-name, face-name.

In the following quote, he indicated that he made a distinction between student confidence and student comfort with the instructor. In response to a question asking if the instructor knowing the students’ names builds their confidence, he said, “The confidence is not confidence in themselves, but it is confidence that they can talk to me.”

In the interview, Phys-4 indicated that he thought that, in most cases, the standards-based teaching methods were better than traditional methods. He further identified cases in which he thought the standards-based methods would not work.
They work, the others don’t work. That’s an exaggeration. I am not very skilled
with terms so some of my terms might seem pejorative, but I don’t mean them that
way. ... Lectures, I think, are better for … a rather small group of people who are
sufficiently introverted that they don’t want the connection. They don’t want to be
brought out. They would prefer to be anonymous and when you bring them out
they resent it. So all of these techniques actually affect them adversely. But most
of the techniques using groups and developing a great deal of student-instructor
contact, work[s] for most people. And a great lecture will not work.

The following passage illustrates that Phys-4 saw it as his responsibility to help his
fellow faculty be better teachers. He understood the limits that they had as a result of
their research responsibilities, but felt that he could contribute to an environment in
which his colleagues could improve their methods.

And there’s a great story, which I tell everybody. There is a movie about Bob
Fosse who was a great choreographer. An actress comes up to him and asks, “Can
you make me a star?” and he looks at her and he says, “I can make you better than
you are.” And I think you need to work with your faculty. Some people are
receptive and others are less receptive. And there is a reason. They are doing
research and teaching, most people try to do a good job, but it is not number one
on their priority sheet. And so you can’t take them as far, but it is important to
create an atmosphere where you can take people as far as you can with these
methods.

Phys-4 stated that the physics faculty were becoming more and more interested in
standards-based teaching. He mentioned in the interview that he thought that might be
because people get quicker gratification from teaching success than research success. He
described the composition of his department in terms of their interest in teaching as
follows:

I think the percentage is higher than it was 20-30 years ago. At least I think this is
true. I don’t know everyone in the department, but I think there is about 1/3 that
are really interested in their teaching and really interested in trying new things. A
second third of the department, maybe if you set up a something and say this is a
standard procedure, they will follow it. And then the last third of the department,
well let me say something pejorative, are mired in the past.
When I asked Phys-4 with whom he would share his ideas about standards-based teaching and how he would go about sharing them, he presented a complex plan.

The first thing that you have got to do is for a year or two; you have got to do it on your own to make sure that the idea works. … Once you understand that the ideas actually work, which can take several years, then you start bringing the rest of the people in. So … you bring in … the people who are really interested in that sort of thing and then you need to bring in the department, because there is money involved. … So you have to convince a few people. That is the role that the department plays. They can furnish the money or they can put the break on the process. So I think it is a great influence. I think it is a great idea, but you have to get your own ideas straight.

When I asked Phys-4 what resources he would like to be able to implement additional standards-based teaching techniques, he mentioned money, assessments to see if the methods work, and staff to help him implement the changes.

In the following quote, Phys-4 explained how educational research and standards-based teaching could be diffused in his department.

Physics education research in a lot of people’s hearts is looked down on. But [in] a lot of people’s hearts, it is viewed as research. Remember when I said 1/3, 1/3, 1/3? Probably 2/3 of the department looks down on physics education research. The 1/3 of the department that is leading the way in teaching does not. That’s a fairly high number. So that means that you can influence the 1/3 that will then establish the courses that the next 1/3 will follow, so I think the interaction is pretty good. [When] you get something going in physics education research, there are two [important] things, one is to learn how people think. That’s the same as doing high energy physics, nobody cares. [Two is] the curriculum development, and that’s what’s distributed to the department. You can get the top 1/3, the people who are really interested to do it, and then another 1/3, the next 1/3 down will accept it, and I think that is fine. There are a lot of ideas. If you look at all of the labs in physics right now, pretty much, they are based on what physics education people did.

*Phys-4 EDLs Profile*

Phys-4’s profile on the SoCQ indicates that his concerns about EDLs were greatest in the areas of awareness and information. (See Figure 4.14.) According to the SoC
analysis, his awareness concerns indicate that he did not know much about EDLs, but the fact that he would like more information can mean that he was interested enough from what he knew to want to learn more. Phys-4’s comments in the interview support the analysis of the SoCQ profile data. In the interview, he said the first time he had heard about EDLs was in the physics group meeting at the 4-year institution. He said that he thought that the lists of resources returned would be better suited to his needs and that “the chance of having a completely dead end over and over again is reduced.”

Figure 4.14: Phys-4 stages of concern profile related to his adoption of EDLs
Phys-4 said that he had done a little looking around in the EDLs, but not much. Even though he had not actively looked in EDLs for something specific before our interview, he said that he was inclined to try EDLs in the near future.

I didn’t hear about it until this spring. In this summer I have been developing labs, so it hasn’t been necessary yet. And I fully believe that in the coming years, whenever I want to get something off the web, I will do that.

He was specifically looking for animations and graphics to support student learning. He said he had seen them used in someone else’s class and thought the animations were successful at getting the concepts across.

I was also able to watch the students. These animations are hugely successful, so now we are going to start to pick up animations, either from the web or using mathematics or something that I develop on my own.

You can’t just talk about a baseball flying through the air. If you look at a home run, it doesn’t go in a nice arc. It sort of goes up for a long time and then sort of drops straight down. … If you are going to talk about it now, you have to show it.

Phys-4 stated that he was strongly inclined to use EDLs because

I have been doing what education digital libraries are strong in for 5 or 6 years, but I have been doing it in Google. And [in] Google, you can go a lot of different ways. Google is a pretty good search engine, but in Google you can be surprised [with] what you come up with sometimes when you put in something that you think is science.

Phys-4 cited the ease with which he found things as the major difference between EDLs and other methods of finding curricular and professional development materials.

When I go out on the web to develop a course, sometimes I spend days—a week trying to get material. For a given lecture, it might take me 5 hours to find the material I wanted. With animations, it takes even more time. So you have to have a rich mother load, you can’t just do it with Google anymore.

Phys-4 stated that he thought that EDLs fit well into his current methods and that his colleagues would find value in them as well. He pointed out, “But I don’t think that in

189
physics that they are recognized to any great extent. But you know, neither was the web at some point in time.” Just as Phys-4 shared ideas about standards-based teaching, the following quote illustrates that Phys-4 had a clear view of how to approach his colleagues about EDLs.

I’d do it in a double step process. I’d find something that’s got a lot pizzazz and really works. First step, [show that it is] easy to use. That is the most important, then [show that it has] a lot of pizzazz and works well with the students. And then I would go to the top 1/3 that I talked about and I’d say, “Boy isn’t this fun!” I wouldn’t say, you never say, do you want to use this? That is death. It destroys the creative process. Say, “Isn’t this fun?” And so then they will want to try it.

Phys-4 stated that he would like some instruction on how to use EDLs before he tried them extensively. That instruction could be in the form of a tutorial or personal guidance.

I think it would be great to develop tutorials so that people could come into a lab where they are connected to the web and there are lots of computers. And everybody has their own computer, or at most two people per computer. And you just have an expert in front and for a couple of hours, you do stuff. So then you are over the fear, you are over the technology at some level and now you are on your own. But I think that most people find those first few hours [are] very painful.

Phys-4’s comments about the frustration and pain of using technology might indicate that he has experienced these emotions related to computer-related innovations in the past. He mentioned in the interview that he did not read instructions, so a personal walk-through with a human being would most likely be better than a tutorial that he might have ignored.

**Phys-4 Rate of Innovation Diffusion**

Phys-4 had extensive experience teaching science at the undergraduate level. The data suggest that Phys-4 felt totally prepared to use inquiry methods. The categories of standards-based teaching methods that he regularly used were developing student conceptual understanding, using inquiry methods, using textbooks as a reference, and
responding to student diversity. He was in the early stages of adoption of EDLs, with his primary stage of concern being awareness and his secondary being informational.

Table 4.8 summarizes Phys-4’s responses related to the diffusion of standards-based teaching and EDLs as innovations. Nearly all of the variables that influence the rate of diffusion were positive for both innovations. The synthesis of all of the data suggests that Phys-4 has the potential to be an adopter and a good agent of change for standards-based teaching and EDLs.
<table>
<thead>
<tr>
<th>Rate of Diffusion Factor</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Comfort in using the innovation</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Teacher-centered vs. learner-centered</td>
<td>Learner-centered</td>
<td></td>
</tr>
<tr>
<td>Source of information about the innovation</td>
<td>Experts in physics education</td>
<td>The researcher</td>
</tr>
<tr>
<td>Willingness to accept change</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Trialability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Observability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Relative advantage</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Types of innovation - decisions: optional, collective, or mandated by authority</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Sharing ideas in the community</td>
<td>Complex plan in the department orally and with short papers</td>
<td>Colleagues through one-on-one conversations</td>
</tr>
<tr>
<td>Current support to facilitate adoption</td>
<td>Nothing was mentioned</td>
<td>Previous experience with educational technology</td>
</tr>
<tr>
<td>Desired supports to facilitate adoption</td>
<td>Money, assessments, additional staff</td>
<td>Instruction for use</td>
</tr>
<tr>
<td>Research and teaching cultures</td>
<td>Research and teaching compete for time</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.8: Phys-4 responses related to the diffusion of standards-based teaching and EDLs.

Phys-4’s experience in physics education gave him a deep understanding of how hard and yet beneficial the change to standards-based teaching could be. The fact that he immediately said that he had no idea of what the term “standards-based teaching” means indicates that this is a term that has not yet made it into his physics education vocabulary.
He was proud of his teaching achievements and, the fact that he has come out of retirement to continue doing it, indicates that he feel he has more work to do. He is comfortable getting students more involved in their own learning. His role in the Physics Department and his approach to education puts him in a position to be a potential agent of change for both standards-based teaching and EDLs. His complex plans to implement standards-based teaching and share both innovations make him an important contributor to their diffusion. His scientific background contributes to his concerns about empirically verifying the validity of his teaching methods.

*Geology Faculty at the 4-Year Institution (Geo-4)*

*Geo-4 Background*

Geo-4 was a geologist who was a tenured Associate Professor with 35-years of experience teaching Geological Sciences in higher education institutions. He participated in professional development related to teaching practices, mentored other faculty in terms of teaching science, observed other faculty teaching science as part of his own professional development, and met regularly with other faculty to study and discuss science teaching issues. He never took a formal college or university course in the teaching of science, but he had attended national and state science teaching association meetings.

I have known Geo-4 to be an active advocate for science education in many settings. That was why I contacted him when my attempts to organize a departmental group meeting through the Chairperson were unsuccessful. Geo-4 has participated with me in seminars about the nature and history of geological science, has been on an advisory board for digital libraries, and, at my request, has written an article in a K-12 professional
development magazine. Almost every time I saw Geo-4, he was carrying materials for a hands-on presentation. He led the program for introductory geoscience courses at a 4-year institution, which means that he set the curriculum for the introductory geology courses.

*Geo-4 Standards-Based Teaching Profile*

Geo-4’s Standards-Based Teaching Profile is illustrated in Figure 4.15. Geo-4’s responses on the Standards-Based Teaching Instrument indicate that he felt partially prepared to develop student conceptual understanding, use textbooks as a reference, respond to student diversity, create a student-centered environment, and use a variety of assessment methods. Of those categories, he regularly used textbooks as a reference, and intermittently used methods to develop student conceptual understanding, respond to student diversity, create a student-centered environment, and use multiple means of assessment. Geo-4’s adjusted scores indicate that he felt totally prepared to use inquiry methods, but he intermittently used inquiry methods. It is of note that Geo-4’s adjusted scores indicate that he felt unprepared to use computers and the Internet in his teaching even though he intermittently used those resources.
Geo-4’s comments during the interview indicated that he had a good understanding of standards-based teaching. In the following passage, his reference to the pedagogy makes it clear that he saw standards-based teaching as being something more than following content standards. When asked what standards-based teaching means to him, he said,

To me it means both content and pedagogy as far as some sort of standard or prescribed level of performance. … [A standard] for the faculty presenting the material primarily to the students, … maintaining the standards of coverage and approach.
Geo-4 comments suggest that he feels very comfortable using and evaluating standards-based teaching techniques. In an e-mail communication, Geo-4 identified his classroom as both teacher-centered and learner-centered. He said,

What I do centers on the student's needs and learning … a combination of approaches that include: lecture, how the topic or the course relates each day to the news of the day, discussions of topics and events, questions posed to the group with one or two students asked to respond, how the topic relates to the lab, responses to questions (if raised during presentation).

Usually [there is] a writing activity or calculations or completion of a diagram that is submitted during class or next period, or in some cases they keep.

The teacher-centered aspect includes: plan of the quarter [the syllabus] and of the day [with alterations as the class develops that day; coverage depth and length tends to be elastic, as long as the cases/examples and the concepts are addressed in a satisfactory way], and all other management of the course. … The teacher is the center of attention most of the time, and decisions are made on a combination of learning and efficiency [for both the student and the teacher].

Both aspects continue to evolve. ... The ideal educational approach varies with the circumstances and, even though there are proven approaches, it is an evolving system.

He had already made some changes to the traditional methods that were previously used in the introductory geology courses and was open to other changes. The following quote from the interview identifies some of his guided-design philosophy of teaching, including hands-on laboratories and a laboratory manual that was flexible enough to use in multiple instructional settings.

I use a combination of techniques that include the lecture primarily, but [use] hands-on laboratory activities [as well]. And once or twice during a 2-hour lecture, [I use] … some additional activities, which are essentially labs. We have our own lab manual that we drew up. We can use that in formal labs, we can use that in homework assignments, in class assignments. That combination of formats in the formal lecture and then in the actual laboratory gives us a bunch of different ways of doing it. It’s not a full-blown inquiry technique where we just say here are a bunch of things, here see what you can discover. We guide them through. Guided design, I guess, is a better way of describing it.
Geo-4 regularly had his students discuss geology in the news.

Normally the class starts out with the news of the day in this course, so we utilize what they are hearing on the radio, seeing in TV, and in this case, most recently what’s on in the movies. We discuss it and then we also look at the newspaper. But it is mainly me who looks at the newspaper, because they don’t get the newspaper; they don’t read the newspaper. I get up at 5:30 am and read the newspaper to pick out articles. ... There is always something in the news. I made the joke yesterday that we don’t control the news, that is, what we plan in our syllabus doesn’t dictate it, but it almost looks like that. I mean, earthquakes come up.

During the interview, Geo-4 said that he understood that using these techniques did not necessarily lead to improved student learning for all students. He said that many students did poorly on the quizzes and tests because they did not come to class.

Geo-4’s comments indicate that the information about standards-based teaching came to him from a variety of sources. Geo-4 said that he was first introduced to the guided inquiry methods in the mid-1970s by a colleague who wanted to overhaul the approach used in the 4-year institution’s Geology Department. He explained that he had learned quite a bit about standards-based teaching through professional reading and interactions with other colleagues, both in the science community and in the general education community, during the previous 10 years.

Geo-4 stated that he saw a difference between what he described as the traditional method at the university level, with chalk and overheads, and the techniques that he used with his students. He pointed out that many of the changes created more work for him. The faculty used to buy expensive slide sets to help bring geological examples into the lecture. At the time of the current study, he had to find the slides himself, produce PowerPoint presentations, and be available to students 24 hours a day. His comments
indicate that he understands that the methods that he uses give him more control and that the methods help the students learn, but they are very time consuming. He does recognize the time advantage of technology-based resources.

I think I mean it is all science-based, interpretations or understandings of how people learn. So what is driving it in part is the basic research in education. The other part is the technology. Both of those things are working to change how we present information and teach and learn and that sort of thing, and interact with the students. It is just a tremendous thing. The whole world is now connected, or we think it is, and it makes it very easy for people to get material off the web.

Geo-4 stated that the non-traditional methods fit well into his practice and that many of his colleagues across the country felt the same way. He said that field trips were the best way to implement the dimensions of standards-based teaching, specifically depth over breadth, authentic assessments, and student-to-student interactions. He mentioned that there was a strong movement in the geoscience community to pay attention to science education concerns.

Since Geo-4 was in charge of the program for introductory geoscience courses, he had the opportunity to share ideas about teaching with the other faculty who taught that course.

I’ve got all of those 100 instructors to say, check this thing out from the [faculty development center]. Do this. Here are some ideas that we can use about assessment. Here is something we could use about guided notes—things of that nature. This is the way that we should be going.

He also shared ideas through a geoscience education listserv and by writing articles for the *Journal of GeoScience Education.*
When asked what supports he would like to help him with standards-based teaching, he said,

I guess somebody to set up demonstrations and hands-on activities for lectures. … I guess somebody to take my slide set and reproduce them and catalog them so I would be all ready to just drop them into presentations. There are other things, but I think a person, more time, maybe my own cart with a projector and computer on it so I didn’t have to share and look around for things at the last moment [would be helpful].

It seems that Geo-4 needed supports that paved the way so that he could do what he was doing more efficiently. Both the additional staff and the cart would be time savers for him. I am interpreting this to mean that he does not feel an immediate need for help in understanding new teaching techniques. It sounds as though he has the understanding to do what he would like to do, but feels that time-saving supports may make doing it easier.

He described the relationship between the teaching and research cultures in his department in the following way.

I guess it is a strange culture because we don’t have any people who are formally in the education section except me and [another faculty member], who is retired. And [someone else] who is interested in teacher education. And it also goes along with outreach and pre-college level [and] things of that nature for students. I should be doing more [research], but I do so much teaching on my own, … devising new courses, and things of that nature, that I haven’t done as much as I should.

Everybody’s supposed to be doing everything. … People would be foolish to spend time on teaching if you get most of your reward and judgment on how much you did in your research. So that has always been offset that way.

From his comments, it appears that Geo-4 does not perceive an easy mix between teaching and research in his department. I am interpreting his response to mean that he knows that the research, teaching, and service responsibilities often conflict and that the
research tasks are the main priority of many faculty. Even so, it appears that Geo-4 may continue in his efforts to improve geoscience education at his institution.

*Geo-4 EDLs Profile*

Geo-4’s SoCQ profile has three peaks: informational, awareness, and collaboration concerns (see Figure 4.16). From this profile, it can be interpreted that he was still gaining an awareness of EDLs and needed more information to use them effectively. His concerns about collaboration indicate that he was concerned about the ways that he could work with others to maximize the effects of EDLs and help diffuse the innovation. This was not surprising since he took a leadership role in the introduction to geology course and collaborated with others on digital library projects in the past.

![Figure 4.16: Geo-4 stages of concern profile related to his adoption of EDLs](image)

200
Geo-4 had an idea of what EDLs are, but it was not complete.

Usually it is on the web. Usually it is something that can be downloaded for free, or parts of it. It covers activities, background information, or reading materials, sources of materials, supplies. I suppose some of the stuff could be mailed out in digital form. I think of it also, the fact that we have digital materials now stored in the library …, so you can go over there and grab video or DVD and away you go. So that aspect, I see a broader range than just what’s up on the web.

His conception that nondigital resources were included in a digital library was slightly inaccurate. The notion that one could get non-digital resources from a digital library was a misconception, but a minor one. He felt comfortable looking around digital libraries for images and simulations. Geo-4 was involved in the beginning phases of a digital library for undergraduate science faculty. I later became the Assistant Director of that digital library.

Geo-4’s comments suggest that he is very inclined to try digital libraries.

Oh, try them out. I look for images, maybe some activities, demos that I could use in the classroom and in the lecture where you can use it as a grabber or an engager at the beginning of class or midway of class and that sort of thing.

He said that time was the biggest limitation for him, blocking his extensive use of EDLs to date.

Depends on how much time I’ve got. I guess I will be using them more. If that helps. It isn’t saying much about how inclined I am. I am inclined to, or I am interested in, but I don’t know if I have the time.

Geo-4’s comparison of EDLs to education journals sheds additional insight into his conception of EDLs. Even though EDL developers and education journal publishers would probably not equate the two media, Geo-4 clumped the two sources of information together. He thought that the physical nature of the journals made him more apt to give them his attention.
Well, you get the paper copy in the journal and they are related to education. So I get *Ohio Earth Sciences Newsletter* and that is good stuff. I am more faithful at stacking up things to be read. If I see it sitting there for days and weeks, I say I have to get to that. Thanksgiving break. That gives me a chance to catch up on that stuff, whereas, I don’t think I usually want to go in and scan through the digital libraries on Thanksgiving.

Geo-4 said that using EDLs was advantageous because they help share useful information for class preparation.

In digital libraries, they have a quality control component and there are comments about [the] work and so you know you are building a knowledge base or a content standard for a certain level. It is almost like in the old days people were interested in sharing their syllabus for their geomorphology courses. Oh, what are you teaching? Well, what books are you using? What are you covering? What topics? And how are you doing it in the lab? … So this is building toward something. It should be very beneficial I think.

The following quote indicates that EDLs fit into Geo-4’s current practice even though he did not use them much. He identified new faculty as the group who would best be able to make use of the resources in EDLs. Geo-4 mentioned the role of the publisher in providing overheads and digital images for the faculty to use in their classes. He said that some faculty felt that it was important for the pictures in the book to match the images they are using in class. Geo-4 said that he liked to select the images himself.

Those people who need it or could use it right away and those are the people who are teaching undergraduates, I think. And those people are new to the game. I think part of their needs is going to be met by the book publisher … how much they want to embellish it. I was surprised to learn that one of our faculty members said I don’t want to use that book because they don’t have overhead transparencies of every diagram that is in the textbook. … And they wanted to have everything that they were going to talk about be the same as what was in the textbook. And I never even thought that way. I thought my pictures were better than the textbook or I could talk about them better or there were diagrams that I preferred over what was in the textbook. And I expect them to get the information from several different sources, so the philosophy differs about what we should be doing for them.
Based on Geo-4’s responses, he probably would share what he knows about EDLs through personal communication with his colleagues. As the leader of the program for introductory geoscience courses, he has the potential to serve as an agent of change through direct personal communication. In the following passage, Geo-4 was answering the question, what would best support your adoption of EDLs?

Having a central area where you can log on and allow people to go elsewhere. I mean on the web, when you search for it, then you find out what’s out there and everybody builds their own network of what they want to use and what is effective for them, but there must be the big five or the big ten or something. Go here and then dig deeper if you need to.

From this response, it appears that Geo-4 would like a well-developed central digital library portal.

*Geo-4 Rate of Innovation Diffusion*

Geo-4 has had extensive experience teaching science at the undergraduate level. The data suggest that Geo-4 felt totally prepared to use inquiry methods and unprepared to use computers and the Internet for educational purposes. It appears from his interview data that he under-reported his use of inquiry methods on the Standards-Based Teaching Instrument. This could be because he has a deep understanding of inquiry methods and understands that these methods may be used more in what he describes as a course that uses “full-blown inquiry.” His lack of preparation for using the computers and the Internet may hamper his adoption of EDLs. It was not surprising that he regularly used textbooks as a reference because they are easy tools to use and are fundamental in traditional undergraduate learning environments. He was in the middle stages of adoption of EDLs, with his primary stage of concern being informational and his secondary stages being awareness and collaboration. His collaboration concerns indicate that he has
already considered using EDLs enough to worry about how he can work with others to make EDLs optimally useful.

Table 4.9 summarizes Geo-4’s responses related to the diffusion of the standards-based teaching and EDLs as innovations. All of the variables that influence the rate of diffusion were positive for both innovations. The synthesis of all of the data points to the idea that Geo-4 has the potential to be an adopter and a good agent of change for standards-based teaching and EDLs.
<table>
<thead>
<tr>
<th>Rate of Diffusion Factor</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>Positive with limitations</td>
<td>Positive</td>
</tr>
<tr>
<td>Comfort in using the innovation</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Teacher-centered vs. learner-centered</td>
<td>Both teacher- and learner-centered</td>
<td></td>
</tr>
<tr>
<td>Source of information about the innovation</td>
<td>Colleagues and professional readings</td>
<td>His work on an EDL</td>
</tr>
<tr>
<td>Willingness to accept change</td>
<td>Positive</td>
<td>Yes</td>
</tr>
<tr>
<td>Trialability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Observability</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Relative advantage</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td>Types of innovation - decisions: optional, collective, or mandated by authority</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Sharing ideas in the community</td>
<td>Colleagues through participation in his program and publishing articles</td>
<td>Colleagues through one-on-one</td>
</tr>
<tr>
<td>Current support to facilitate adoption</td>
<td>On-campus support network</td>
<td>Nothing identified</td>
</tr>
<tr>
<td>Desired supports to facilitate adoption</td>
<td>Extra staff</td>
<td>Time and a central portal for digital resources</td>
</tr>
<tr>
<td>Research and teaching cultures</td>
<td>Research culture gets greater rewards</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.9: Geo-4 responses related to the diffusion of standards-based teaching and EDLs.

Geo-4 was a leader in advancing standards-based teaching in his department at a 4-year institution. He has the potential to be an important agent of change for both standards-based teaching and EDLs, even though he has advanced further in the adoption process of the former. It is important to give him enough information and opportunities to try out the innovations so that he can understand how they can best be used. He is very
interested in collaborating with others within his department, within his university, and within the science education community. The collaborations can focus on standards-based teaching or EDLs. Because of his greater experience and level of expertise in both innovations, his faculty development needs are slightly different than those who are novices. He seems to understand the language and concepts underlying standards-based teaching, but not EDLs. Since he has such a strong interest in both educational research and technology, it appears that he may become more interested in using EDLs if he can see their utility in saving him time as he constructs his guided-design based courses.

Synthesis

The case studies in this chapter point out that several factors influence faculty member’s feelings of preparedness for and frequency of use of standards-based teaching methods, their stages of concern about EDLs, and their role in the diffusion of both innovations. In terms of their roles in the diffusion of the innovations, it was important to consider their understanding of the innovation, their receptivity to the concept, the means by which they shared what they knew about the innovation, and the types of support that would have helped them in the adoption process. Language issues increased the complexity of both innovations. Time was a chronic problem for all of the faculty and all of the faculty were open to the idea of changing their methods and had the option of deciding whether or not to adopt the innovation.

In the next chapter, the individual case-study data for the faculty will be compared and contrasted in an effort to identify patterns. Patterns will be examined by institution, discipline, and locus of control. The patterns will be used to develop a grounded theory
model that may be used to identify ways to support other faculty in their adoption of standards-based teaching and EDLs and to identify ways to support the diffusion of these innovations to other undergraduate science faculty.
CHAPTER 5
CROSS-CASE ANALYSES

Introduction

In this chapter, groups of faculty are compared to identify patterns based on three characteristics. Two of the characteristics, type of institution and discipline were identified a priori as potential contributors to the following three facets of the faculty: their feelings of preparedness for and frequency of use of standards-based teaching, their stages of concern related to the adoption of EDLs, and the variables influencing the faculty’s role in the diffusion of each of these innovations. The third characteristic, locus of control, emerged as a potentially important contributor to each of these facets.

This chapter is divided into sections that describe the analyses for each of the three characteristics: institution, discipline, locus of control. Within each characteristic comparison group, the facets are analyzed by comparing the standards-based teaching profiles, the stages of concern profiles, and the descriptions related to the variables influencing the faculty’s role in the diffusion of each innovation. In the context of the institutional document analyses, the 2-year and 4-year institutional environments have distinguishing characteristics that could impact the faculty’s feelings about and use of standards-based teaching and EDLs. The data from the web-based, mission-related documents were used to gain insight into the aspects of the institutional environments related to standards-based teaching and EDLs.
Based on the analysis of each group, patterns emerged by considering responses at the extremes, areas of complete agreement, and areas where there is agreement among a majority of the faculty. For the institutional group analysis, a majority was considered to be 3 out of 4 faculty. For the discipline pairs, the majority was considered to be 2 out of 2 faculty. For the faculty group central to the locus of control, the majority was considered to be 2 out of 3, and for the faculty group peripheral to the locus of control, the majority was considered to be 3 or 4 out of 5 faculty.

Trends and patterns found for each characteristic comparison group are highlighted in a table for each facet. The standards-based teaching tables feature the extreme characteristics that fall into the bottom quartile (with a score of 1) or the top quartile (with a score of 3) on the standards-based teaching profile. The stages of concern tables highlight the faculty’s concerns noting sets of concerns of the highest and second highest relative intensity related to EDLs. In contrast to the individual case descriptions, the group analysis of the stages of concern profile focuses on the highest two levels of relative intensity and not the entire graph. Both analysis techniques are recommended by Hall et al. (1998). If two or more concerns are very close (less than 5% apart) in relative intensity, they are both mentioned. The tables depicting the faculty’s role as either a potential adopter of or agent of change for standards-based teaching and EDLs are based upon a holistic analysis and thematic descriptors.

Comparison of Faculty by Institution

2-Year Institution Mission/Goals

The mission/goal statement, institutional goals, and supporting statements of the 2-year institution emphasize quality teaching and learning, fostering an appreciation and
understanding of diversity, supporting a student-centered classroom environment, and promoting technology in teaching and learning. These aspects of the documents may affect the faculty’s feelings about and use of standards-based teaching and EDLs. In addition, the documents have statements supporting the community needs and nurturing extra-institutional collaborations.

The support of quality teaching and learning can be identified in the mission/goal statements and the values with phrases such as “provide quality educational programs;” “recognize, develop, and support excellence in both learning and teaching;” and “we value being an outstanding learning environment.” The support of diversity within the institution can be seen in the mission/goal statements values with phrases such as “commitment to diverse learners,” “meet the changing needs of individuals in a multicultural community,” and “we value being a diverse learning community.” In these documents, diversity may refer to people with various cultures, ages, and disabilities. Evidence of this is in the goals of “providing lifelong education” and values of “offering accessible, affordable, lifelong learning opportunities” and “being an accessible educational institution.” One institutional goal is “To provide a learner-centered environment that provides the support services which assure that the learners attain their educational goals,” which directly links to the standards-based teaching category, create a student-centered environment. The documents promote the use of technology in teaching and learning as well as supporting community needs with the comment in the mission/goal statement, “The college will proactively respond to the changing needs of our community and its role in the global economy through the use of instructional and emerging technologies.” The support of extra-institutional collaborations is indicated in
phrases in the documents such as “the college will serve as a catalyst for creating and fostering linkages among the community, business, and educational institutions;” “develop and strengthen partnerships with industry, primary and secondary education, business, labor, community organizations, and government to enhance the economic development of our service community;” and “we value being an integral, respected, trusted partner in our community.” Since all of the faculty involved in the current study were part of the Biological and Physical Sciences Department, it should be noted that the departmental mission and goals reiterate those of the institution, with special emphasis on the science disciplines.

2-Year Institution Faculty

With regard to the faculty from the 2-year institution, Figure 5.1 illustrates their feelings of preparedness for each standards-based teaching category and Figure 5.2 illustrates their frequency of use of these methods. It is noteworthy that in the three categories in which there is complete agreement within this institutional group, everyone responded that these categories are ones in which they felt partially prepared and used intermittently. All of the faculty in this group felt partially prepared to develop student conceptual understanding, use inquiry methods, and use multiple means of assessment. In addition, all of the faculty in this group intermittently used methods to develop student conceptual understanding, used inquiry methods, and used multiple means of assessment. A majority of the faculty (3 out of 4) felt partially prepared to respond to student diversity and use computers/Internet. In addition, a majority (3 out of 4) intermittently used computers/Internet and methods to create a student-centered environment.
When reviewing the responses at the extremes related to preparation for and use of standards-based teaching, two patterns emerged (see Table 5.1). First, the majority of the faculty (3 out of 4) did not have any categories in which they felt unprepared. Second, a majority of the faculty (3 out of 4) did not have any categories that they did not use.

The institutional mission/goal statements’ recommendation to respond to student diversity, create a student-centered environment, and use technology in teaching and learning did not appear to translate into feelings of preparedness for or regular use of standards-based teaching methods for the faculty from the 2-year institution. For example, 3 out of the 4 faculty felt partially prepared and 1 felt unprepared to use computers and the Internet. Not surprisingly, the same faculty who felt partially prepared to use computers and the Internet used them intermittently. These results suggest, at this time, that specific standards-based teaching methods encouraged in institutional documents do not necessarily correspond to faculty feeling totally prepared to use them or regularly using them.
Figure 5.1: Preparedness profiles related to standards-based teaching for 2-year institution faculty
Figure 5.2: Use profiles related to standards-based teaching for 2-year institution faculty

Table 5.1: Preparedness and use of standards-based teaching (extreme scores) for 2-year institution faculty.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Preparedness Score</th>
<th>Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>LS-2</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Chem-2</td>
<td>None</td>
<td>TR, RD, SC</td>
</tr>
<tr>
<td>Phys-2</td>
<td>None</td>
<td>TR</td>
</tr>
<tr>
<td>Geo-2</td>
<td>CI</td>
<td>SC</td>
</tr>
</tbody>
</table>

*Note.* CU=Develop conceptual understanding; IM=Use inquiry methods; TR=Use textbooks as a reference; RD=Respond to student diversity; CI=Use computers/Internet; SC=Create a student-centered environment; MA=Use multiple means of assessment.
With regard to concerns related to the adoption of EDLs, all of the faculty at the 2-year institution demonstrated highest levels of relative intensity in the awareness and informational stages (see Figure 5.3). Chem-2 stood out from the group because his highest relative intensity concerns involved management and personal issues (see Table 5.2).

![Figure 5.3: Stages of concern profile related to the adoption of EDLs for 2-year institution faculty](image)

Figure 5.3: Stages of concern profile related to the adoption of EDLs for 2-year institution faculty
Faculty Member | EDLs Stages of Concern | Standards-Based Teaching | Diffusion of Innovation | EDLs | Agent of Change
---|---|---|---|---|---
LS-2 | I | No | No | Yes | No
Chem-2 | A, I, P | Yes | No | Yes | No
Phys-2 | I, M | Yes | Yes | Yes | Yes
Geo-2 | A | Yes | No | Yes | No

Table 5.2: Highest stages of concern for 2-year institution faculty.

Table 5.3: Diffusion of standards-based teaching and EDLs for 2-year institution faculty.

Note. A=Awareness; I= Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.
4-Year Institution Mission/Goals

The vision and academic plan of the 4-year institution indicate an emphasis on quality teaching and learning, fostering an appreciation and understanding of diversity, and promoting technology in teaching and learning. These statements may affect the faculty’s feelings about and use of standards-based teaching and EDLs. In addition, the documents support research and service to the community. The vision document replaces an earlier mission statement and “stands today as the underpinning and conceptual framework for the strategies and initiatives outlined in the [academic] plan that follows. It also reflects the values and aspirations of a broad cross section of the University community.”

The documents include the following comments that indicate an emphasis on quality teaching and learning: the 4-year institution “continues to make great progress in attracting better-prepared undergraduate students, enhancing their experience, and helping them successfully progress toward graduation;” set compensation levels “To attract and retain world class faculty;” and “strengthen the undergraduate experience.” Sections of the academic plan that refer to fostering an appreciation and understanding of diversity include “create a diverse university community” and “academic excellence will be enriched by an environment that mirrors the diverse world in which we live.”

Technology is promoted in statements such as “The [Digital Library] project to collect, preserve and share important digital assets of faculty and students is now in its second year of operation;” “We have increased the number of technology-enhanced central classrooms on campus this year to 105;” and “Provide faculty, staff, and students with the latest technology tools for leadership in teaching, research, and career development within the next five years.” LS-4 is in the College of Biological Sciences and Chem-4,
Phys-4, and Geo-4 are in the College of Physical Sciences and Mathematics. Both of these colleges have mission/goal statements that support the academic plan.

*4-Year Institution Faculty*

With regard to the faculty from the 4-year institution, Figure 5.4 illustrates their feelings of preparedness for each standards-based teaching category and Figure 5.5 illustrates their frequency of use of these methods. It is noteworthy that there were three categories related to preparedness in which there was total agreement among faculty from the 4-year institution. The entire group felt partially prepared to respond to student diversity, create a student-centered environment, and use multiple means of assessment. Three out of 4 faculty felt partially prepared to develop student conceptual understanding and use computers/Internet. Of note, 3 out of 4 faculty felt totally prepared to use inquiry methods. All of the faculty from the 4-year institution regularly used textbooks as a reference. This may indicate a comfort with textbooks as an instructional resource. In addition, all of the faculty in this group intermittently used methods to create a student-centered environment and intermittently used multiple means of assessment. Three of the 4 faculty regularly used methods to respond to student diversity and intermittently used computers/Internet.
Develop student conceptual understanding
Use inquiry methods
Use textbooks as a reference
Respond to student diversity
Use computer/Internet
Create a student-centered environment
Use multiple means of assessment

Figure 5.4: Preparedness profiles related to standards-based teaching for 4-year institution faculty
Tables 5.4 illustrates the patterns in the faculty’s extreme low and high standards-based teaching preparedness and use scores. As noted previously, all of the faculty from the 4-year institution regularly used textbooks as a reference. It is striking that 3 of the 4 faculty from the 4-year institution (LS-4, Phys-4, and Geo-4) felt totally prepared to use inquiry methods and that they regularly used inquiry methods in their classes. The conclusion that Geo-4 regularly used inquiry methods is derived from the interview data informing the Standards-Based Teaching Instrument data. In contrast, Chem-4 felt unprepared to use inquiry methods and did not use them. In addition, 3 out of 4 faculty regularly used methods to respond to student diversity, even though they all felt partially
prepared to do so. Perhaps these faculty used methods to respond to student diversity because this is encouraged in the institutional mission/goal statements, but could benefit from more preparation to do so.

The institutional mission/goal statements also encourage the use of technology in teaching and learning, but that did not translate into feelings of total preparedness or regular use of technology. Three of the faculty felt partially prepared and 1 felt unprepared to use computers and the Internet. A different combination of 3 out of 4 faculty intermittently used technology-based methods, while 1 faculty member did not use this method at all.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Preparedness Score</th>
<th>Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-4</td>
<td>None</td>
<td>CI</td>
</tr>
<tr>
<td></td>
<td>CU, IM, TR</td>
<td>CU, IM, TR, RD</td>
</tr>
<tr>
<td>Chem-4</td>
<td>IM</td>
<td>IM</td>
</tr>
<tr>
<td></td>
<td>TR</td>
<td>TR, RD</td>
</tr>
<tr>
<td>Phys-4</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>IM</td>
<td>CU, IM, TR, RD</td>
</tr>
<tr>
<td>Geo-4</td>
<td>CI</td>
<td>IM</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>IM⁣, TR</td>
</tr>
</tbody>
</table>

*Note. CU=Develop conceptual understanding; IM=Use inquiry methods; TR=Use textbooks as a reference; RD=Respond to student diversity; CI=Use computers/Internet; SC=Create a student-centered environment; MA=Use multiple means of assessment.

⁣Even though questionnaire data indicated that inquiry methods were not regularly used, interview data indicated that they were.

Table 5.4: Preparedness and use of standards-based teaching (extreme scores) for 4-year institution faculty.

With regard to their concerns related to the adoption of EDLs, all of the faculty at the 4-year institution demonstrated highest levels of relative intensity in the awareness and informational stages (see Figure 5.6). Table 5.5 highlights the fact that LS-4 and Chem-4
differed from the group as they also displayed somewhat elevated concerns related to management and Geo-4 differed based on his somewhat elevated collaboration concerns.

Figure 5.6: Stages of concern profiles related to the adoption of EDLs for 4-year institution faculty

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>EDLs Stages of Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Second Highest</td>
</tr>
<tr>
<td>LS-4</td>
<td>I, M</td>
</tr>
<tr>
<td>Chem-4</td>
<td>A, M</td>
</tr>
<tr>
<td>Phys-4</td>
<td>I</td>
</tr>
<tr>
<td>Geo-4</td>
<td>A, CL</td>
</tr>
</tbody>
</table>

*Note. A=Awareness; I= Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.*

Table 5.5: Highest stages of concern for 4-year institution faculty.
When comparing the data regarding the faculty’s contributions to the diffusion of the innovations of standards-based teaching and EDLs, it appears that all of the faculty are potential candidates to be adopters of and agents of change for both standards-based teaching and EDLs (see Table 5.6). Although Chem-4 does not seem to be as strong an agent of change as the other 3 faculty members, he does have a network of people with whom he discusses teaching issues.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Standards-Based Teaching</th>
<th>Diffusion of Innovation</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adopter</td>
<td>Agent of Change</td>
<td>Adopter</td>
</tr>
<tr>
<td>LS-4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chem-4</td>
<td>Yes</td>
<td>Possible</td>
<td>Yes</td>
</tr>
<tr>
<td>Phys-4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Geo-4</td>
<td>Yes</td>
<td>Yes</td>
<td>Possible</td>
</tr>
</tbody>
</table>

*Note. Geo-4 is considered a possible adopter of EDLs because he was more focused on print resources than digital ones. He did indicate that he saw great value to digital libraries and would share information about them with others.*

Table 5.6: Diffusion of standards-based teaching and EDLs for 4-year institution faculty.

Comparison of Faculty by Discipline

Life Science Faculty

With regard to the life science faculty, Figure 5.7 illustrates their feelings of preparedness for and frequency of use of each standards-based teaching category. It is noteworthy that in most of the categories in which there is agreement between the life science pair, both responded that the category is one in which they felt partially prepared or used intermittently. Both felt partially prepared to respond to student diversity, use
computers and the Internet, create a student-centered environment, and use multiple means of assessment. Both life science faculty intermittently used multiple means of assessment.

Both faculty regularly used textbooks as a reference and responded to student diversity. Their regular use of textbooks could be due to the fact that textbooks are both a familiar and traditional instructional resource and therefore their use provides a degree of comfort. Both faculty repeatedly stressed the diversity among their students, so it is not surprising that they both would indicate that they regularly used methods to respond to that diversity.

Noteworthy differences are in the categories of developing student conceptual understanding and using inquiry methods. For both of these categories, LS-4 felt totally prepared and regularly used these standards-based teaching methods; LS-2 felt partially prepared and intermittently used them. In addition, creating a student-centered environment was the only standards-based teaching category that LS-2 regularly used and LS-4 did not. Lastly, based on their responses, LS-4 did not use computers and the Internet whereas LS-2 intermittently used this method.
Table 5.7 highlights the differences and similarities between the extremes in LS-2 and LS-4’s standards-based teaching profiles. Both LS-2 and LS-4 did not consider themselves to be unprepared for any of the categories of standards-based teaching. However, LS-2 also did not consider herself totally prepared for any of the categories and LS-4 felt totally prepared to develop student conceptual understanding, use inquiry methods, and use textbooks as a reference. In addition, there were no categories that were not used by LS-2. In contrast, LS-4 did not use computers and the Internet. Of note, both LS-2 and LS-4 regularly used textbooks as a reference and responded to student diversity.
With regard to their concerns related to the adoption of EDLs, both faculty demonstrated highest levels of relative intensity in the awareness and informational stages (see Figure 5.8). One difference between the two profiles is that LS-4 exhibited elevated concern related to management (see Table 5.8). Even though LS-2 had the same level of relative intensity regarding the management concern, it was not as salient since this level of relative intensity was so much lower than her awareness and informational concerns.
Figure 5.8: Stages of concern profiles related to the adoption EDLs for life science faculty

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>EDLs Stages of Concern</th>
<th>Second Highest</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-2</td>
<td>I</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>LS-4</td>
<td>I, M</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

*Note. A=Awareness; I=Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.*

Table 5.8: Highest stages of concern for life science faculty.

When comparing the data regarding the life science faculty contributions to the diffusion of the innovations of standards-based teaching and EDLs, it appears that there is a clear dichotomy (see Table 5.9). LS-2 is neither a potential adopter of nor an agent of
change for standards-based teaching whereas LS-4 is both. A point of agreement is that they both are potential adopters of EDLs.

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Standards-Based Teaching</th>
<th>Diffusion of Innovation</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adopter</td>
<td>Agent of Change</td>
<td>Adopter</td>
</tr>
<tr>
<td>LS-2</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>LS-4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 5.9: Diffusion of standards-based teaching and EDLs for life science faculty.

_Chemistry Faculty_

With regard to the chemistry faculty, Figure 5.9 illustrates their feelings of preparedness for and frequency of use of each standards-based teaching category. It is noteworthy that in most of the categories in which there is agreement between the chemistry faculty pair, both responded that the category is one in which they felt partially prepared and used intermittently. Both felt partially prepared to develop student conceptual understanding, use computers and the Internet, and use multiple means of assessment. Both chemistry faculty intermittently used methods to develop student conceptual understanding, use computers and the Internet, create a student-centered environment, and use multiple means of assessment. In addition, both faculty members felt totally prepared to use textbooks as a reference. That both chemists reported regularly using methods to respond to student diversity is striking.
Figure 5.9: Preparedness and use profiles related to standards-based teaching for chemistry faculty

Table 5.10 highlights the differences and similarities between the extremes in Chem-2 and Chem-4’s standards-based teaching profiles. Of note, Chem-4 did not feel prepared to use inquiry methods and did not use them. Chem-2 did not indicate that there were any standards-based teaching categories for which he felt unprepared nor which he did not use. It is also notable that Chem-2 reported that he felt prepared to use more standards-based teaching categories compared to Chem-4.
Table 5.10: Preparedness and use of standards-based teaching (extreme scores) for chemistry faculty.

With regard to their concerns related to the adoption of EDLs, both faculty demonstrated highest levels of relative intensity in the awareness, informational, and management stages (see Figure 5.10). One difference between the two profiles is that Chem-2 displayed elevated personal concern (see Table 5.11). However, this personal concern (see Figure 5.10), was not as salient since the level of relative intensity was lower than his awareness, informational, and management concerns.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Preparedness Score</th>
<th>Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem-2</td>
<td>None</td>
<td>TR, RD, SC</td>
</tr>
<tr>
<td>Chem-4</td>
<td>IM</td>
<td>TR</td>
</tr>
</tbody>
</table>

*Note. CU=Develop conceptual understanding; IM=Use inquiry methods; TR=Use textbooks as a reference; RD=Respond to student diversity; CI=Use computers/Internet; SC=Create a student-centered environment; MA=Use multiple means of assessment.*
Figure 5.10: Stages of concern profiles related to the adoption of EDLs for chemistry faculty

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>EDLs Stages of Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chem-2</td>
<td>A, I, P</td>
</tr>
<tr>
<td>Chem-4</td>
<td>A, M</td>
</tr>
</tbody>
</table>

*Note. Abbreviations are used in the table for the following terms: A=Awareness; I= Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.*

Table 5.11: Highest stages of concern for chemistry faculty.

When comparing the data regarding the chemistry faculty contributions to the diffusion of the innovations of standards-based teaching and EDLs, it appears that there is somewhat of a difference (see Table 5.12). For both innovations, Chem-2 did not appear
to be a good agent of change candidate and Chem-4 could possibly be an agent of change. Chem-4 had a strong network with which he felt comfortable discussing teaching issues. A point of agreement is that they both are potential adopters of standards-based teaching and EDLs.

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adopter</td>
<td>Agent of Change</td>
</tr>
<tr>
<td>Chem-2</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Chem-4</td>
<td>Yes</td>
<td>Possible</td>
</tr>
</tbody>
</table>

Table 5.12: Diffusion of standards-based teaching and EDLs for chemistry faculty.

*Physics Faculty*

With regard to the physics faculty, Figure 5.11 illustrates their feelings of preparedness for and frequency of use for each standards-based teaching category. It is noteworthy that in most of the categories in which there is agreement between the physics faculty pair, both responded that the category is one in which they felt partially prepared and used intermittently. Both felt partially prepared to develop student conceptual understanding, respond to student diversity, use computers and the Internet, create a student-centered environment, and use multiple means of assessment. Both physics faculty intermittently used methods to use computers and the Internet, create a student-centered environment, and use multiple means of assessment. In addition, both faculty members regularly used textbooks as a reference.
Develop student conceptual understanding
Use inquiry methods
Use textbooks as a reference
Respond to student diversity
Use computers/Internet
Create a student-centered environment
Use multiple means of assessment

Figure 5.11: Preparedness and use profiles related to standards-based teaching for physics faculty

Table 5.13 highlights the differences and similarities between the extremes in Phys-2 and Phys-4’s standards-based teaching profiles. It is interesting that there were no categories of standards-based teaching about which the physicists felt unprepared or did not use. It is noteworthy that both Phys-2 and Phys-4 reported regularly using textbooks as a reference. This may be because textbooks are both a familiar and traditional instructional resource, and therefore their use provides a degree of comfort. It is striking that Phys-4 regularly used four of the standards-based teaching categories and Phys-2 regularly used only one.
<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Preparedness Score</th>
<th>Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Phys-2</td>
<td>None</td>
<td>TR</td>
</tr>
<tr>
<td>Phys-4</td>
<td>None</td>
<td>IM</td>
</tr>
</tbody>
</table>

|               | 1                  | 3         |
| Phys-2        | None               | TR        |
| Phys-4        | None               | CU, IM, TR, RD |

Note. CU=Develop conceptual understanding; IM=Use inquiry methods; TR=Use textbooks as a reference; RD=Respond to student diversity; CI=Use computers/Internet; SC=Create a student-centered environment; MA=Use multiple means of assessment.

Table 5.13: Preparedness and use of standards-based teaching (extreme scores) for physics faculty.

With regard to their concerns related to the adoption of EDLs, both faculty demonstrated highest levels of relative intensity in the awareness and informational stages (see Figure 5.12). One difference between the two profiles is that Phys-2 reported elevated concern related to management (see Table 5.14). Phys-4 displayed a similar level of relative intensity related to management, but this concern is relatively less salient because it is so much lower compared to his awareness and informational concerns.
Figure 5.12: Stages of concern profiles related to the adoption of EDLs for physics faculty

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>EDLs Stages of Concern</th>
<th>Second Highest</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phys-2</td>
<td>I, M</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Phys-4</td>
<td>I</td>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

*Note. A=Awareness; I= Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.*

Table 5.14: Highest stages of concern for physics faculty.

When comparing the data regarding the physics faculty contributions to the diffusion of the innovations of standards-based teaching and EDLs, it appears that the two faculty
are very similar (see Table 5.15). Both faculty are potential adopters of both standards-based teaching and EDLs as well as both being good candidates to be agents of change for the two innovations. The physics faculty showed the greatest level of overlap of all of the discipline pairs. This might be related to the influence of physics education research at the 4-year institution. Both have been involved with this physics education research to some degree, Phys-2 as a graduate student and Phys-4 as a researcher. The physics education research has focused on inquiry-based methods and have been widely disseminated.

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Diffusion of Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standards-Based Teaching</td>
</tr>
<tr>
<td></td>
<td>Adopter</td>
</tr>
<tr>
<td>Phys-2</td>
<td>Yes</td>
</tr>
<tr>
<td>Phys-4</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 5.15: Diffusion of standards-based teaching and EDLs for physics faculty.

*Geology Faculty*

With regard to the geology faculty, Figure 5.13 illustrates their feelings of preparedness for and frequency of use of each standards-based teaching category. It is noteworthy that in most of the categories in which there is agreement between the geology faculty pair, both responded that the category is one in which they felt partially prepared or used intermittently. Both felt partially prepared to develop student conceptual understanding, use textbooks as a reference, respond to student diversity, and use multiple means of assessment. Both geology faculty intermittently used methods to
develop student conceptual understanding, use inquiry methods, respond to student diversity, create a student-centered environment, and use multiple means of assessment. In addition, both faculty members felt unprepared to use computers and the Internet.

Figure 5.13: Preparedness and use profiles related to standards-based teaching for geology faculty

Table 5.16 highlights the differences and similarities between the extremes in Geo-2’s and Geo-4’s standards-based teaching profiles. It is noteworthy that both geologists felt unprepared to use computers and the Internet. This may be related to the fact that the study of geology relies heavily on field work and so faculty may not be as interested in virtual resources that are accessed in class. It is also of interest that Geo-2 reported that
he did not regularly use any of the categories of standards-based teaching, whereas Geo-4 regularly used inquiry methods (as was indicated from the analysis of the data from both the Standards-Based Teaching Instrument and the semi-structured interview) and textbooks as a reference.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Preparedness Score</th>
<th>Standards-Based Teaching Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geo-2</td>
<td>1</td>
<td>CI</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SC</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>CI</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>None</td>
</tr>
<tr>
<td>Geo-4</td>
<td>CI</td>
<td>IM</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>IM a, TR</td>
</tr>
</tbody>
</table>

*Note. CU=Develop conceptual understanding; IM=Use inquiry methods; TR=Use textbooks as a reference; RD=Respond to student diversity; CI=Use computers/Internet; SC=Create a student-centered environment; MA=Use multiple means of assessment.

aEven though questionnaire data indicated that inquiry methods were not regularly used, interview data indicated that they were.

Table 5.16: Preparedness and use of standards-based teaching (extreme scores) for geology faculty.

With regard to their concerns related to the adoption of EDLs, both faculty demonstrated highest levels of relative intensity in the informational and awareness stages (see Figure 5.14). One difference between the two profiles is that Geo-4 displayed heightened concern related to collaboration that was equal to his awareness concern. Other than the collaboration concern, the two faculty members had similar stages of concern profiles (see Table 5.17).
Figure 5.14: Stages of concern profiles related to the adoption of EDLs for geology faculty

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>EDLs Stages of Concern</th>
<th>Second Highest</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geo-2</td>
<td>A</td>
<td>Geo-4</td>
<td>A, CL</td>
</tr>
<tr>
<td>Geo-4</td>
<td>I</td>
<td></td>
<td>I</td>
</tr>
</tbody>
</table>

Note. A=Awareness; I=Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.

Table 5.17: Highest stages of concern for geology faculty.

When comparing the data regarding the geology faculty contributions to the diffusion of the innovations of standards-based teaching and EDLs, it appears that there is a dichotomy (see Table 5.18). It appears that Geo-2 may not be an agent of change.
candidate for either innovation compared to Geo-4, who appears to be an agent of change for both innovations. A point of agreement is that they both are potential adopters of standards-based teaching.

Table 5.18: Diffusion of standards-based teaching and EDLs for geology faculty.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adopter</td>
<td>Agent of Change</td>
</tr>
<tr>
<td>Geo-2</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Geo-4</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Comparison of Faculty by the Locus of Control

As the analysis of the data progressed, it appeared that an additional characteristic could be contributing to the faculty profiles. Some faculty had a greater sphere of influence than others and as a result were more central to the locus of control. All of the faculty responded that they had control over the decisions about whether or not to use standards-based teaching and EDLs. This identification of locus of control is more complex than simply the ability to make those decisions. In the current study, the locus of control is related to the role of having the responsibility for the quality of all of the sections of the introductory courses. The responsibilities associated with this role may have encouraged the leaders to investigate alternative methods of teaching and to share this information more proactively.

Three faculty, LS-4, Phys-4, and Geo-4, had tremendous impact on the way that introductory courses were taught. LS-4 and Geo-4 were in charge of introductory life
science and geology courses, respectively. These courses had enrollments of thousands of students each year. There are many other faculty who taught these classes, but they followed the direction provided by either LS-4 or Geo-4. In their leadership capacity, LS-4 and Geo-4 had the ability to make decisions about how the subject was going to be taught. Similarly, Phys-4 was in a position where he was in charge of curricular changes for some introductory physics courses. Even though he was not overseeing the courses, he was the one leading the development of new curricula and finding different ways to teach the material to help the students learn. Because they had such broad spheres of influence, it can be said that they were each central to locus of control.

The remaining 4 faculty who taught at the 2-year institution and Chem-4 were more peripheral to the locus of control. All of these faculty took the lead from someone else and/or did not feel comfortable sharing their ideas with others. The faculty at the 2-year institution indicated that they each worked independently and in isolation. What they taught is controlled by the departmental course descriptions, which must be aligned to the course descriptions at the 4-year institution. Chem-4 collaborated with others, but looked to people who he considered to be experts for guidance about teaching issues. An analysis based on locus of control was performed because the position of the locus of control may have affected the faculty member’s feelings of preparedness for and use of standards-based teaching, stages of concern for the adoption of EDLs, and his/her role in the diffusion of both innovations.

Faculty Central to the Locus of Control

With regard to LS-4, Phys-4, and Geo-4, who were the faculty central to the locus of control, Figure 5.15 illustrates their feelings of preparedness for each standards-based
teaching category and Figure 5.16 illustrates their frequency of use of those methods. It is noteworthy that in most of the categories in which there is agreement among the faculty central to locus of control, everyone responded that the category is one in which they felt partially prepared or used intermittently. All of the faculty in this group felt partially prepared to respond to student diversity, create a student-centered environment, and use multiple means of assessment. In addition, all of the faculty in this group intermittently used methods to create a student-centered environment and used multiple means of assessment. Moreover, all of these faculty regularly used textbooks as a reference. It is striking that all 3 faculty felt totally prepared and regularly used inquiry methods, although the assessment related to Geo-4’s use of these methods was derived from the consideration of data from both the Standards-Based Teaching Instrument and the semi-structured interview data. This distinguishes them from all of the other faculty.
Figure 5.15: Preparedness profiles related to standards-based teaching for faculty who were central to the locus of control
Figure 5.16: Use profiles related to standards-based teaching for faculty who were central to the locus of control

Table 5.19 highlights the differences and similarities between the extremes among the standards-based teaching profiles of the faculty who were central to the locus of control. It is noteworthy that 2 of the 3 faculty indicated that there were no standards-based teaching categories for which they were either unprepared or that they did not use. Two out of 3 of these faculty regularly used methods to develop student conceptual understanding and respond to student diversity. As noted previously, all of these faculty central to the locus of control felt totally prepared for and regularly used inquiry methods and regularly used textbooks as a reference.
### Table 5.19: Preparedness and use of standards-based teaching (extreme scores) for faculty who were central to the locus of control.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Preparedness Score</th>
<th>Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>LS-4</td>
<td>None</td>
<td>CU, IM, TR</td>
</tr>
<tr>
<td>Phys-4</td>
<td>None</td>
<td>IM</td>
</tr>
<tr>
<td>Geo-4</td>
<td>CI</td>
<td>IM</td>
</tr>
</tbody>
</table>

*Note. CU=Develop conceptual understanding; IM=Use inquiry methods; TR=Use textbooks as a reference; RD=Respond to student diversity; CI=Use computers/Internet; SC=Create a student-centered environment; MA=Use multiple means of assessment.*  
*aEven though questionnaire data indicated that inquiry methods were not regularly used, interview data indicated that they were.*

With regard to their concerns about the adoption of EDLs, all 3 faculty who were central to the locus of control demonstrated high levels of relative intensity in the awareness and informational concerns (see Figure 5.17). Two of the 3 had an additional high relative intensity concern (see Table 5.20). LS-4 was concerned about management and Geo-4 was concerned about collaboration.
Figure 5.17: Stages of concern profiles for the adoption of EDLs for faculty who were central to the locus of control.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>EDLs Stages of Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Second Highest</td>
</tr>
<tr>
<td>LS-4</td>
<td>I, M</td>
</tr>
<tr>
<td>Phys-4</td>
<td>A</td>
</tr>
<tr>
<td>Geo-4</td>
<td>A, CL</td>
</tr>
</tbody>
</table>

*Note. A=Awareness; I= Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.*

Table 5.20: Highest stages of concern for faculty who were central to the locus of control.

When comparing the data regarding the contributions to the diffusion of the innovations of standards-based teaching and EDLs of the faculty who were central to the locus of control, it appears that there is agreement (see Table 5.21). All 3 of the faculty
are potential adopters of and agents of change for each innovation, although Geo-4 is merely a possible adopter of EDLs because of his focus on print resources. However, the status of agent of change can be considered to be an adopter who is actively diffusing the innovation. For this reason, it can be assumed that Geo-4 is also an adopter. It appears that this is an important group to target for the adoption of educational innovations as they are potential agents of change.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Standards-Based Teaching</th>
<th>Diffusion of Innovation</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adopter</td>
<td>Agent of Change</td>
<td>Adopter</td>
</tr>
<tr>
<td>LS-4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Phys-4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Geo-4</td>
<td>Yes</td>
<td>Possible(^a)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

\(^a\) Geo-4 is considered a possible adopter of EDLs because he was more focused on print resources than digital ones. He did indicate that he saw great value to digital libraries and would share information about them with others.

Table 5.21: Diffusion of standards-based teaching and EDLs for faculty who were central to the locus of control.

*Faculty Peripheral to the Locus of Control*

With regard to LS-2, Chem-2, Phys-2, Geo-2, and Chem-4, who were the faculty peripheral to the locus of control, Figure 5.18 illustrates their feelings of preparedness for each standards-based teaching category and Figure 5.19 illustrates their frequency of use of these methods. It is noteworthy that in all of the categories in which there is agreement among faculty peripheral to locus of control, everyone responded that the category is one in which they felt partially prepared or used intermittently. All of the faculty in this group felt partially prepared to develop student conceptual understanding and use multiple means of assessment, which are both categories of methods that everyone in this group
used intermittently. Four of 5 of the faculty who were peripheral to the locus of control indicated that they felt partially prepared to use inquiry methods, respond to student diversity, and use computers and the Internet. In addition, 4 of the 5 faculty in this group intermittently used inquiry methods, computers and the Internet, and methods to create a student-centered environment. Of interest is the pattern that appears when comparing the feelings of preparedness (see Figure 5.18) and frequency of use (see Figure 5.19) responses. The 4 faculty members who felt partially prepared to use inquiry methods or computers and the Internet, intermittently used these categories of standards-based teaching methods. Similarly, the faculty members who felt unprepared to use inquiry methods or computers and the Internet, did not use these methods.

![Figure 5.18: Preparedness profiles related to standards-based teaching for faculty who were peripheral to the locus of control](image)

Figure 5.18: Preparedness profiles related to standards-based teaching for faculty who were peripheral to the locus of control
Table 5.22 highlights the differences and similarities between the extremes among the standards-based teaching profiles of the faculty who were peripheral to the locus of control. Three out of 5 faculty in this group indicated no categories of standards-based teaching about which they felt unprepared and did not use. In addition, 3 out of 5 of the faculty felt totally prepared to use and regularly used textbooks as a reference. Three out of 5 faculty also regularly used methods to respond to student diversity.
<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Preparedness Score</th>
<th>Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>LS-2</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Chem-2</td>
<td>None</td>
<td>TR, RD, SC</td>
</tr>
<tr>
<td>Phys-2</td>
<td>None</td>
<td>TR</td>
</tr>
<tr>
<td>Geo-2</td>
<td>CI</td>
<td>SC</td>
</tr>
<tr>
<td>Chem-4</td>
<td>IM</td>
<td>TR</td>
</tr>
</tbody>
</table>

*Note. CU=Develop conceptual understanding; IM=Use inquiry methods; TR=Use textbooks as a reference; RD=Respond to student diversity; CI=Use computers/Internet; SC=Create a student-centered environment; MA=Use multiple means of assessment.*

Table 5.22: Preparedness and use of standards-based teaching (extreme scores) for faculty who were peripheral to the locus of control.

With regard to their concerns about the adoption of EDLs, all 5 faculty who were peripheral to the locus of control demonstrated high levels of relative intensity in the awareness and informational stages (see Figure 5.20). Chem-2 is distinguished from the rest of the group because his highest relative intensity concern was management and his personal concern was almost as intense as his awareness and informational concerns (see Table 5.23). Other profiles demonstrated a peak at the management concern, but since the relative intensity of that peak was lower than their two highest peaks, the management concern was not considered as salient. Nonetheless, the fact that 3 of the 5 faculty who are peripheral to the locus of control had some management concerns indicates that they could use support to understand how to manage the tasks related to EDLs along with their other work.
Figure 5.20: Stages of concern profiles for faculty who were peripheral to the locus of control

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>EDLs Stages of Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Second Highest</td>
</tr>
<tr>
<td>LS-2</td>
<td>I</td>
</tr>
<tr>
<td>Chem-2</td>
<td>A, I, P</td>
</tr>
<tr>
<td>Phys-2</td>
<td>I, M</td>
</tr>
<tr>
<td>Geo-2</td>
<td>A</td>
</tr>
<tr>
<td>Chem-4</td>
<td>A, M</td>
</tr>
</tbody>
</table>

*Note.* A=Awareness; I=Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.

Table 5.23: Highest stages of concern for faculty who were peripheral to the locus of control.

When comparing the data regarding the contributions to the diffusion of the innovations of standards-based teaching and EDLs of the faculty who were peripheral to
the locus of control, it appears that there is some agreement (see Table 5.24). Four out of 5 of the faculty appear to be potential adopters of standards-based teaching and all are potential adopters of EDLs. In terms of their roles as agents of change, 3 out of 5 faculty were not potential candidates for either innovation.

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Standards-Based Teaching</th>
<th>Standards-Based Teaching</th>
<th>EDLs</th>
<th>EDLs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adopter</td>
<td>Agent of Change</td>
<td>Agent of Change</td>
<td>Agent of Change</td>
</tr>
<tr>
<td>LS-2</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Chem-2</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Phys-2</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Geo-2</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Chem-4</td>
<td>Yes</td>
<td>Possible</td>
<td>Yes</td>
<td>Possible</td>
</tr>
</tbody>
</table>

Table 5.24: Diffusion of standards-based teaching and EDLs for faculty who were peripheral to the locus of control.

Cross-Case Analyses Summary

In this chapter, similarities and differences in the facets of standards-based teaching, stages of concern, and rate of diffusion of the innovations were found for faculty in groups identified by the following characteristics: type of institution, discipline, and locus of control. Regarding the first characteristic, type of institution, several patterns emerged (see Table 5.25). It appears that institutional mission documents have some influence, but are not enough to ensure the faculty’s feelings of total preparedness for or regular use of standards-based teaching. It is interesting that the faculty from the 2-year institution indicated that there were no categories of standards-based teaching about which they felt unprepared or did not use.
<table>
<thead>
<tr>
<th>Institution</th>
<th>2-year</th>
<th>4-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparedness</td>
<td>None unprepared</td>
<td>Totally prepared: IM</td>
</tr>
<tr>
<td>Use</td>
<td>None unused</td>
<td>Regularly used: IM&lt;sup&gt;a&lt;/sup&gt;, TR, RD</td>
</tr>
<tr>
<td>Stage of Concern</td>
<td>A, I</td>
<td>A, I</td>
</tr>
<tr>
<td>Diffusion of Innovation</td>
<td>Adopters</td>
<td>Adopters</td>
</tr>
<tr>
<td>EDLs</td>
<td>Adopters</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Life Science</th>
<th>Chemistry</th>
<th>Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparedness</td>
<td>None unprepared</td>
<td>Totally Prepared: TR</td>
<td>None unprepared</td>
</tr>
<tr>
<td>Use</td>
<td>Regularly used: TR, RD</td>
<td>Regularly Used: RD</td>
<td>None unused</td>
</tr>
<tr>
<td>Stage of Concern</td>
<td>A, I</td>
<td>A, I, M</td>
<td>A, I</td>
</tr>
<tr>
<td>Diffusion of Innovation</td>
<td>No pattern</td>
<td>Adopters</td>
<td>Adopters/Agents of Change</td>
</tr>
<tr>
<td>EDLs</td>
<td>Adopters</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Locus of Control</th>
<th>Central (LS-4, Phys-4, Geo-4)</th>
<th>Peripheral (LS-2, Chem-2, Phys-2, Geo-2, Chem-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparedness</td>
<td>None unprepared</td>
<td>Totally prepared: IM</td>
</tr>
<tr>
<td>Use</td>
<td>None unused</td>
<td>Regularly used: CU, IM, TR, RD</td>
</tr>
<tr>
<td>Stage of Concern</td>
<td>A, I</td>
<td>A, I, M</td>
</tr>
<tr>
<td>Diffusion of Innovation</td>
<td>Adopters/Agents of Change</td>
<td>Adopters</td>
</tr>
<tr>
<td>EDLs</td>
<td>Adopters/Agents of Change</td>
<td>Adopters</td>
</tr>
</tbody>
</table>

Note. The majority refers to for each characteristic: each institution—at least 3 of 4 faculty; each discipline—2 of 2 faculty; central to the locus of control—2 of 3 faculty; peripheral to the locus of control—3 or 4 of 5 faculty.

CU=Develop conceptual understanding; IM=Use inquiry methods; TR=Use textbooks as a reference; RD=Respond to student diversity; CI=Use computers/Internet; SC=Create a student-centered environment; MA=Use multiple means of assessment, A=Awareness; I=Informational; P=Personal; M=Management; CN=Consequence; CL=Collaboration; R=Refocusing.

<sup>a</sup>Even though questionnaire data indicated that inquiry methods were not regularly used, interview data indicated that they were.

<sup>b</sup>Geo-4 is considered a possible adopter of EDLs because he was more focused on print resources than digital ones. He did indicate that he saw great value to digital libraries and would share information about them with others.

Table 5.25: Cross-case facet patterns of the majority of faculty (extreme scores) based on type of institution, discipline, and locus of control.
The mission documents could have had an influence on the faculty from the 4-year institution. Its mission documents emphasize the importance of responding to student diversity, which was a category of methods that was regularly used by most of the faculty from the 4-year institution. A large number of 4-year institution faculty felt totally prepared and regularly used inquiry methods, which may indicate that these methods are used in many disciplines at the 4-year institution. In addition, the majority of the faculty at the 4-year institution regularly used textbooks as a reference.

The stages of concern facet of the description of the faculty from both institutions is very clear. All of the faculty at both institutions, regardless of discipline, demonstrated highest and second highest levels of relative intensity in the awareness and informational stages. In addition, individual faculty from the 2- and 4-year institutions had personal, management, and collaboration concerns, which indicate a later stage of development in the adoption process. Most of these faculty had interactions either with the development of EDLs or with innovations in educational technology, which may influence the ease with which they advance through the stages of concern.

Patterns emerged regarding the adoption and diffusion of standards-based teaching and EDLs related to faculty at the 2-year and 4-year institutions. Most of the faculty at the 2-year institution are potential adopters of standards-based teaching and all of the faculty appear to be adopters of EDLs; however, most are not potential agents of change for either innovation. This combination of patterns could relate to the passion that the
faculty at the 2-year institution have for teaching their students, the institutional mission that supports use of technology in teaching, and the lack of institutional collaborative norms that would support diffusion.

The innovation/diffusion facet of the description of the faculty from the 4-year institution indicates that the institution appears to provide an environment that supports educational innovations. All of the faculty at the 4-year institution appear to be potential adopters of and agents of change for both standards-based teaching and EDLs. This could be related to the emphasis on teaching excellence in the institutional mission documents and the institutional collaborative network that supports the faculty.

The second characteristic is discipline. Several patterns emerged that were distinct from the institutional patterns. Concerning the standards-based teaching facet, it is striking that both life scientists and chemists reported regularly using methods to respond to student diversity. Also, it is interesting the life scientists and physicists indicated that there were no categories of standards-based teaching for which they felt unprepared. Additionally, the majority of the physicists indicated that there were no categories of standards-based teaching that they did not use. A pattern regarding the use of textbooks as a reference also emerged. The chemists all felt totally prepared to use textbooks as a reference and the life scientists and physicists regularly used textbooks as a reference. Both geologists felt unprepared to use computers and the Internet. This might be related to the fact that the study of geology relies heavily on fieldwork and so faculty might not have been as interested in virtual resources that are accessed in class. No pattern emerged with regard to the geologists’ frequency of use of any standards-based teaching methods.
Regarding the adoption and diffusion facet, no pattern emerged related to the life scientists’ adoption and diffusion of standards-based teaching, but they were both potential adopters of EDLs. The chemistry, physics, and geology faculty members were all potential adopters of standards-based teaching and EDLs. In addition, the physics faculty were good candidates to be agents of change for the two innovations, which might be related to the influence of the physics education research activities at the 4-year institution. Phys-2 learned about this research as a graduate student at the 4-year institution and Phys-4 participated directly in the research.

The last characteristic discussed is locus of control. Concerning the standards-based teaching facet, the majority of the faculty who were either central to or peripheral to the locus of control had no categories of standards-based teaching that they felt unprepared to use and did not use. The majority of faculty who were either central to the locus of control or peripheral to the locus of control regularly used textbooks as a reference and used methods to respond to student diversity. However, only the faculty peripheral to the locus of control felt totally prepared to use textbooks as a reference. In addition, the majority of the faculty who were central to the locus of control used methods to develop student conceptual understanding. It is notable that all three faculty who were central to the locus of control felt totally prepared and regularly used inquiry methods, although this conclusion about Geo-4 was derived from mixed data from the Standards-Based Teaching Instrument and the semi-structured interviews. This total preparation and regular use of inquiry methods distinguishes them from the faculty who are peripheral to the locus of control.
In terms of the adoption and diffusion facet, it is striking that all 3 of the faculty who were central to the locus of control were potential adopters of and agents of change for each innovation, although Geo-4 was a potential adopter of EDLs. Similarly, 4 out of 5 of the faculty who are peripheral to the locus of control were potential adopters of standards-based teaching and all were potential adopters of EDLs. In contrast, 3 of the 5 faculty who were peripheral to the locus of control were not good candidates to be agents of change. This may indicate that the faculty who were central to the locus of control tended to take a more active role in the diffusion of innovations.

It is of note that regardless of the type of institution, discipline, or locus of control, many of the faculty felt totally prepared and regularly used textbooks as a reference. From the data, this is the only category of standards-based teaching that clearly and consistently emerged for all science faculty. Textbooks are very familiar to the faculty and have traditionally been used as instructional resources. Perhaps their use provides the science faculty with a degree of comfort.

The patterns that emerged from the analysis of groups of faculty based on institutional type, discipline, and locus of control help us to understand the individual cases from a variety of perspectives and contexts. By considering the possible influence from different characteristics, we are better able to develop a rich understanding of undergraduate science faculty. In addition, both the analyses of the individual cases presented in Chapter 4 and the cross-case analyses presented in this chapter (Chapter 5) contribute to the development of the grounded theoretical model presented in Chapter 6.
CHAPTER 6
GROUND THEORETICAL MODEL

Introduction

This study was designed to better understand how undergraduate science faculty can be described in terms of their feelings of preparedness for and use of standards-based teaching and their concerns about adopting EDLs. Standards-based teaching and EDLs are both educational innovations. The individual case studies presented in Chapter 4 and the cross-case analyses presented in Chapter 5 help us to understand the faculty and selected groups, defined by institution, discipline, and locus of control, in terms of the two innovations. This chapter contains an examination of the following: (a) an adaptation of Rogers’ (1995) description of the rate of innovation adoption, (b) an adaptation of the Stages of Concern dimension of the Concerns-Based Adoption Model, (c) innovation 1: standards-based teaching, (d) innovation 2: EDLs, (e) the synergistic adoption of standards-based teaching and EDLs, (f) other applications of the grounded theoretical model, and (g) implications for future research. The resulting model can be used in other contexts and situations to identify ways to support the adoption of standards-based teaching and EDLs as well as provide a framework for innovation and professional developers to support the adoption of other innovations.
Adaptation of Rogers’ Description of the Rate of Innovation Adoption

Figure 6.1 illustrates a slight adaptation of Rogers’ (1995) description of the rate of adoption, which identifies the factors that affect the rate of adoption of an innovation. In the figure, Rogers’ description is modified to make it easier to identify those aspects that need the most support in the adoption of standards-based teaching and EDLs. The three main components in this adjusted model are the innovation, the organization, and the faculty member. The variables that Rogers identifies as affecting the rate of adoption of an innovation are perceived attributes (of innovations), type of innovation decision, nature of the social system, communication channels, and the extent of change agents’ promotion efforts. In the adapted model, each of those variables is associated with one of the three main components salient to the current study.

Figure 6.1: Adapted innovation model from Roger’s description of the rate of adoption
The perceived attributes of an innovation refer to how the potential adopter feels about the innovation in terms of how easy it is to understand (complexity), if they think it is better that the current alternative (relative advantage), if it fits in with their current habits and approaches (compatibility), if it is easy to test (trialability), and if they can see a difference between it and the current alternative (observability). Since the perceived attributes of the innovation are all aspects of the innovation, they are grouped with the innovation in the diagram. These are all aspects that the innovation developer should consider during the innovation’s creation and implementation.

One characteristic of an organization is to identify who makes the decision about the adoption of an innovation. In some cases, the decision about whether to adopt an innovation is up to each individual. In other cases, it is a group decision, and in still others, it is determined by an authority figure. Another characteristic of an organization is the social system within it. Does the social system support a network that is complex and well integrated or are people within the organization isolated? Are the norms of the social system conducive to people collaborating about problems and planning? Since type of innovation decision and nature of the social system are both characteristics of the organization, they are grouped with the organization component.

Each faculty member could potentially serve as a change agent by actively sharing what they know about the innovation with their colleagues. On the other hand, the rate of each faculty member’s adoption of the innovation could be determined by who the change agent is and how they go about sharing the information. For these reasons, the extent of the change agents’ promotion efforts is grouped with the faculty component of the model.
Communication channels is a variable that is depicted as an arrow running through the three components. It is illustrated this way because the communication channels could be managed by the innovation developers, the organization, or the individual faculty members. Communication channels would be managed differently if the innovation developers create a mass media campaign or a series of workshops about the innovation; a department shares information about it through a newsletter or a departmental meeting demonstration; or an individual faculty member writes an article, presents a paper at a professional meeting, or does a demonstration at an institutional inservice day. The organization component is represented as a dotted line because there are interactions that can take place that may or may not involve it. Communication channels is an example of one of these interactions. The innovation developers could have communication channels directly with the faculty and never involve the infrastructure of the organization.

Adaptation of the Stages of Concern Dimension of Concerns-Based Adoption Model

The Concerns-Based Adoption Model (CBAM) provides a framework to support change in education. The Stages of Concern (SoC) dimension of the model focuses on the concerns of the people who potentially will adopt the change. The philosophy of the SoC dimension underscores the notion that the relative intensity of people’s concerns about the educational change shifts as they move developmentally from one stage of adoption to the next. The seven stages of concern are categorized into dimensions of self, task, and impact dimensions. The self dimension, which is characterized by awareness, informational, and personal concerns, focuses on what the potential adopter knows about the innovation and if the potential adopter feels confident enough to implement the
innovation without fear of failure. The task dimension is characterized by the
management concern and generally becomes more intense just prior to implementation.
The potential adopter is worried how the innovation is going to fit in with all the other
tasks that have to be done. The impact dimension generally occurs when the potential
adopter has begun to implement the innovation and wants to carry out the implementation
as well as possible. At that point, the potential adopter is concerned about the
consequences of the innovation on the students, how collaboration can improve
implementation, and how refocusing the implementation of the innovation can support
the special needs of the students (Hall et al., 1978; Hord et al., 1987).

Figure 6.2 illustrates a slightly different way of applying the SoC dimensions of
CBAM. This illustration uses the same three components featured in Figure 6.1, the
innovation, the organization, and the faculty member. The reorganization into this
framework was designed to help identify who can best support the adoption of the
innovation.

The curved arrow pointing from the innovation to the faculty member encompasses
the awareness, informational, and personal concerns. This indicates that the innovation
developers can provide support to help the faculty members become aware that the
innovation exists, understand what it does, and offer them support in how to begin to use
it. The management, consequence, and collaboration concerns fall into the block that runs
along the side of the innovation, the organization, and the faculty member. The reasoning
behind this arrangement is that these advanced concerns can be supported in different
ways by actions of the innovation developers, the faculty members’ organization, and the
faculty members themselves. For example, the innovation developers can offer a help line
to answer frequently asked questions about implementation, offer evaluation tools, and identify others who are interested in working together as they use the innovation.

Similarly, the faculty members’ organization can help the faculty members prioritize their other tasks, evaluate the impact of the innovation, and offer a network for collaboration, such as grants to support the scholarship of teaching and learning and regularly scheduled discussions about teaching. The faculty can be proactive as they work out management issues, collect evaluation data, and enlist others to collaborate. The refocusing concern is drawn as an arrow starting with the faculty member and running through the organization back to the innovation. This arrangement signifies that the faculty member is adapting the innovation to be customized for his/her students and his/her organization. Ideas about adaptations could be incorporated in next-generation versions of the innovation.

![Adapted Concerns-Based Adoption Model](image)

Figure 6.2: Adapted Concerns-Based Adoption Model
Innovation 1: Standards-Based Teaching

Standards-based teaching is an innovation that was defined for K-12 education in the *NSES* (NRC, 1996), but has not yet been adopted and implemented on the undergraduate level. What is impeding its adoption? What supports would help pave the way for adoption? By considering the variables controlling the rate of adoption in terms of the innovation, the organization, and the faculty member, the aspects of adoption that need the most support can be identified.

Figure 6.3 illustrates aspects of an adaptation of Rogers’ description (1995) in terms of standards-based teaching. The data presented in this study indicate that the innovation characteristics that Rogers identifies are only slight obstacles for most of the faculty. Even though they have a notion of what most of the characteristics of standards-based teaching mean and feel comfortable trying some of them, they might not understand the vocabulary associated with standards-based teaching. Faculty often referred to content standards when asked about standards-based teaching.

Many of the faculty indicated that they felt prepared to use textbooks as a reference, which was a method that they used often. This could be because textbooks have historically been common tools in teaching and faculty are familiar with them. It might be easier for them to take a commonly used tool and change its application compared to using a technique that is relatively new, such as computers and the Internet. Similarly, the nature of the discipline might slow the adoption of a standards-based teaching category. Geologists indicated that they did not feel prepared and did not use computers and the Internet, but with their interest in fieldwork, using technology in this way may not be as beneficial to them.
Multiple definitions emerged for student-centered, inquiry, and collaborative groups. Uncertainty about the vocabulary could lead to alternative conceptions about what standards-based methods are and how to implement them. It appeared that some faculty, such as LS-2 and Geo-4, were repelled by some of the educational improvements because of the jargon and “glitz.” Any effort to promote standards-based teaching with undergraduate science faculty should start with a shared vocabulary and understanding of the terms.

Figure 6.3: Adapted innovation model from Roger’s rate of adoption in terms of standards-based teaching

In terms of the organization characteristics, all of the faculty from both the 2-year and 4-year institutions said that they were in charge of making the decision about whether or
not they should adopt standards-based teaching. The nature of the social system varied from department to department. For example, the physicists, Phys-2 and Phys-4, had the benefit of participation in the physics education research at the 4-year institution, which may have given them a community of faculty who were interested in investigating ways to improve student learning. In addition, the faculty who were central to the locus of control may perceive an obligation to share advances in science teaching with those who were peripheral to the locus of control, which may be why, they felt prepared to and regularly used inquiry methods.

It appeared from the comments during the group meetings and during the interviews that some departments, such as the life science, chemistry, physical sciences, and geology at the 4-year institution, had a tightly knit network through which the faculty learned about new ideas and solved problems. The department at the 2-year institution did not have the same collaborative norms. The faculty often mentioned that they were hesitant to discuss teaching issues with their colleagues.

Documents related to missions and goals are published on the web sites for both the 2-year and 4-year institutions as well as on websites for specific colleges, departments, and programs within the institutions. The document analyses of the mission-related documents indicated that responding to student diversity and using technology that supports teaching and learning are encouraged by both the 2- and 4-year institutions. In addition, the goals of the 2-year institution promote the creation of a student-centered environment. The analysis also indicated that both institutions encourage excellence in teaching, but did not identify what excellent teaching includes. If the institutions and
departments had clear missions and goals that included additional aspects of standards-based teaching that support teaching excellence, that innovation may be more easily adopted.

The leadership in the different departments also appeared to reflect different approaches. The Chairman of the Biological and Physical Sciences Department in the 2-year institution was involved in curriculum selection and Chem-2 considered him an important person with whom to share ideas about teaching. The Chairman’s comment that he did not want to send the invitation to the faculty inviting them to participate in the group discussion about standards-based teaching and EDLs because it was something that was outside the faculty job description implies that he thinks he has to be careful about how he encourages faculty to spend their time. In contrast, the fact that the Life Science Department Chairman in the 4-year institution extended the invitation to the group meeting and attended one of the sessions indicates that he endorses collegial communication about educational matters.

Any effort to promote standards-based teaching with undergraduate science faculty should start with an assessment of the organizational norms and networks. In terms of the 2-year faculty in the current study, it would be recommended that the departmental leadership take measures to establish a cultural norm to increase collaboration among faculty and establish multiple alternative networks to serve as a means of that collaboration, such as faculty communities that focus on a particular topic or departmental listservs dedicated to teaching issues. It is also recommended that the leadership identify clear missions that incorporate dimensions of standards-based teaching with specific actions and roles for the faculty.
The 2-year institution does not require faculty to do research in their field of science but the 4-year institution does. In this study, it had been expected that the research requirements would negatively impact the faculty members’ interest in improving their teaching. On the contrary, the data from this study indicate that the research requirement encourages an organizational norm in which the faculty seek research-based solutions to their teaching questions.

There were many characteristics of the individual faculty members that could have contributed to the variations in their profiles. Length of teaching experience science on the undergraduate level could impact the adoption of standards-based teaching. Many people speak of faculty who have taught for many years as curmudgeons who resist change. This was not the situation with any of the faculty in this study. Of the five faculty with lengthy careers, LS-2, Chem-2, LS-4, Phys-4, and Geo-4, all of them were open to change. Of those, LS-2 was the only one who was resistant to the notion of standards-based teaching. Her resistance was not because she was not interested or did not care about student learning, but rather she was worried how she would be able to fit standards-based teaching methods into what she currently does. The other faculty with lengthy experience were seeking out new teaching methods and showing others how to implement these methods. The faculty who had less experience mentioned that they would need time and support to be able to know how to implement standards-based teaching.

Regarding the Standards-Based Teaching Instrument, the feeling of preparedness can be considered a characteristic of the faculty member and the frequency of use can be considered a measurement of the implementation of the innovation. There was great
variation from person to person in terms of their feelings of preparedness for using the different categories of standards-based methods. It appears that faculty at the 4-year institution are implementing inquiry methods, using textbooks as a reference, and use methods to respond to student diversity.

There was great variability among the 2-year and 4-year institution faculty members’ perceptions in terms of their institutional goals and subsequently their role in fulfilling the goals. Some, such as Geo-2, thought the goal was to get through the material and the instructor’s role was to cover the material in the course outline. Others, such as LS-2, thought the goals were to prepare the students to pass licensure tests and the instructor’s role was to support them emotionally and academically. Still others, such as Chem-2, Chem-4, and Geo-4, thought that it was important to improve students’ critical thinking skills and scientific literacy. They thought that the instructor’s role was to lead the class in such a way that the students would have to evaluate information and develop solutions.

Three of the 5 faculty with lengthy teaching experience were central to the locus of control in their programs. Both LS-4 and Geo-2 led the programs for the introductory courses in their departments. Phys-4 was in the process of developing the curriculum for the introductory physics courses. Those faculty who were central to the locus of control were distinct from the other faculty because they all felt totally prepared to use inquiry methods. Control over the course program appears to impact adoption of standards-based teaching for these faculty members. In addition, control also appears to contribute to whether or not the faculty may serve as an agent of change and help diffuse the innovation.
Many of the faculty were very reflective about their teaching practices. This seemed to be linked to whether or not their teaching goals centered on improved student learning. If the faculty were focusing on covering the material, then they were less likely to consider whether or not their methods were successful or not. It would be evident at the end of the course. If the goal is to cover the material and the material was covered, then there is nothing to reflect upon. If the goal is to support student understanding of the scientific concepts involved in the course, then there are great opportunities for reflection.

Efforts to promote standards-based teaching with undergraduate science faculty should take into consideration the faculty members’ feelings of preparedness toward the teaching methods, their length of experience teaching science on the undergraduate level, their position relative to the locus of control, and whether or not they are reflective about their practices as they try to meet their teaching goals. Different approaches should be used depending upon each of these characteristics. If they feel unprepared, professional development efforts should be targeted to help them feel better prepared. Agents of change should also consider if the faculty are inexperienced. Inexperienced faculty might have a different outlook and degree of insight with regard to students compared to those who have greater experience. Knowing the faculty members’ notions about teaching and student learning will help clarify how best to facilitate the faculty adopting standards-based methods. Those who are central to the locus of control may feel more empowered to effect change than those who are peripheral. Efforts to empower those with peripheral control could make them more invested in making the change. A clear message from the organizational leadership encouraging reflective practice and clarifying teaching goals may change the focus of those who only want to cover the material.
Innovation 2: EDLs

In the current study, the adoption of EDLs was considered both in terms of the faculty’s concerns and in terms of the variables contributing to the rate of innovation adoption. Figure 6.4 is an integration of the combined adaptations of both models. The combination of the models provides a richer, more coherent picture of the adoption of EDLs in terms of the users’ stages of concern and the variables affecting the rate of adoption.

Figure 6.4: Combined adaptations of Rogers’ Rate of Adoption Model and the SoC dimension of CBAM

In the current study, all of the faculty exhibited high relative intensity concern in the awareness and informational stages. This is not surprising because EDLs are such a new innovation and no widespread awareness and informational campaigns have been conducted. Some of the faculty, such as Phys-2, Chem-2, LS-4, Chem-4, and Geo-4, have
concerns related to management and collaboration, which are developmentally more mature. Three of these faculty have been actively involved in digital library projects, so it is not surprising that their concerns are more typical of a more mature adopter than the rest of the faculty.

The perceived attributes of the innovation, such as its complexity, relative advantage over the current system, compatibility with their current practices, trialability, and the observability of distinct characteristics of EDLs, were not slowing down the adoption process for most of the faculty. The geologists might not have been as interested in EDLs because of their feelings of preparedness for and actual use of computers and the Internet. After the overview of EDLs at the group meetings, all of the faculty indicated that they understood the general concept of EDLs, they could see the difference between EDLs and other means of finding educational resources, and felt that EDLs would be compatible with their current approaches to teaching. All of the faculty could perceive the relative advantage of EDLs and stated that that they were easy to try.

All of the faculty said that they could make the decision about whether or not to personally adopt EDLs. They could use any means they thought reasonable to find educational resources. Many of the faculty mentioned the influence of publishers in the selection of the resources. They mentioned that the publishers send them an abundance of ancillary materials to go with the textbooks. The easiest route for many faculty is to use the textbooks and ancillary materials because they are readily available. Others, such as Chem-2 seek out alternative materials because they feel that the publishers have motives that might not be in the students’ best interest.
Just as in the situation regarding the adoption of standards-based teaching, the nature of the social system varied from department to department. The department at the 2-year institution did not have the same norms as the departments at the 4-year institution. The faculty at the 2-year institution did not have a tightly integrated departmental network through which to share ideas about EDLs. This difference in the social systems may make the adoption of EDLs in the 2-year institution slower than that at the 4-year institution.

The extent of the change agents’ promotional efforts could have a great impact on the rate of adoption of EDLs. The three faculty who were identified as central to the locus of control were further along in their adoption of EDLs than the other faculty. They could serve as advocates for EDLs and help others know what EDLs are and how to use them. The faculty identified as peripheral to the locus of control will most likely not be agents of change, but may be influenced by agents of change. They may increase their use of EDLs if people they respected encouraged and helped them in the change process.

The variable controlling the rate of adoption of EDLs that may have the greatest effect is the communication channels. Since EDLs are so new, most faculty have not previously heard of them. Most of the faculty stated that they had first heard about EDLs during our group meetings. This is not an effective way of disseminating an innovation. The digital library developers need to have an awareness and informational campaign. If they target the department chairmen and the program directors, who are central to the locus of control, they could develop a strong group of agents of change who may accelerate the community’s rate of adoption.
Synergistic Adoption of Standards-Based Teaching and EDLs

Both standards-based teaching and EDLs are innovations that have not been completely adopted by undergraduate science faculty. The adoption of both of these innovations by undergraduate science faculty were investigated together in this study because they have common elements. The goal of both innovations is to improve student learning. Standards-based teaching offers a pedagogical guide for how to improve student learning. EDLs help faculty find and access digital resources for students to use to help them understand the content or for faculty to use to provide alternative ways of teaching the content. Some faculty, such as the geologists in the current study, consistently reported feeling unprepared to use computers and the Internet in the science class, and in fact, did not use this strategy. If faculty use the resources that are available in EDLs, their feelings of preparedness and frequency of use related to computers and the Internet in science class may improve. If faculty are interested in finding standards-based resources, EDLs may be a good place to look. If faculty are using EDLs, they will be able to find resources that support standards-based teaching. The adoption of both innovations would be supported by helping the faculty feel better prepared to use computers and the Internet in science classes.

Implications for Innovation Developers

Faculty may be better able to adopt both standards-based teaching and EDLs if the proponents of standards-based teaching and EDL developers considered recommendations from this study. Efforts to support the adoption of standards-based teaching should join forces with efforts to support the adoption of EDLs. It is crucial to
establish a shared understanding regarding the vocabulary used to describe standards-based teaching. This is important both for communication and implementation of standards-based teaching and EDLs, since the resources in EDLs could be related to standards-based teaching. National awareness campaigns should be conducted to help faculty know about and understand how to use standards-based teaching and EDLs. Proponents of both innovations need to develop and distribute tools to help faculty manage standards-based teaching and EDLs with their current commitments. These tools could be resources such as templates or models of others who have successfully adopted the two innovations.

Implications for Professional Developers

Professional developers need to take into consideration the faculty member’s pre-existing understanding of standards-based teaching and EDLs as well as their organizational norms. If the professional developers understand what areas of standards-based teaching the faculty feel unprepared or partially prepared to use, it will help them target the faculty’s needs. For example, the fact that none of the faculty felt totally prepared to use computers and the Internet in class should have an impact on how professional developers try to support faculty members’ adoption of EDLs. Faculty will most likely be more compelled to use standards-based applications of technology and EDLs if they feel very confident in how to use computers and the Internet in science classes. Similarly, the professional developer can build on faculty members’ experience and comfort with using standards-based teaching and EDLs so that the faculty will be able to continue to find new ways to help students learn.
Implications for Undergraduate Science Departments

This study indicates that there are actions that undergraduate science departments can take to increase the rate of diffusion of standards-based teaching and EDLs. If undergraduate science departments have a clear mission that involves helping students to achieve deep conceptual understanding, faculty will be better able to understand their role in that mission. As long as the faculty focus on covering the material and not student conceptual understanding, they may not be interested in different teaching methods. It may be helpful for the undergraduate science departments to encourage the faculty who are central to the locus of control to diffuse what they practice in terms of inquiry methods. If faculty in specific disciplines, such as life science and chemistry, find it easier to regularly use methods to respond to student diversity, it may be helpful to have cross-discipline workshops that could support others’ adoption of these standards-based teaching methods. It is important for the departmental leadership to establish a strong network within which faculty can consult and collaborate with one another about teaching issues. This could help allay faculty members’ management, collaboration, and consequence concerns.

Other Applications of the Grounded Theoretical Model

The grounded theoretical model developed in the current study to describe undergraduate science faculty can be useful for other disciplines and education levels. Educational change is difficult in all settings. If the adoption of educational innovations is to be successful, it needs to be considered from multiple perspectives. The innovators need to consider how the educators perceive the innovation, understand the organizational structures within which the educators are working, and recognize the
aspects of the educators (e.g., experience, feelings of preparedness, goals of teaching, locus of control, and reflective practice) that may influence their receptivity to adopting the innovation. Assessing the educators’ concerns (e.g., awareness, informational, personal, management, consequence, collaboration, and refocusing) and the variables that affect the rate of adoption (e.g., perceived attributed, type of innovation decision, nature of the social system, communication channels, and extent of the change agent’s promotional efforts) may help proponents of the changes have a snapshot in time of what aspects of the innovation-organization-educator system need the most attention and focused effort. Understanding the users’ specific needs in their particular situation is essential for the success of any change effort. Combining Rogers’ description (Rogers, 1995) and the SoC dimension of the Concerns-Based Adoption Model (Hall et al., 1978) allows the innovation developer, the professional developer, and educators to reflect on those needs and customize the support for change.

Implications for Future Research

Several aspects of this study have implications for future research. First, not much is known about undergraduate science faculty’s use of standards-based teaching and EDLs. This study describes 4 volunteer faculty members from a 2-year institution and 4 volunteers from a 4-year institution, with one faculty member from each institution being a life scientist, a chemist, a physicist, or a geologist. If standards-based teaching and EDLs are to be fully adopted, additional studies of faculty in different settings and with different backgrounds need to be conducted.

Second, more research should be conducted about the effect of locus of control on the adoption of innovations. This study indicates that locus of control may impact the
adoption of standards-based teaching and EDLs. Additional studies that focus on locus of control will help clarify the degree to which this characteristic affects the adoption of standards-based teaching and EDLs or any other educational innovation. Also, future studies should be conducted to clarify the potential relationship between professional development activities and experience with locus of control. Those faculty who are central to the locus of control and have professional development activities might subsequently act as a professional developer for faculty who are peripheral to the locus of control.

Third, the current study relied on self-reported data. Also, the terms describing standards-based teaching that were used in the instrument may be interpreted differently by different participants. Thus, it is recommended that future studies couple the questionnaire with classroom observations and an analysis of documents related to the participants’ teaching, such as syllabi, assessments, and handouts.

Fourth, it is recommended that future studies use a more granular approach to investigate aspects of standards-based teaching. For ease of analysis, the current study aggregated the individual items describing specific aspects of standards-based teaching into categories. Each of the categories, such as the development of student conceptual understanding, use of inquiry methods, and use of multiple means of assessment should be investigated in greater depth across different populations and their adoption of standards-based teaching.

Fifth, use of additional demographic information as variables of interest may provide a clearer picture of undergraduate science faculty. For example, this study did not investigate differences based on gender, age, tenure status, or years of service. Focus on
variables such as these may add to our understanding of what currently appears to be individual differences among faculty.

Sixth, the current study did not use the Innovation Configuration and Levels of Use components of CBAM. Future studies that use the Innovation Configuration to clearly describe the different aspects and desired results from the use of standards-based teaching and EDLs in undergraduate science education would help elucidate what the innovations are and when they are being used. In addition, studies that use the Levels of Use with a larger sample would illustrate the degree to which different groups are adopting the innovations.

Seventh, the current study provided a snapshot in time of the adoption of standards-based teaching and EDLs. Since change is a lengthy process, additional studies that capture the description of faculty as they developmentally progress to different degrees of adoption would help innovation developers, professional developers, and undergraduate science departments evaluate the progress being made. The faculty members’ needs and concerns will change and so should the innovation supporters’ approaches.

Eighth, research related to the impact of institutional support of collaboration on the adoption and diffusion of educational innovations may clarify the role of the organization in the adoption process. Specific areas of interest may be the role of institutional grants to support the scholarship of teaching and learning or the impact of departmental learning communities related to teaching strategies.

Finally, the study protocols and instruments may be valuable tools for others studying educational change and innovations. Further testing and refinement of these protocols
and instruments will help innovation designers and agents of change understand potential adopters. Well-honed tools will facilitate the identification of ways to best support educational innovation adoption and diffusion.


Hall, G. E., George, A. A., & Rutherford, W. L. (1978). *Stages of concern about innovation: The innovation, the concept, verification, and implications*. Austin, TX: Southwest Educational Development Laboratory.


Roempler, K. S. (1995). *Understanding science teacher leaders' concerns regarding the use of portfolio assessment: Facilitating the process using the Concerns-Based Adoption Model*. Unpublished Dissertation, The Ohio State University, Columbus, OH.


APPENDIX A

Sample E-Mail Invitation to Chairpersons
Dear [Insert name],

I am a doctoral candidate in science education at The Ohio State University. The purpose of my research project is to describe undergraduate science faculty members' attitudes toward the innovations of standards-based teaching and the education digital libraries. As part of my dissertation research, I would like have a meeting with the faculty members in your department so that we can talk about their teaching methods, their use of digital resources, and the features of education digital libraries. I plan to audiotape our discussion and ask the participants to complete a questionnaire. I would like to do follow-up interviews with 4-8 of the participants. Their participation in all aspects of the project is voluntary. Participating in any part of this does not obligate the faculty to provide any other information or response related to other procedures that may be used for my dissertation research.

All information that the participants provide will be kept in the strictest confidence. Responses will not be identified with any individual. I will assign a participant code number or pseudonym only to connect all papers that participants complete for my project.

I am working under the direction of Professor Donna F. Berlin at The Ohio State University. If you have any questions, you may ask me or Professor Berlin. I can supply her contact information.

Please let me know when would be a good time for me to attend one of your faculty meetings.

Thanks you,

Judy Ridgway
Science Education Doctoral Student
The Ohio State University
(614) 292-0837
jridgway@enc.org
APPENDIX B

Sample E-Mail Invitation to Group Meeting
I am a former adjunct faculty member of the CSCC Department of Biological and Physical Sciences and am currently a Ph.D. candidate in Science Education at The Ohio State University. I am requesting your assistance in gathering data for my dissertation. This assistance involves a combination of roundtable discussion and completion of a questionnaire. To facilitate my gaining as much input as possible, I would like to schedule 2-3 group discussions next week.

The Objectives for the roundtable meeting are:

Participants learn more about digital libraries.

Participants share stories about their use of digital libraries.

Participants share strategies for using digital resources to support student learning.

Data gathering to help describe undergraduate science faculty in terms of their concerns related to digital libraries as well as their attitudes toward and use of nontraditional teaching methods.

In order for me to select times that are convenient for you, please let me know if you are interested in participating in a session and which time is best for you. I hope to send out formal announcements with times, dates, and locations by the end of the week.

Tuesday, March 16, 12-1

Tuesday, March 16, 3-4

Wednesday, March 17, 3-4

Thursday, March 18, 10-11

If none of these times work for you and you would like to make alternative arrangements, please let me know.

I intend for these meetings to be as useful to the participants as they are to me. Thank you in advance for your help.

Judy Ridgway
Science Education Doctoral Candidate
The Ohio State University
(614) 292-0837
jridgway@enc.org
APPENDIX C

Demographics and Experience Questionnaire
Name ___________________   Birth date _______   Gender (please circle)     Male     Female

Professional Experience at Current Institution (e.g., college, university, other)

1. Type of higher education institution are (Circle all that apply)

a. 4-year doctoral granting, graduate or professional school   c. 2-year degree granting
b. 4-year non-doctoral granting college   c. Other postsecondary___________

2. Academic rank/title (Circle the highest rank that applies)

a. Professor   c. Assistant Professor   e. Lecturer
b. Associate Professor   d. Instructor   f. Other (please specify) ____________

3. Tenure status

a. Tenured   c. On tenure track but not tenured
b. Not on tenure track although institution has a tenure system   d. No tenure system at this institution

4. Years teaching in higher education institutions ______

5. Years teaching science on the undergraduate level ______

Total number of science classes/sections taught last year ______

6. Circle principle field or discipline of science teaching (If equal areas, select one)

Biological Sciences

<table>
<thead>
<tr>
<th>Biochemistry</th>
<th>Botany</th>
<th>Immunology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>Genetics</td>
<td>Microbiology</td>
</tr>
<tr>
<td>Biological Sciences, Other</td>
<td>Physiology</td>
<td></td>
</tr>
</tbody>
</table>

Physical Sciences

<table>
<thead>
<tr>
<th>Astronomy</th>
<th>Geologic Sciences</th>
<th>Physical Sciences, Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>Physics</td>
<td></td>
</tr>
</tbody>
</table>

7. Teaching Experience Last Year

<table>
<thead>
<tr>
<th></th>
<th># of Science Classes/Sections</th>
<th># of Preparations</th>
<th>Average Class Size</th>
<th># of Graduate Assistants Instruction Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Division Courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Division Courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

Standards-Based Teaching Instrument
Please indicate how prepared you currently feel and how frequently you use each of the following in your science instruction. Please mark once for Preparation and once for Use.

<table>
<thead>
<tr>
<th></th>
<th>Not Adequately Prepared</th>
<th>Somewhat Prepared</th>
<th>Fairly Well Prepared</th>
<th>Very Well Prepared</th>
<th>Never</th>
<th>Sometimes (e.g., once or twice a month)</th>
<th>Often (e.g., once or twice a week)</th>
<th>All or Almost All Science Lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take students’ prior understanding into account when planning curriculum and instruction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop student’s conceptual understanding of science</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide deeper coverage of fewer science concepts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make connections between science and other disciplines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead a class of students using inquiry strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manage a class of students engaged in hands-on work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manage a class of students engaged in project-based work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of Preparation</td>
<td>Frequency of Use</td>
<td>All or Almost All Science Lessons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------</td>
<td>----------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Adequately Prepared</td>
<td>Never</td>
<td>Have student’s work in cooperative working groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Somewhat Prepared</td>
<td>Sometimes (e.g., once or twice a month)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fairly Well Prepared</td>
<td>Often (e.g., once or twice a week)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Well Prepared</td>
<td>All or Almost All</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Have student’s work in cooperative working groups
- Listen/ask questions as students work in order to gauge their understanding
- Use the textbook as a resource rather than the primary instructional tool
- Teach groups that are heterogeneous in ability
- Teach students who have limited English proficiency
- Recognize and respond to student cultural diversity
- Encourage students’ interest in science
- Encourage participation of females in science
- Encourage participation of minorities in science
<table>
<thead>
<tr>
<th>Degree of Preparation</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Adequately Prepared</td>
<td>Never</td>
</tr>
<tr>
<td>Somewhat Prepared</td>
<td>Sometimes (e.g., once or twice a month)</td>
</tr>
<tr>
<td>Fairly Well Prepared</td>
<td>Often (e.g., once or twice a week)</td>
</tr>
<tr>
<td>Very Well Prepared</td>
<td>All or Almost All Science Lessons</td>
</tr>
</tbody>
</table>

- Use computers for drill and practice
- Use computers for science learning games
- Use computers to collect and/or analyze data
- Use computers to demonstrate scientific principles
- Use computers for laboratory simulations
- Use computers to ask students questions for tests and quizzes
- Use the Internet in your science teaching for general reference
- Use the Internet in your science teaching for data acquisition
- Use the Internet in your science teaching for collaborative projects with classes/individuals in other institutions
- Introduce content through formal presentations
- Pose open ended questions
- Engage the whole class in discussions
<table>
<thead>
<tr>
<th>Degree of Preparation</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Adequately Prepared</td>
<td>Sometimes (e.g., once or twice a month)</td>
</tr>
<tr>
<td>Somewhat Prepared</td>
<td>Often (e.g., once or twice a week)</td>
</tr>
<tr>
<td>Fairly Well Prepared</td>
<td>All or Almost All Science Lessons</td>
</tr>
<tr>
<td>Very Well Prepared</td>
<td></td>
</tr>
</tbody>
</table>

- **Require students to supply evidence to support their claims**
- **Ask students to explain concepts to one another**
- **Ask students to consider alternative explanations**
- **Allow students to work at their own pace**
- **Help students see connections between science and other disciplines**
- **Assign science homework**
  - Read and comment on the reflections students have written, e.g., in their journals
  - Conduct a pre-assessment to determine what students already know
<table>
<thead>
<tr>
<th>Degree of Preparation</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Adequately</td>
<td>Never</td>
</tr>
<tr>
<td>Prepared</td>
<td></td>
</tr>
<tr>
<td>Somewhat Prepared</td>
<td></td>
</tr>
<tr>
<td>Fairly Well Prepared</td>
<td></td>
</tr>
<tr>
<td>Very Well Prepared</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
</tr>
<tr>
<td></td>
<td>(e.g., once or</td>
</tr>
<tr>
<td></td>
<td>twice a month)</td>
</tr>
<tr>
<td></td>
<td>Often</td>
</tr>
<tr>
<td></td>
<td>(e.g., once or</td>
</tr>
<tr>
<td></td>
<td>twice a week)</td>
</tr>
<tr>
<td></td>
<td>All or Almost</td>
</tr>
<tr>
<td></td>
<td>All Science</td>
</tr>
<tr>
<td></td>
<td>Lessons</td>
</tr>
<tr>
<td>Use assessments</td>
<td></td>
</tr>
<tr>
<td>embedded in class</td>
<td></td>
</tr>
<tr>
<td>activities to see if</td>
<td></td>
</tr>
<tr>
<td>students are</td>
<td></td>
</tr>
<tr>
<td>“getting it”</td>
<td></td>
</tr>
<tr>
<td>Review student</td>
<td></td>
</tr>
<tr>
<td>homework</td>
<td></td>
</tr>
<tr>
<td>Review student</td>
<td></td>
</tr>
<tr>
<td>notebooks/journals</td>
<td></td>
</tr>
<tr>
<td>Review student</td>
<td></td>
</tr>
<tr>
<td>portfolios</td>
<td></td>
</tr>
<tr>
<td>Have students do</td>
<td></td>
</tr>
<tr>
<td>long term science</td>
<td></td>
</tr>
<tr>
<td>projects</td>
<td></td>
</tr>
<tr>
<td>Have students</td>
<td></td>
</tr>
<tr>
<td>present their work</td>
<td></td>
</tr>
<tr>
<td>to the class</td>
<td></td>
</tr>
<tr>
<td>Give predominantly</td>
<td></td>
</tr>
<tr>
<td>short answer tests</td>
<td></td>
</tr>
<tr>
<td>(e.g., multiple</td>
<td></td>
</tr>
<tr>
<td>choice, true/false,</td>
<td></td>
</tr>
<tr>
<td>fill in the blank)</td>
<td></td>
</tr>
<tr>
<td>Give tests</td>
<td></td>
</tr>
<tr>
<td>requiring open-</td>
<td></td>
</tr>
<tr>
<td>ended responses</td>
<td></td>
</tr>
<tr>
<td>(e.g., descriptions,</td>
<td></td>
</tr>
<tr>
<td>explanations)</td>
<td></td>
</tr>
<tr>
<td>Grade student work</td>
<td></td>
</tr>
<tr>
<td>on open-ended and/or</td>
<td></td>
</tr>
<tr>
<td>laboratory tasks</td>
<td></td>
</tr>
<tr>
<td>using defined</td>
<td></td>
</tr>
<tr>
<td>criteria (e.g., a</td>
<td></td>
</tr>
<tr>
<td>scoring rubric)</td>
<td></td>
</tr>
</tbody>
</table>
In the past **12 months**, have you: (Mark with an X on each line.)

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Been a participant in professional development related to teaching practices?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Mentored other faculty in terms of the teaching of science?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Taken a formal college/university course in the teaching of science?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Observed other faculty teaching science as part of your own professional development (formal or informal)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Met with a group of other faculty on a regular basis to study/discuss science teaching issues?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Attended a national or state science teaching association meeting?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions drawn with permission from

APPENDIX E

Stages of Concern Questionnaire (SoCQ)
Educational Digital Library (EDL) Concerns Questionnaire

Participant Number ______________________________   Date ________________

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the innovation adoption process. The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years experience using them. Therefore, a good part of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time. For the completely irrelevant items, please circle “0” on the scale. Other items will represent those concerns you do have, in varying degrees of relative intensity, and should be marked higher on the scale, according to the explanation at the top of each of the following pages.

For example

| This statement is very true of me at this time | 0 | 1 | 2 | 3 | 4 | 5 | 6 | (7) |
| This statement is somewhat true of me now.    | 0 | 1 | 2 | (3)| 4 | 5 | 6 | 7  |
| This statement is not at all true of me at this time. | 0 | (1)| 2 | 3 | 4 | 5 | 6 | 7  |
| This statement seems irrelevant to me.        | (0)| 1 | 2 | 3 | 4 | 5 | 6 | 7  |

Please respond to the items in terms of your present concerns, or how you feel about your involvement or potential involvement with Educational Digital Libraries (EDL). We do not hold to any one definition of this program, so please think of it in terms of your own perceptions of what it involves. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with EDL.

Thank you for taking time to complete this task.
<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrelevant</td>
<td>Not true of me now</td>
<td>Somewhat true of me now</td>
<td>Very true of me now</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>I am concerned about students’ attitudes toward NSDL.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>I know of some other approaches that might work better.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>I don’t even know what the EDUCATIONAL DIGITAL LIBRARIES is.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>I am concerned about not having enough time to organize myself each day.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>I would like to help other faculty in their use of the EDUCATIONAL DIGITAL LIBRARIES.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>I have very limited knowledge about the EDUCATIONAL DIGITAL LIBRARIES.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>I would like to know the effect of reorganization on my professional status.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>I am concerned about conflict between my interests and my responsibilities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>I am concerned about revising my use of the EDUCATIONAL DIGITAL LIBRARIES.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>I would like to develop working relationships with both our faculty and outside faculty using the EDUCATIONAL DIGITAL LIBRARIES.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>I am concerned about how the EDUCATIONAL DIGITAL LIBRARIES affects students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>I am not concerned about the EDUCATIONAL DIGITAL LIBRARIES.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>I would like to know who will make the decisions in the new system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>I would like to discuss the possibility of using the EDUCATIONAL DIGITAL LIBRARIES.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>I would like to know what resources are available if we decide to adopt the EDUCATIONAL DIGITAL LIBRARIES.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>I am concerned about my ability to manage all that the EDUCATIONAL DIGITAL LIBRARIES requires.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>I would like to know how my teaching or administration is supposed to change.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
18. I would like to familiarize other departments or persons with the progress of the EDUCATIONAL DIGITAL LIBRARIES.

19. I am concerned about evaluating my impact on students.

20. I would like to revise the EDUCATIONAL DIGITAL LIBRARIES’ instructional approach.

21. I am completely occupied with other things.

22. I would like to modify our use of the based on the experiences of our students.

23. Although I don’t know about the EDUCATIONAL DIGITAL LIBRARIES, I am concerned about other things in the area.

24. I would like to excite my students about their part in the EDUCATIONAL DIGITAL LIBRARIES.

25. I am concerned about time spent working with nonacademic problems related to the EDUCATIONAL DIGITAL LIBRARIES.

26. I would like to know what the use of the EDUCATIONAL DIGITAL LIBRARIES will require in the immediate future.

27. I would like to coordinate my effort with others to maximize the EDUCATIONAL DIGITAL LIBRARIES’S effects.

28. I would like to have more information on time and energy commitments required by the EDUCATIONAL DIGITAL LIBRARIES.

29. I would like to know what other faculty are doing in this area.

30. At this time, I am not interested in learning about the EDUCATIONAL DIGITAL LIBRARIES.

31. I would like to determine how to supplement, enhance, or replace the EDUCATIONAL DIGITAL LIBRARIES.

32. I would like to use feedback from students to change the program.

33. I would like to know how my role will change when I am using the EDUCATIONAL DIGITAL LIBRARIES.

34. Coordination of tasks and people is taking too much of my time.

35. I would like to know how the EDUCATIONAL DIGITAL LIBRARIES is better than what we have now.
PLEASE COMPLETE THE FOLLOWING:

1. What other concerns about the digital libraries, if any, do you have at this time? (Please describe them in complete sentences.)

2. Please briefly provide your definition of digital libraries

APPENDIX F

Semi-Structured Interview Data Rubric
<table>
<thead>
<tr>
<th>Category</th>
<th>Negative Indicator of Adoption</th>
<th>Intermediate Indicator of Adoption</th>
<th>Positive Indicator of Adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand the term standards-based</td>
<td>Says they have never heard the terms</td>
<td>Thinks the standards all refer to content</td>
<td>Is aware of content and process standards but not teaching</td>
</tr>
<tr>
<td>Self described as learner centered</td>
<td>No</td>
<td></td>
<td>Knows that the term standards-based teaching refers to methods outlined in NSES and PSSM</td>
</tr>
<tr>
<td>What they think learner centered is</td>
<td>Adjusting when students look confused</td>
<td>Giving students control of what happens in the class</td>
<td>Teacher led discussion</td>
</tr>
<tr>
<td>How they heard about teaching methods</td>
<td>Never heard about them</td>
<td>From classes in school</td>
<td>Placing the responsibility of learning on the student - interactive</td>
</tr>
<tr>
<td>Use standards-based techniques</td>
<td>Sole teaching method is transmissive (lecture), Instructor serves as source of knowledge - students follow recipe in lab</td>
<td>Considers student responsibility to ask the instructor questions in class and then the instructor find the answers</td>
<td>Uses the Socratic method, encourages the students to collaborate, students are asked occasionally seek out answers on their own</td>
</tr>
<tr>
<td>Do they see the difference between the standards-based and traditional methods</td>
<td>no</td>
<td></td>
<td>Lectures, has students collaborate, puts responsibility of learning on student</td>
</tr>
<tr>
<td>Do they see a benefit to using SBTs?</td>
<td>no</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How easily can they fit SBTs into their current methods?</td>
<td>Methods don't fit</td>
<td>Methods fit with major overhaul of methods</td>
<td>Methods fit easily</td>
</tr>
</tbody>
</table>

<p>| Methods fit with some changes to current methods | Methods fit with major overhaul of methods | Methods fit with | Methods fit easily |</p>
<table>
<thead>
<tr>
<th>Category</th>
<th>Negative Indicator of Adoption</th>
<th>Intermediate Indicator of Adoption</th>
<th>Positive Indicator of Adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who controls whether they use SBTs?</td>
<td>The University</td>
<td>The chairman</td>
<td>The faculty</td>
</tr>
<tr>
<td>Who would you first approach</td>
<td>No one</td>
<td>Friends</td>
<td>People in the community</td>
</tr>
<tr>
<td>How would they share the</td>
<td>Wouldn't share</td>
<td>Face-to-face interaction</td>
<td>Paper publication in a journal</td>
</tr>
<tr>
<td>information about SBTs?</td>
<td></td>
<td>In a faculty forum</td>
<td></td>
</tr>
<tr>
<td>Are open to changing their</td>
<td>Won't change</td>
<td>Changes only when forced to change</td>
<td>Changes all the time</td>
</tr>
<tr>
<td>teaching methods</td>
<td></td>
<td>Changes for their own convenience</td>
<td></td>
</tr>
<tr>
<td>Motivation for changing their</td>
<td>Someone else made them</td>
<td>To make life easier for the</td>
<td>To improve student learning</td>
</tr>
<tr>
<td>methods</td>
<td></td>
<td>instructor</td>
<td></td>
</tr>
<tr>
<td>Active participant in systemic</td>
<td>Does not participate in</td>
<td>Participates in only on a person</td>
<td>Participates on a national</td>
</tr>
<tr>
<td>planning</td>
<td>systemic planning</td>
<td>person to person basis</td>
<td>basis</td>
</tr>
<tr>
<td>Has control of own teaching</td>
<td>No Control</td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>methods</td>
<td></td>
<td>control</td>
<td></td>
</tr>
<tr>
<td>Interaction between research</td>
<td>All teaching and no research</td>
<td>Research and teaching both</td>
<td></td>
</tr>
<tr>
<td>and teaching</td>
<td></td>
<td>important</td>
<td></td>
</tr>
<tr>
<td>Additional resources</td>
<td>Teaching materials</td>
<td>People</td>
<td>Money</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Time</td>
</tr>
<tr>
<td>Category</td>
<td>Negative Indicator of Adoption</td>
<td>Intermediate Indicator of Adoption</td>
<td>Positive Indicator of Adoption</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------</td>
<td>-----------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Existing support</td>
<td>Teaching materials</td>
<td>People</td>
<td>Money</td>
</tr>
<tr>
<td>Understand what EDLs are</td>
<td>Have no idea</td>
<td>Think they are digital text</td>
<td>Think that the resources are digital and real resources</td>
</tr>
<tr>
<td>Use EDLs</td>
<td>Looked at them in the presentation only</td>
<td>Has contributed resources</td>
<td></td>
</tr>
<tr>
<td>How they heard about EDLs</td>
<td>Doesn't recall ever hearing about them, even after our meeting</td>
<td>From the researcher</td>
<td>From colleagues</td>
</tr>
<tr>
<td>How they tried EDLs</td>
<td>Haven't tried</td>
<td>Have looked for a few resources after our initial meeting, just to see what is there</td>
<td>Have looked through EDLs</td>
</tr>
<tr>
<td>How inclined are they to use EDLs</td>
<td>Not</td>
<td>Slightly</td>
<td>Only if they can find the time</td>
</tr>
<tr>
<td>Why they would use EDLs</td>
<td>They wouldn't</td>
<td>Someone else made them</td>
<td>It was convenient</td>
</tr>
<tr>
<td>Can they see a difference between EDLs and other methods?</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Do they see a benefit to using EDLs?</td>
<td>no</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>What are they looking for in EDLs?</td>
<td>text that has background information</td>
<td>interactive resources for student use</td>
<td></td>
</tr>
<tr>
<td>Category</td>
<td>Negative Indicator of Adoption</td>
<td>Intermediate Indicator of Adoption</td>
<td>Positive Indicator of Adoption</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------------------------------</td>
<td>-----------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>How easily can they fit EDLs into their current methods?</td>
<td>EDLs don't fit</td>
<td>EDLs fit with major overhaul of methods</td>
<td>EDLs fit easily</td>
</tr>
<tr>
<td>Who controls whether they use EDLs?</td>
<td>The University</td>
<td>The chairman</td>
<td>The department votes</td>
</tr>
<tr>
<td>Who would you first approach</td>
<td>No one</td>
<td>My friends.</td>
<td>People in my department</td>
</tr>
<tr>
<td>How would they share the information about EDLs?</td>
<td>Wouldn't share</td>
<td>Face-to-face interaction</td>
<td>In a faculty forum</td>
</tr>
<tr>
<td>What are the supports that they need for EDLs?</td>
<td>Teaching materials</td>
<td>A central group guiding them how to use EDLs</td>
<td>Tools</td>
</tr>
<tr>
<td>What supports exist for EDLs?</td>
<td>Teaching materials</td>
<td>People</td>
<td>Tools</td>
</tr>
</tbody>
</table>