Providing Content Based Professional Development for North Carolina High School Biology Teachers

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Abstract

In order to have an impact on teacher practice, professional development experiences must transform teachers' understanding about teaching and learning in ways that are closely connected to classroom practice (Ball & Cohen, 1999; Smith, 2001; Thompson & Zeuli, 1999). The Fayetteville State University Statewide Institute for Teaching Excellence in Biology, supported by the North Carolina Mathematics and Science Education Network, is a professional development program designed to improve the teachers' ability to implement the NC Standard Course of Study objectives in science and teach science with enhanced understanding of content and instructional strategies to engage students. In order to meaningfully change teachers' beliefs and practices transformative experiences that allow teachers to re-examine are required (Thompson & Zeuli, 1999). Therefore, the Institute was evaluated for changes in teachers' content knowledge through (a) pre/post content test and (b) classroom practice through an implementation survey, implementation project and effectiveness survey.

Key words: Practice-Based Teaching Model

1. INTRODUCTION

The North Carolina Mathematics and Science Education Network (NC-MSEN) was established by the North Carolina State Legislature in 1984. The goals of the network are to strengthen the quality and increase the size of the teaching base in mathematics and science education. In 1997, the University of North Carolina Center for School Leadership Development (UNC-CSLD) was established and NC-MSEN was placed under its administrative umbrella along with other programs of the UNC system that provide services to K-12 education. The Network currently has one educational research center at North Carolina State University and 10 professional development centers located at Appalachian State University, East Carolina University, Fayetteville State University, North Carolina A&T University, North Carolina School of Science and Mathematics, University of North Carolina Chapel Hill, University of North Carolina Charlotte, University of North Carolina Wilmington, Western Carolina University, and Winston Salem State University.

In order to have an impact on teacher practice, professional educational learning experiences must transform teachers' understandings about teaching and learning in ways that are closely connected to classroom practice (Ball & Cohen, 1999; Smith, 2001; Thompson & Zeuli, 1999). This notion stands in contrast to typical teacher education experiences, which have taken a theory-into-practice approach (Leinhardt, Young, & Merriman, 1995, Cochran-Smith & Lytle, 1999).

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In this view, the education of teachers is aimed at introducing them to theories of teaching and learning, leaving the matter of determining how to apply these theories to the practice of teaching largely unaddressed.

NC-MSEN has recently initiated a series of "Statewide Institutes for Teaching Excellence" or "SITE institutes." These professional development programs will accomplish NC-MSEN goals by improving teachers' abilities: (1) to implement the NC Standard Course of Study (NCSOS) in science or mathematics, no matter what materials are used in a given school; (2) to teach science or mathematics with better understanding of the content and appropriate instructional strategies to engage students actively in the content; and (3) to increase literacy, student interest, and student motivation to enter STEM careers. In the fall of 2006, NC-MSEN and the North Carolina Department of Public Instruction (NC-DPI) partnered to plan, develop, implement and evaluate a SITE institute for high school biology teachers. SITE: Biology institutes were designed to help teachers more effectively implement the NC Standard Course of Study in biology. The institute's content targeted specific NCSOS objectives on which students performed poorly on end-of-course tests.

Furthermore, the institute integrates reading strategies, misconception awareness and concept mapping, as instructional tools to assist the learning process. SITE: Biology is a work in progress and its development to date has been the labor of many excellent North Carolina science educators. The development of SITE: Biology was prepared under the direction of the Science and Mathematics Education Center at the University of North Carolina Wilmington. Support for the development of the SITE: Biology modules were provided by the North Carolina Department of Public Instruction. SITE Biology is aligned with state content standards for biology and also with national standards in the American Association for the Advancement of Science's "Benchmarks for Scientific Literacy."

Fayetteville State University (FSU) is a public comprehensive regional university offering degrees at the baccalaureate, masters and doctoral levels. It is one of sixteen constituent Universities and Colleges within the University of North Carolina (UNC) System. FSU is the 2nd oldest state-supported university in North Carolina. FSU is located in the southeastern region of North Carolina serving Cumberland and five bordering counties (Harnett, Sampson, Robeson, Hoke and Bladen). Approximately half of the FSU student body comes from Cumberland County. Cumberland and the surrounding five counties are less prosperous than the State in general. Only 12.3% of NC residents live below the poverty level, while 12.8% of Cumberland County residents; 14.9% of Harnett; 17% of Sampson; 17.7% of Hoke; 21% of Bladen and 22.8% of Robeson live below the poverty level. The SITE: Biology institute offered at FSU was unique in that participating teachers represented counties with a large minority population and low socioeconomic status. In addition, students from these counties represent a large percentage of the student population at FSU (Table 1).

During the five-day institute, teachers were introduced and/or reviewed the following modules: Energy and Matter, Evolution and DNA. Each module was comprised of a series of introductory lectures supported by hands-on wet and dry laboratory activities. Furthermore, the institute integrated reading strategies, misconception awareness and concept mapping, as instructional tools to assist the learning process. Concept Maps were used as the pedagogical tool for reinforcing key biological concepts.

2. METHODOLOGY

Pre/Post Content Test

The Pre/Post Content Test were prepared by East Main Educational Consulting. The pre-test was administered on-line by East Main Educational Consulting prior to the start of the institute. The post-test was administered by the FSU Site Biology Instructors on the last day of the institute. Participants were asked a series of questions related to the content that would be covered during week long workshop. Eleven of the nineteen participants took the pre-test and fifteen of the nineteen participants took the post-test.

Institute Effectiveness Survey

Institute participants were asked to rate 11 statements using a six point Likert-scale ranging from strongly agree to strongly disagree. They were also asked to rate the quality of the course (excellent to poor) and if they would recommend the course to others (yes/no). Limited choice questions were included to capture participants' judgments about what they were "better prepared to (do)" and what they "plan to do" in the classroom as a result of completing the summer workshop. Another limited choice question asked participants to identify the most valuable aspect of the course. Participants were given the option to choose "other" if they believed the most valuable aspect was not among the limited choices.

Finally, open-ended questions asked participants how they learned of the course, possible barriers to implementation, and recommendations to improve the course.

Classroom Practice through Implementation Survey

Surveys were administered in December 2007 and May 2008. Survey results will be used to determine if any extended effects of the institute are evident as determined by implementation of classroom activities and laboratory experiments presented during the institute.

Lesson Implementation Projects

Teachers were asked to submit a reflective paper about how their content knowledge has increased/grown as a result of the FSU's SITE: Biology institute and how it has affected their teaching. In addition teachers also prepared a lesson plan using activities covered during the institute.

3. RESULTS

FSU's SITE: Biology institute's impact was evaluated for changes in teacher content knowledge through pre/post content tests, classroom practice through an implementation survey, implementation project and institute effectiveness survey. The pre and post content test were administered on day 1 and 5 respectively. Each test contained the same questions (Total = 29). Teachers scored 82% and 81% on the pre and post test (Table 2).
The institute effectiveness survey was administered to each participant enrolled in the SITE biology workshop offered at FSU. The survey response rate was calculated by dividing the number of participant responses by the participant population. Participants rated eleven statements using a six point Likert-scale ranging from strongly agree to strongly disagree (Table 3). Additionally limited choice questions were included to capture participants' judgement regarding: What they are "better prepared to do" in the classroom after completing the institute; What they "plan to do" in the classroom after completing the institute (Figure 1A & B) and The "most valuable" aspect of the institute (Figure 2). Open-ended questions were given that asked participants of possible barriers to implementation of activities (Figure 3).

Participants submitted artifacts as evidence of implementation of the topics/activities covered in SITE: Biology. An example of a Teacher Lesson Plan for Evolution and DNA:

Day One: Review of Aerobic Respiration

- Materials used: Chickpeas 100 per group with 50 soaked, bromothymol blue, 250 mL Erlenmeyer Flasks 3 per group, small test tubes 3 per group, dry paper towels folded in fourths and placed in the bottom of all three flasks.

Day 2: Review Fermentation

- Students set up the lab. Day 2 for this lab—students measured lengths, performed calculations and recorded aerobic respiration data.

Day 3: Photosynthesis

- Independent Practice: Students set up the lab as described in your handouts—except I had each group work on one distance and then they pooled their data at the end of class.

Figures 4A & B provide student responses to content covered under Module II: Evolution and DNA. Artifcat A (Figure 4A) demonstrates that this student has some understanding with translation and transcription but based on teach evaluation appeared frustrated and towards the end of the assignment made errors. Artifact B (Figure 4B) demonstrates that this student did not fully understand that during transcription thymine (DNA) is replaced by uracil (RNA) and paired with adenine.

4. CONCLUSIONS AND RECOMMENDATIONS

The FSU SITE Biology professional development consisted of two modules: (i) Energy and Matter and (ii) Evolution and DNA. Each module was comprised of a series of introductory lectures, by faculty members, and supported by hands-on wet and dry laboratory activities. The institute integrated reading strategies, misconception awareness and concept mapping.

Weaving Unifying Concepts into the Curriculum

Teachers reviewed a unit in groups to produce concept maps on how topics in the unit connect to the unifying concepts. Once this task was completed the teachers posted the unifying concepts for each day on posters throughout the classroom and added additional topics to the posters during the institute.

The posters were used to review biology content at the end of the institute to show progress in understanding key concepts reviewed/discussed during the institute.

Benefits to Teachers

Concept maps are valuable tools to teachers because they provide information about students' understanding. Teachers can examine how well a student understands science by observing the sophistication of their concept map. Highly sophisticated concept maps show highly integrated knowledge structures. Concept maps can be used as an instructional as well as an assessment tool.

Classroom Practice through Implementation

Participants of the FSU SITE Biology reported that the professional development changed their approach to teaching by (a) providing basic fundamental ideas to teach a curriculum with a hands on approach; using the resources provided and a mastery of the content to properly align their curriculum with that of the North Carolina Standard Course of Study; (b) the lab experiences and techniques taught will result in more project based learning with participants more prepared to utilize teaching strategies involving labs, safety and time management; (c) the opportunity to take a visual approach to grasp a keener understanding of the North Carolina Standard Course of Study by creating a more cohesive lesson that will surpass the primary objectives to be taught.

Professional development experiences aimed at practicing teachers have typically consisted of isolated episodes that are often elective and focused on teaching tips, tricks, new curriculum materials, or specific procedures that the instructor is advocating (Smith, 2001; Remillard & Geist, 2002). These types of experiences are designed to be additive in nature, grafting new knowledge and practices into teachers' existing classroom practice (Thompson & Zeuli, 1999). However, in order to meaningfully change teachers' beliefs and practices, transformative experiences that can give teachers cause to re-examine their beliefs and practices with respect to teaching and learning are required (Thompson & Zeuli, 1999). As a result of participating in the institute, a vast majority (89%) of the teachers would recommend the institute to others, and believed the most valuable aspects were the peer interaction, hands-on labs and problems, and the activities to bring back to their classrooms. Teachers did note barriers to classroom implementation including a lack of technology/materials, time, and money, and a discrepancy between the content level and student ability.

5. REFERENCES

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6. TABLES AND FIGURES

Table 1. 2006-2007 Performance on End of Course (EOC) Exam for Surrounding Counties

County	EOC Biology	Economically Disadvantaged
Cumberland	58%	50.2%
Harnett	58%	50.9%
Sampson	49%	48.1%
Robeson	71%	53.4%
Hoke	55%	43.0%
Bladen	42%	39.6%
State of NC	65%	50.7%

Table 2A. Independent Sample Pre/Post Content

	N	mean	SD	Sig. (2-tailed) (= var assumed)		
Pre-Test	11	23.82	4.708	0.864		
Post-Test	15	23.53	3.662			

Table 2B. Paired Sample Pre/Post Content Test

N	Mean (pre)	Mean (post)	SD (pre)	SD (post)	Sig. (2-tailed)
10	**23.4**	**23.3**	**4.742**	**3.974**	**0.903**

Table 3. Institute Effectiveness Survey

Statement	mean	SD
The course met my professional expectations in this content area.	3.2	0.97
The sequence of lessons supported my learning.	3.7	1.12
The course stimulated my thinking about the content of biology.	3.8	0.97
The instructional methods used in this course facilitated my learning.	3.4	1.42
The course materials enhanced my learning.	3.8	1.09
Interaction with classmates assisted with my learning.	4.0	1.41
Course assignments were instrumental to my learning.	3.1	0.93
The course material was presented at an appropriate level.	3.6	1.33
My in-class questions were adequately addressed by the instructor.	4.2	0.83
I was encouraged to take responsibility for my own learning.	4.0	0.86
I was encouraged to participate actively.	4.1	0.93
The overall quality of this course was...	3.8	1.20

Figure 1A.

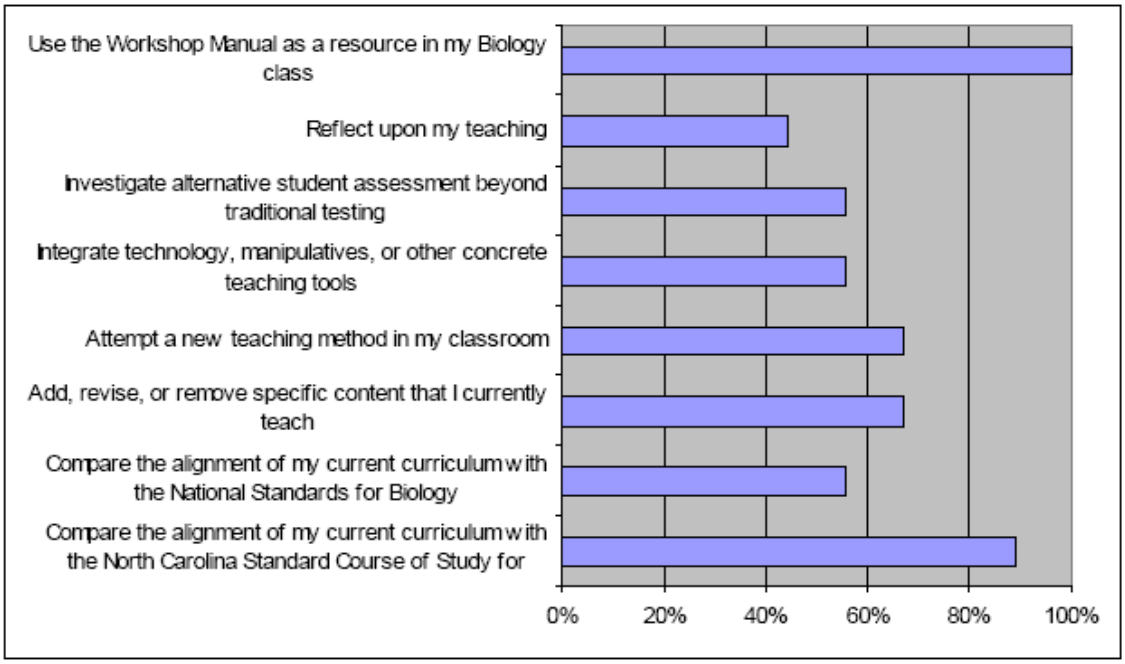


Figure 1B.

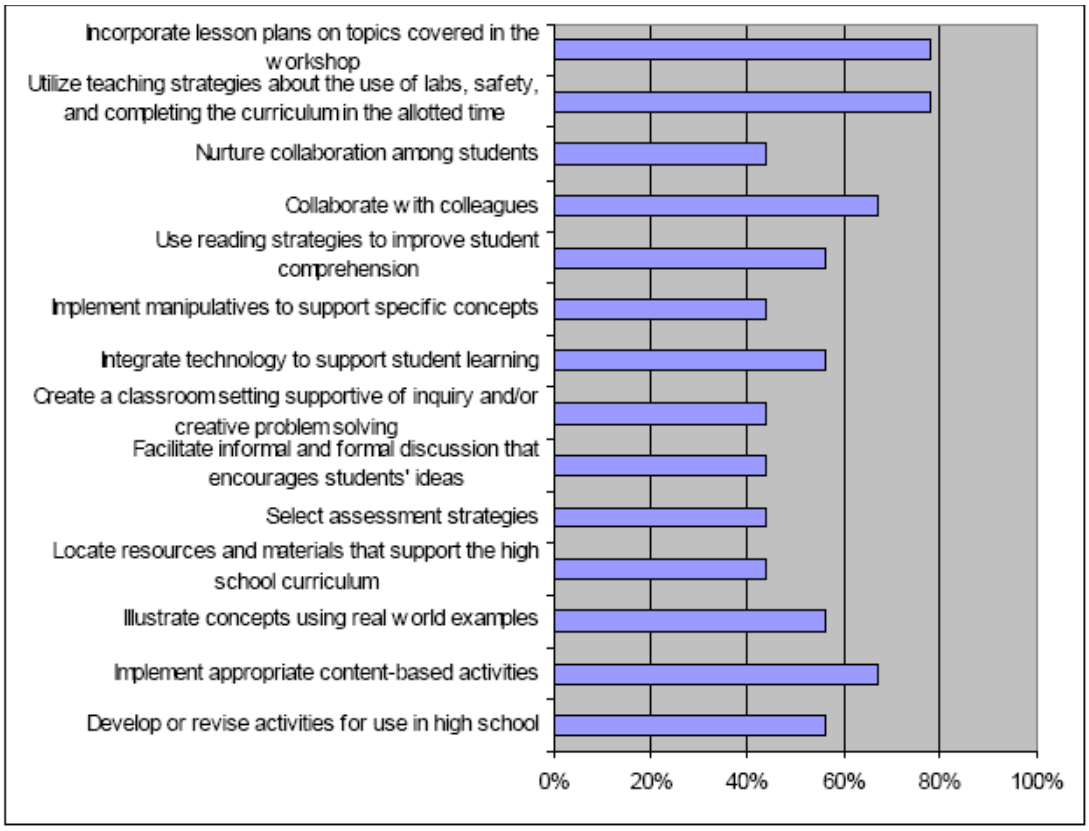


Figure 2. Most Valuable Aspects

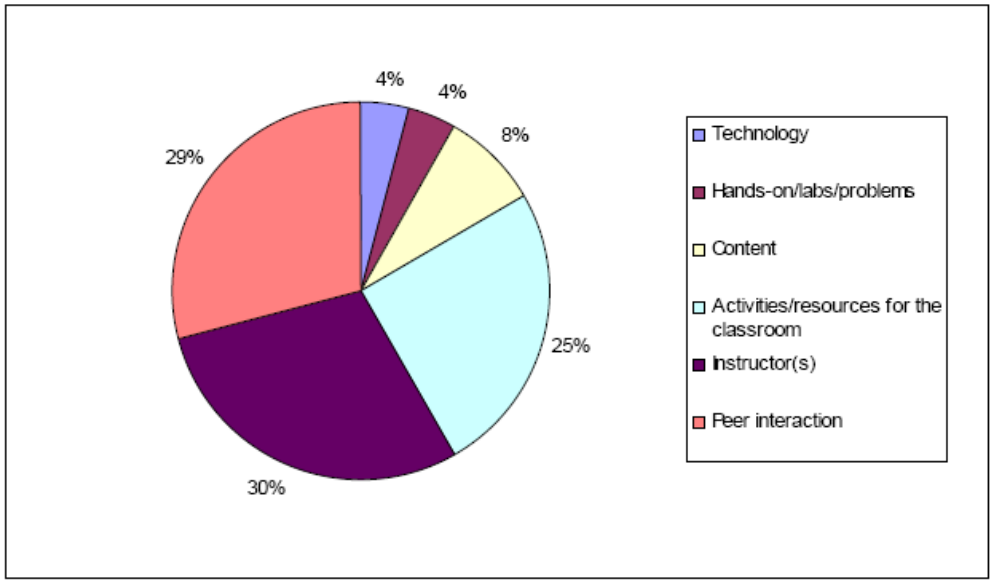


Figure 3. Barriers to Implementation

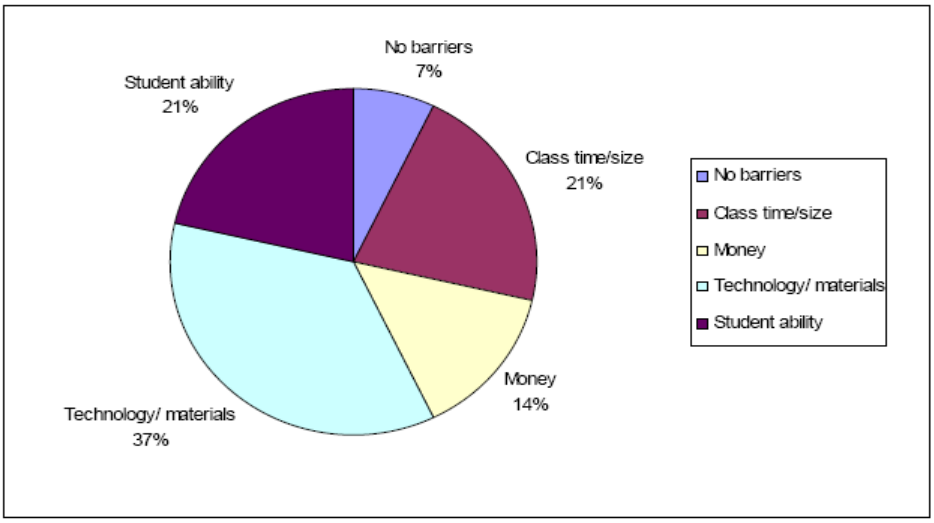
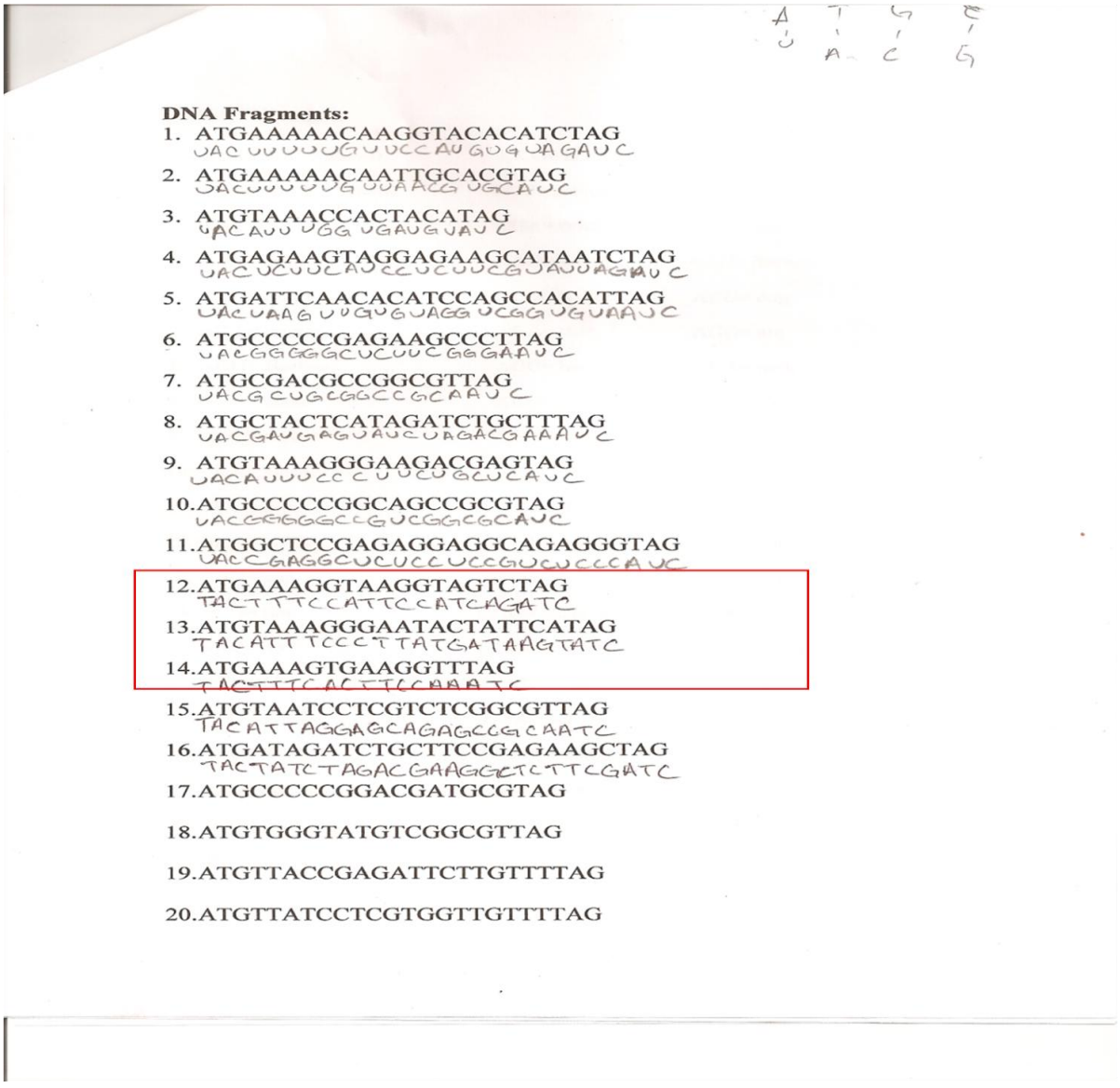


Figure 4A. Implementation Project (Student Response)



DNA Fragments:

1. ATGAAAAACAAGGTACACATCTAG
2. ATGAAAAACAATTGCACGTAG
3. ATGTAAACCACTACATAG
4. ATGAGAAGTAGGAGAAGCATAATCTAG
5. ATGATTCAACACATCCAGCCACATTAG
6. ATGCCCCCGAGAAGCCCTTAG
7. ATGCGACGCCGGCGTTAG
8. ATGCTACTCATAGATCTGCTTTAG
9. ATGTAAAGGGAAGACGAGTAG
10. ATGCCCCCGGCAGCCGCGTAG
11. ATGGCTCCGAGAGGAGGCAGAGGGTAG
12. ATGAAAGGTAAGGTAGTCTAG
13. ATGTAAAGGGAATACTATTCATAG
14. ATGAAAGTGAAGGTTTAG
15. ATGTAATCCTCGTCTCGGCGTTAG
16. ATGATAGATCTGCTTCCGAGAAGCTAG
17. ATGCCCCCCGGACGATGCGTAG
18. ATGTGGGTATGTCGGCGTTAG
19. ATGTTACCGAGATTCTTGTTTTAG
20. ATGTTATCCTCGTGGTTGTTTTAG

Figure 4B. Implementation Project (Student Response)