

An Exploratory Test of a Model for Enhancing the Sustainability of NSF's Advanced Technological Education (ATE) Program

Wayne W. Welch  
University of Minnesota

October 2014 (Revised January 2015)

Author Note

Wayne W. Welch, Department of Educational Psychology, University of Minnesota (ret.). Professor Welch is also a consultant for Rainbow Research, Inc., Minneapolis, MN.

Acknowledgements

Rainbow Research, Inc. served as the administrative group for my NSF grants and I appreciate their assistance. Thanks to Frances Lawrenz and Nanette Keiser for their thoughtful work in developing the model for ATE sustainability used in this research. Thanks also to Lori Wingate, PI of the EvaluATE project, and Arlen Gullickson, PI of the prior ATE evaluation project, for making their survey data available to me. I also want to thank Elizabeth Teles and Frances Lawrenz for reviewing a draft version of this report.

This is my 10th and final report of my two NSF Targeted Research grants to study the impact and sustainability of the ATE program. During that time, I have received valuable assistance from my advisory committee and I wish to express my appreciation to them and to my program officers at NSF.

Ron Anderson, University of Minnesota (ret.)  
Elaine Craft, ATE South Carolina Center of Excellence  
Arlen Gullickson, Western Michigan University  
Frances Lawrenz, University of Minnesota  
Liesel Ritchie, University of Colorado  
Elizabeth Teles, Teles Consulting LLC.  
Gerhard Salinger, NSF (2008–2014)  
Connie Della-Piana NSF (2014)

Finally, thanks to my wife, Jerry, for reviewing draft reports and being there to listen to me talk about research findings and those annoying data problems.

This material is based upon work supported by the National Science Foundation under Grant No. 1132099. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

Correspondence concerning this report should be addressed to Wayne Welch, 621 W Lake South # 300, Minneapolis, MN 55408. Contact: [wwelch@umn.edu](mailto:wwelch@umn.edu)

## Abstract

Lawrenz, Keiser, and Lavoie (2003) conducted an extensive review of the literature on models of sustainability and organizational change and found there was little research on the topic. For the most part, the models were merely advocacy statements based on author experience. No empirical evidence was found to show that the models were useful in predicting sustainability.

The development of a survey designed to measure the sustainability of the Advanced Technological Education (ATE) program (Welch 2011a) provided an opportunity to test these models to determine if the elements of a model were related to sustainability success. I used the sustainability scores to test a model proposed by Lawrenz and Keiser (2001). Their model was based on a literature review, site visits, and their considerable experience of the ATE program.

The model is a list of seven elements they considered important for successful ATE sustainability. These elements are, widespread participation; abundant information; adequate resources; knowledge and skills/training; distributed power; broaden base; coordination with current initiatives and administrative support; and promotion and marketing.

I selected indicators for each of these elements from an annual survey administered to all ATE grantees. The indicators were then correlated with scores on the ATE Sustainability Survey to determine if these elements were related to the survey scores. I used effect size (Cohen, 1988) to indicate the magnitude of the relationships.

I found that four of the model elements were moderately related to sustainability, that is, the effect sizes were between .50 and .80. These elements were staff preparation (.71), adequate resources (.58), fit with current initiatives (.56), and widespread participation.

Promotion and marketing (.41) and distributed power (.31) were slightly related to scores on my sustainability measure while abundant information (.00) was not related. Implications of the findings and limitations of the study were proposed.

## Introduction

The purpose of this research is to examine the effectiveness of a model that purports to improve the sustainability of ATE projects and centers. According to Lawrenz, Keiser, & Lavoie (2003), several models for sustainability have been proposed in the organizational change literature. However, for the most part, the models are advocacy statements based on author experience rather than on empirical studies. These authors concluded there was little research directly related to sustainability.

I examined the more recent literature on sustainability models and found little to contradict the conclusions reached by Lawrenz, et al. I did find an extensive study of the sustainability of NSF's Industry/University Cooperative Research Centers (Gray, Tornatzky, & McGowan, 2012). The program is funded by the Engineering Directorate of NSF and is more than 30 years old. They found that roughly two-thirds of the Centers started by this program were still operating. I would judge this to be a sustainability success story for NSF.

This program did not have a model for sustainability when they started, but they did identify some of the factors related to the sites that continued their work after NSF funding ended. They concluded centers were more successful if they had high research productivity (as measured by publishing rates), had a significant positive impact on their members, provided members access to valuable human capital in the form of Center trained graduate students, and whose directors were not distracted by non-Center administration and other tasks (McGowan, 2012).

I have conducted several studies of the sustainability of the ATE program and used a framework to identify places where sustainability evidence might be found, for example, changes in faculty behavior or collaborations with local businesses. See for example, (Welch, Measuring the sustainability of the advanced technological education (ATE) program, 2012)

The only other NSF sustainability study, I am aware of, is a recent grant to Westat, Inc. to study the factors related to the sustainability of the Math and Science Partnership (MSP) program (National Science Award #1321306). I do know they are developing a logic model to guide their study, however, the project is in its early stages, and results are not yet available.

In the present study, I start with a model for ATE sustainability and determine if there is a relationship between the elements of that model and an empirical measure of sustainability. After several considerations, and the advice of my advisory panel, I decided to use the model proposed by Lawrenz & Keiser (2001) entitled "Sustainability: Increasing the Likelihood of a Long Term Impact by the ATE program. It was specifically developed for the ATE program, and it matched well with information gathered of an annual survey of ATE conducted by Western Michigan University (WMU).

The Lawrenz/Keiser (L/K) model/framework was based on an extensive review of the literature, ATE site visits, and the author's considerable experience with the program (Lawrenz & Keiser, 2001). The model is an explanatory list of seven factors or elements they consider important to ensure that the work started by an NSF/ATE grant is continued in some form after federal funding ends.

The seven elements of their model are listed below. The name in the parentheses is a one or two word descriptor for each element.

1. Widespread participation. (Collaboration) This element refers to a large number of relationships among members of a project/center and the various groups with which it works.
2. Abundant information. (Information) The model states that ATE sustainability will be enhanced if there is information available to help determine if the activities are worth sustaining, to decide how to continuously update and improve the projects, and reward behaviors aiding the project.
3. Adequate Resources. (Resources) This factor refers to the need to have the necessary fiscal resources to adequately implement and sustain an ATE project or center.
4. Knowledge and Skills/Training (Preparation). To be successful, a project or center must provide students and faculty with the knowledge and skills required to achieve project goals.
5. Decision Making/Distributed Power. (Broaden Base) The project must develop wide participation and share power so everyone involved feels responsible for the project.
6. Coordination with Current Initiatives. Administrative Support. (Institutionalization) It is necessary to fit the project into other institutional goals and initiatives and use existing institutional processes to meet project needs
7. Promotion and Marketing. (Dissemination). The team should market the project's value and target resources to help it be flexible to meet the changing needs of students.

Information on these elements was sought from the 2010 survey of ATE Projects and Centers conducted by Western Michigan University (WMU). (Wingate, Westine, & Gullickson, 2011) This annual survey requests information from ATE PIs on a variety of topics concerning the ATE program. Several of the questions pertain to the elements of the L/K model and were used as indicators for each of the seven elements.

This research is a secondary analysis of existing data. As such, I needed to work with what was available. I examined the WMU data file to select the most appropriate indicator for each element. In most cases, this was straightforward. Lawrenz and Keiser were helpful here because they provided descriptive information about the element. I used this information to select an indicator that seemed the best match to each element.

The measure of ATE sustainability was a survey created during a Targeted Research Project funded by the National Science Foundation (Welch, The sustainability of the advanced technological education program, 2011a). The survey was developed using a process I called peer generated item development. Statements about sustainability were solicited from a group of PIs about their own ATE projects and centers. Following a review process using ATE PIs and measurement experts, these statements became Likert-type items on an ATE Sustainability

Survey. This format requires the eventual respondents to express their degree of agreement or disagreement with each statement. Scores can be computed on an item by item basis (reported as the percent of respondents agreeing with a statement) or total survey scores can be calculated. Further information on the development and analysis of this survey is available in the reference cited above.

The ATE sustainability survey has been shown to have content validity. It has high reliability and discriminates among groups, for example, between projects and centers or between two- and four-year colleges. In addition, a replication study has increased the confidence one has that it is a true measure of the concept (Welch, A Replication Study of the Advanced Technological Education (ATE) Sustainability Survey, 2014).

### **Method**

The steps in my research were to describe the factors of the model, select indicators of these factors, and then empirically determine if those factors were related to the survey scores. Scores on the sustainability survey were correlated with the indicator values for each of the seven elements.

I used Pearson's product-moment correlation coefficient  $r$  to compare the sustainability scores with my indicators for each element of the model. Although several of the indicators were not normally distributed, Pearson's product-moment correlation is robust when the sample size exceeds 30 – 40 subjects (Elliott & Woodward, 2007). My sample exceeded 100 for all but one of the comparisons I made, so I felt comfortable using a parametric statistic such as Pearson's  $r$ . This also made it possible for me to compute effect sizes for the relationships between the indicators and the sustainability scores.

### **Elements of the model and the indicators for that element**

The elements of the Lawrenz/Keiser model are listed below along with the indicators I selected for each element. I computed the frequency distribution of these indicators and used this information to identify non-normal distributions and/or outliers. The correlations between scores on the Sustainability Survey and indicators for each of the seven elements were computed and reported.

**Widespread Participation** (Collaboration). The authors suggest that one indicator of this element is the number of collaborations a project or center has. They believe the more people and groups involved in a project; the more likely its work will continue after NSF funding ceases.

The WMU survey contained questions on the number and types of collaborations. A "collaboration" was defined as a relationship with another institution, business, or group that provides money and/or other support to a project or center. Five types of collaborating organizations were listed along with a category for "Other." Examples here included business/industry, other ATE grantees, and groups within the host institution. I summed the

responses to these options to calculate a Total Collaboration score, which served as my indicator for this element.

There were 104 cases where sustainability scores were available from my survey and participation information was available from the WMU survey. I computed the frequency and summary statistics for each variable. The mean score for these cases on the Sustainability Survey was 74.1 with a standard deviation of 17.9. This is similar to the results I obtained for my total population of 212 respondents. There, the mean was 74.5 and the standard deviation was 17.2. The survey scores were normally distributed. The ATE sites where I had both a Total Collaboration score and a Sustainability score appear to be representative of my total population.

I examined the distribution of the Collaboration scores and found the distribution was skewed to the right. There were three outliers; that is, scores that were more than three standard deviations from the mean. I excluded these cases for my calculations leaving a sample size of 101. The skewness index dropped from 3.1 to 1.7, which is considered acceptable. The mean number of collaborations was 30.1 per grantee. The standard deviation was 35.1.

I computed a Pearson product moment correlation between the number of collaborations and the scores of the sustainability survey and obtained a value of .25. This translates to a Cohen d effect size (ES) of .51. This is considered a medium effect by (Cohen, 1988). He suggests the following: an ES of .20 is considered, small; .50 is medium; and .80 is large (Howell, 2011).

The analysis of this element supports the contentions of Lawrenz and Keiser that widespread participation as measured by the total number of collaborations is important in sustaining an ATE project or center.

**Abundant Information** (Information). The model states that ATE sustainability will be enhanced if there is adequate information available to determine if the activities are worth sustaining, to decide how to continuously update and improve the projects, and reward behaviors aiding the project. I examined the WMU survey to determine which items were indicators of a project possessing the information necessary to effectively implement its grant.

The ATE annual survey included items on the percent of budget that was devoted to evaluation, advisory committees, and internal research on project activities. All of these should provide information that projects can use to implement their work effectively. I summed these three percents and used the total percent of the budget devoted to information gathering activities as my indicator for Element 2.

There were 103 sites that had Sustainability Scores and scores for Abundant Information. I examined the frequency distribution of my information variable. I excluded two outliers that were more than three standard deviations from the mean. The mean of the remaining 101 cases was 12.3% and a standard deviation of 8.8%. The percent of the budget spent on information gathering activities ranged from 0% to 49%.

The Pearson correlation between the Sustainability Scores and the Abundant Information variable was .003; that is, there was no relationship between the two. Thus, the claim that

abundant information is important for sustaining the work of an ATE project was not supported for this analysis, at least for the indicators I used.

**Adequate Resources (Resources).** This factor refers to the need to have the necessary fiscal resources to adequately implement and sustain an ATE project or center. I selected three variables from the WMU data: the NSF grant amount, institutional monetary support, and in-kind support. I summed these three variables to create an indicator for adequate resources.

The mean for the total resources indicator was \$1,067,509 with a standard deviation of \$1,101,775. The minimum and maximum values were \$77,482 and \$7,500,000 respectively. The scores were skewed toward the right but with a sample size of 110, this should not be a problem.

There were three outliers, that is, they were more than three standard deviations above the mean and were excluded from the analysis. The correlation between the Sustainability Scores and the Adequate Resources indicator was 0.28. The Cohen *d* effect size for an *r* of this size is .58, above the generally accepted standard for a medium effect. These findings support the claims of the model that having ample resources will enhance the likelihood of sustaining an ATE grant after NSF funding ends.

**Knowledge and Skills Training (Preparation).** This element refers to the need to have well prepared and competent people implementing a project or center. One way to do this is to have an effective staff development program. One question on the WMU survey requested information on the number of staff development activities implemented, for example, attendance at a conference, site visits to other programs, or participation in a short-term workshop.

Nine possible staff development activities were listed. Respondents were asked which of these their project/center faculty and staff engaged in under ATE support. I created a staff development indicator by summing the number of activities that staff participated in under ATE support. This indicator is based on the belief that the more staff are involved with professional development activities, the more effective they will be.

I show the distribution of the staff development indicator, which I called SumStaffDevelop, in Figure 1. Note the scores are normally distributed. Their mean is 3.79 and the standard deviation was 1.35. The range was one to seven out of the nine possibilities.

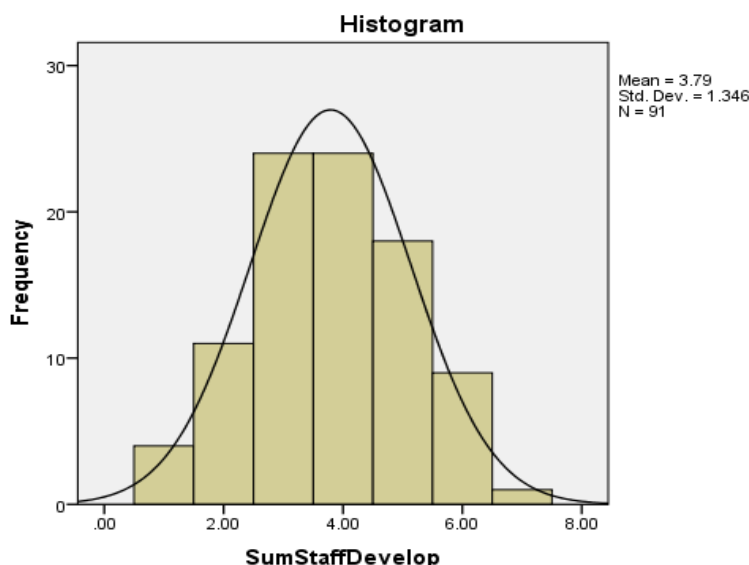


Figure 1. Distribution of the sum of staff development opportunities for ATE projects and centers.

I correlated the Sum Staff Development scores with the scores on the sustainability survey and obtained an  $r$  of .34 ( $n = 91$ ). This indicates a strong relationship between the staff development indicator and sustainability. The equivalent Cohen  $d$  was .71 generally considered a large effect size. The relationship predicted by the Lawrenz/Keiser model is supported by this analysis.

**Distributed Power/Decision Making (Broaden Base).** The model postulates that a project/center is more likely to be sustained if a large number of people and institutions are involved in the work of the grantee. A site that is working with 20 institutions to provide instruction would seem to have a larger number of people involved in the decision making process than would a site that was working with just 2 or 3 institutions. In addition, arranging for such programming would involve shared decision making between the location and the ATE project/center.

Sixty-eight (68) projects and centers were involved with a project/center by agreeing to offer ATE programming at their site. The average number of off-site locations where programming was offered was 6.9 per grantee. The range was one to 60. The correlation between the number of locations and the project's sustainability score was .16. This corresponds to an effect size of .32. This is about midway between the small and moderate rating according to Cohen.

## 6. Coordination with Current Initiatives. Administrative Support.

(Institutionalization). A key way to sustain a project is to institutionalize it. I could not find an item in the WMU data that seemed an appropriate indicator. However, I did have an item from a survey I did on the impact of an ATE grant. This survey was administered at the same time as the sustainability survey. It read, "Our ATE project/center is isolated (antonym: linked) to the rest of the college." The distribution of the responses is shown in Figure 2.



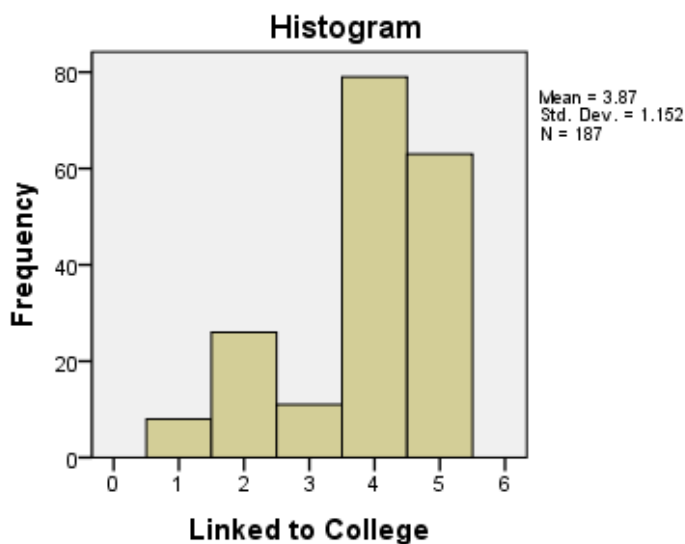


Figure 2. *Distribution of dissemination efforts*

The response options ran from Strongly Disagree to Strongly Agree and they were coded 1 to 5. I correlated these responses to the sustainability scores reported by those same sites and obtained a Pearson product moment correlation of 0.27. This translates to an Effect Size of .56 suggesting that institutionalization as measured by this indicator is an important component for sustainability.

**7. Use of Promotion and Marketing (Dissemination).** According to the model, projects and centers are more likely to be sustained if they have a dissemination and marketing plan. They need to publicize the value of their work, take advantage of unforeseen opportunities, and keep the need for sustainability at the forefront of their work.

The WMU survey contained a question that asked respondents to describe how the projects or centers would be sustained beyond the end of the grant funding. Six different options were presented and ATE team leaders were to check all strategies used by their project. For example, one option was to develop a business entity, while another was to use the activities and results of the current project to develop a new grant proposal.

I summed the number of options marked by respondents to create a dissemination and marketing score called Market/Disseminate. One hundred nine (109) ATE team leaders had completed the Sustainability Survey and provided marketing information on the WMU survey a year later. The mean number of dissemination and marketing activities was 2.2 with a standard deviation of 1.0. The responses were normally distributed.

I correlated my indicator of dissemination with scores on the Sustainability Survey and obtained a Pearson  $r$  of .20. An  $r$  of .20 is equivalent to a Cohen's effect size of .41. This is just below the standard of .50 for a medium effect (Cohen, 1988). This finding supports the relationship between sustainability and marketing and dissemination as predicted by the model.

### Findings and Limitations.

This was an exploratory study of the effectiveness of a model in identifying those factors to consider when planning to enhance the sustainability of the ATE program. The table below summarizes the findings for each of the seven elements of the Lawrenz/Keiser model.

Table 1. Summary of relationships between sustainability scores and model elements

Model Element	Indicator	Effect Size
Widespread Participation	Number of collaborations	.51
Abundant Information	Budget for evaluation, advisory committees, and internal research	.00
Adequate Resources	Amount of NSF grant	.58
Knowledge and Skill Training	Number of staff development activities	.71
Distributed Power/Decision Making	Number of locations where ATE programming is offered	.32
Fit to Current Initiatives, Administrative Support	Degree to which ATE project is linked to other college efforts	.56
Use of Promotion and Marketing	Number of dissemination efforts used by a project/center	.41

In general, the predictions of the Lawrenz/Keiser model of ATE sustainability were supported. Four of the indicators reached the medium level effect size and two were rated midway between small and medium. One indicator, Abundant information, was not correlated with the ATE Sustainability scores.

This last finding is interesting. One might assume that the more information a project/center has, the better they could ensure continuation of their work. Recall the indicator was the percent of budget a site allocated to three information gathering activities; evaluation, internal research, and advisory committees. That seems a reasonable indicator to me, but it is a secondary factor in implementing a project. That is, the site might have the information but may not know how to use this information. Perhaps there is a disconnect between having the information and putting it to use.

The element that had the highest effect size was staff preparation; the more professional development of the staff, the higher the scores on the Sustainability Scale. I would think this finding would be useful for NSF and for the grantees as well. As I wrote this, I recalled Lawrenz and Keiser making the same point in their report back in 2001. They urged the Foundation to pay attention to preparing their grantees for successfully implementing ATE projects and centers. The Foundation does have an annual PI meeting where training opportunities are provided and grantees are brought together to share ideas. This is one staff development process but given the importance of this element in enhancing sustainability, it may be appropriate for the Foundation to provide other opportunities. For example, develop a checklist or brochure for PIs that outlines

successful procedures for enhancing ATE sustainability.

Other indicators related to the successful continuation of work started under an ATE grant are Adequate resources, Institutionalization, and Collaboration. All had effect sizes of .50 (medium relationships) or greater. These are areas that ATE PIs need to address in order to enhance the likelihood that their work will be sustained.

I found that the dissemination/marketing and shared decision-making elements of the model had smaller effect sizes but still were related moderately to effective sustainability. Only the indicator for adequate information was not related to scores on the sustainability survey.

An important fact to remember is the data of this analysis were drawn from two different studies. The data were gathered on different instruments from different researchers at different times (but within the same year), yet many relationships were found between the two studies. This speaks well for the success of the model. However, the study would need to be replicated using pre-determined indicators to determine if the findings are confirmed.

This study has several limitations including those inherent in any secondary analysis of data. One must use what is there instead of using measures specifically designed to gather the information of interest. Future research should select a set of valid indicators and then gather data on them to assess the relative importance.

This study might be strengthened if a multiple regression approach was used where all seven elements are considered simultaneously. However, this is beyond the scope of the present study. In addition, the people who responded for each correlation were different to some extent. A regression or path analysis would require that the same group answered all the indicators used and this was not the case. A study designed to repeat this analysis would want to plan the data gathering so this kind of analysis could be done.

This was an exploratory study to determine if a model for ATE sustainability could be tested empirically to provide validity information for the model. The preliminary findings were positive; the model did provide useful information, however additional work needs to be done to support that conclusion.

## References

- Bishara, A., & Hittner, J. (2012). Testing the significance of a correlation with non-normal data: Comparison of Pearson, Spearman, transformation, and resampling approaches. *Psychological Methods*, 399-417.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd. ed.)*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Elliott, A., & Woodward, W. (2007). *Statistical analysis quick reference guidebook with SPSS examples. 1st ed.* London: Sage Publications.
- Frechting, J. (2013). Examination of Factors that Influence Long-term Sustainability of MSP Partnership Projects. *NSF Award Number 1321306*. Rockville, MD: National Science Foundation.
- Gray, D., Tornatzky, L., & McGowen, L. (2012). *Research Center Sustainability and Survival: Case Studies of Fidelity, Reinvention and Leadership of Industry/University Cooperative Research Centers*. Retrieved from Industry/University Cooperative Research Centers; Program Evaluation Project: <http://www.ncsu.edu/iucrc/SupplementalResearch.htm>
- Howell, D. C. (2011). *Fundamental Statistics for the Behavioral Sciences*. Belmont, CA: Wadsworth.
- Larenze, F., & Keiser, N. (Not dated). *Guide for Improving Sustainability*. Retrieved from EvaluATE: <http://ate.wmich.edu>
- Lawrenz, F., & Keiser, N. (2001, Fall). *Sustainability: Increasing the Likelihood of a Long-Term Impact by the ATE program*. Retrieved from Evalu\_ATE.
- Lawrenz, F., & Keiser, N. (Not dated). *ATE Program; Guide for improving sustainability*. Retrieved from ATE Evaluation Project: <http://ate.wmich.edu>.
- Lawrenz, F., Keiser, N., & Lavoie, B. (2003). Sustaining Innovation in Technological Education. *Community College Review*, 47-64.
- McGowan, L. (2012). *Program Sustainability For Cooperative Research Centers: A Longitudinal Analysis*. Retrieved from Research Center Sustainability and Survival: Case Studies of Fidelity, Reinvention and Leadership of Industry/University Cooperative Research Centers: <http://www.ncsu.edu/iucrc/SupplementalResearch.htm>
- Welch, W. W. (2011a). *The sustainability of the advanced technological education program*. Retrieved from DECA: <http://www.colorado.edu/ibs/decaproject/pubs/>
- Welch, W. W. (2012). *Measuring the sustainability of the advanced technological education (ATE) program*. Retrieved from Evalu-ATE: <http://www.colorado.edu/ibs/decaproject/pubs/>
- Welch, W. W. (2014, January). *A Replication Study of the Advanced Technological Education (ATE) Sustainability Survey*. Retrieved from EvaluATE: [http://evalu-ate.org/featured\\_resources/resources/ate](http://evalu-ate.org/featured_resources/resources/ate)
- Wingate, L., Westine, C., & Gullickson, A. (2011, July). *ERIC*. Retrieved from Advanced Technological Education Survey 2011 Fact Sheet: <http://files.eric.ed.gov/fulltext/ED541557.pdf>