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AUTHOR Clark, Aaron C.
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ABSTRACT

A study was conducted to identify specific quality characteristics for North Carolina local technology education programs that can be used by educational leaders to assess quality within their programs. The indicators developed in this research study were validated through consensus drawing measures from a panel of experts in the fields of technology education, vocational administration, and teacher education. The process and procedures used to develop and validate this information was a conventional Delphi process. Round one of the Delphi process solicited information about what were the quality indicators of a technology education program from an expert panel. Once this information was obtained, round two had the expert panel rate these indicators; in round three, they ranked each indicator within a category. Round four validated those indicators kept from previous rounds. The process resulted in a list of 26 quality indicators for assessing technology education programs in North Carolina, grouped in the following categories: (1) philosophy and mission of program; (2) student populations; (3) program requirements; (4) safety and health; (5) professional development; (6) facilities, equipment, and materials; and (7) public relations. (Contains 23 references.) (Author/KC)

# Identification of Quality Characteristics for Technology Education Programs (A North Carolina Curriculum Research Project)





by
Aaron C. Clark, Ed.D
North Carolina State University



Abstract

The study was to identify specific quality characteristics for North Carolina local technology education programs that can be used by educational leaders to assess quality within their programs. The indicators developed in this research study were validated through consensus drawing measures from a panel of experts in the fields of technology education, vocational administration, and teacher education. The process and procedures used to develop and validate this information was a conventional Delphi process. Round one of the Delphi process solicited information about what were the quality indicators of a technology education program from an expert panel. Once this information was obtained, round two had the expert panel rate these indicators and in round three rank each indicator within a category. Round four validated those indicators kept from previous rounds. Conclusions reached include a listing of quality indicators for assessing technology education programs in North Carolina. The results represent just one significant of the first steps in the long process towards establishing quality technology education programs within the North Carolina and can be a template for other states to do the same.

## Introduction

Nationally, since its beginning in manual training, technology education has continued the process to provide and establish outputs of quality within its curriculum. Especially during the past 25 years, the process of establishing standards or outputs has been a major area of focus at the national and state levels (Dugger, W.E., 1988). Once the assessment criteria is established, a benchmarking process can begin by first identifying those characteristics that define a technology education program of excellence (Dyrenfurth, Custer, Loepp, Barnes, Iley, and Boyt, 1993; World-Wide Education and Research Inst., Salt Lake City, Utah, 1982). More recently, the Standards Project currently being conducted at Virginia Tech (Technology for All Americans Project, 1995), will aid in this endeavor to establish assessment benchmarks for the profession.

North Carolina does not have standards established beyond its curriculum components nor does it have identified quality indicators for a model that can be used to assess whether technology education programs throughout the state are meeting statewide curriculum goals and objectives (D. Shumate, personal communications, October 3, 1995). Therefore, a need existed to establish these quality standards and begin the benchmarking process of improving our state's technology education programs.

### *Justification of Research*

Nearly every aspect of a person's life is touched by the products or by-products of technology. It is known that change is driven by advancing technology with both positive and negative results. One of the more positive aspects of advancing technologies has been that it "provided the means by which this area of education (technology) can be legitimately presented" (Gloeckner, 1990). Certainly the field of technology education can supply this needed knowledge so students can make informed decisions about the use of technology in their everyday lives and career.

Assuredly, justification for quality technology education programs is on the minds of the discipline practitioners. For example, Henak (1992) indicated in an article in the Technology Teacher that one area that needs to be researched in our profession of technology education is quality. He indicated in his article that quality needs to be a consideration in the learning environment for all students that take technology education courses. Henak declared that quality learning in a technology education program comes from the content, learning process, experiences, and growth opportunities offered to the students.

In technology education, states across the country are working towards setting new standards for technology programs, but North Carolina has not. Even though there has been a furry of activity on seeking new standards, "new forms of assessment will be needed to determine the quality of education provided in schools, districts, states, and the nation as a whole" (1992). The Federal Coordinating Council of Science, Engineering, and Technology (1993) adds that an evaluation process is needed in each state to analyze programs so that questions about the quality of a program can be answered. Further, if responsible change efforts are to be made to establish quality in a technology curriculum, it "must include structures for intentional, objective, and critical assessment in order to benchmark the process" (Dyrenfurth, Custer, Loepp, Barnes, Iley, and Boyt, 1993).

## Problem Statement

The problem that this study dealt with was the lack of adequate program quality characteristics that could be used to competently assess whether goals and objectives are met. Therefore, the purpose of this study was to identify those quality characteristics to assess technology education programs in North Carolina. From these characteristics, a quality assessment check sheet was designed to aid in establishing quality programs for technology education throughout the state.

## Research Methodology

The review of research literature led to selecting the conventional Delphi technique for achieving the stated purpose of this study. The Delphi process started by having administrative units within educational areas throughout the state of North Carolina give names of candidates to be selected for the expert panel. The expert panel consisted of 15 technology teachers, three vocational directors, and one technology teacher educator. The number of expert panel members representing these three areas were directly proportional to the total number of individuals within the state who could have been selected for the panel.

Next, a review panel of three members was randomly selected from the list of names not selected to be on the expert panel. The review panel approved each Delphi round instruments and all modifications and materials prior to mailing them to the panel of experts (Delbecq, 1986; Linstone & Turoff, 1975; Sackman, 1975; Dalkey, Lewis, & Snyder, 1972; Meyer & Booker, 1990; Volk, 1993).

The instrument for round one of the Delphi process was developed from information found in the review of literature and personal interviews with professionals in the field of education. Examples of categories and quality indicators were identified and placed in a survey instrument to show the operational format of how the categories and indicators were to be written, and to suggest some possible starting areas. Once the instrument was approved by the review panel, it was sent to the panel of experts. Results from round one were tabulated, with alike indicators and categories collapsed together. The indicators were placed in random order under their corresponding categories (Delbecq, 1986; Linstone & Turoff, 1975; Meyer & Booker, 1990).

Round two of the Delphi process included the rating of those indicators from round one. The instrument was developed and sent to the review panel for verification before being sent to the expert panel. The round consisted of rating each indicator from the previous round. Indicators with a mean of 3.01 or higher on a Likert Scale rating system were kept for the next round. A One Factor Repeated Measures Analysis of Variance (ANOVA) statistical ranking of categories through the collected rated means of indicators for each particular category in this round was used to show that no one category dominated the rating process (Delbecq, 1986; Linstone & Turoff, 1975; Meyer & Booker, 1990; Agresti & Finalay, 1986).

Round three consisted of ranking the information gathered from round two. The expert panel members were asked to rank, in order of priority, each quality indicator within each category. A Spearman's Coefficient Correlation nonparametric statistical test was ran on the data collected from rounds two and three to show correlation between the statistical ranking and the actual rankings conducted in this round. The test was also ran on the actual rankings and their medians from round three to show correlation between information collected within this round and that consensus was being achieved. Indicators kept from this round were those that ranked in the upper 50 percent for a category, and therefore, were the indicators with the highest level consensus for a given category.

Delphi round four consisted of gaining final approval of the quality indicators from the panel of experts. Each panel member was asked to approve the final outcomes as established from round three of the Delphi process. Expert panel members were asked to accept or reject each indicator kept from round three. Once this data was collected, a Chi Square Test was conducted to show indicators that had met consensus through the Delphi process and these were kept in the final list of indicators (Delbecq,k 1986; Linstone & Turoff, 1975; Meyer & Booker, 1990; Daniel, 1978; Gibbons, 1976; Runyon, 1977; Sackman, 1975).

## Research Findings

A demographic survey and Delphi instrument were sent to the expert panel (round one of the study) with a return rate of 100 percent. The following information is a summary of the specific demographic data obtained from the expert panel, as well as the stratification of panel members by area codes, and grade levels taught (See table 1). The expert panel members were representatives from across the state in the full-time positions related to technology education.

The demographic survey asked the number of years each expert panel member had taught and/or worked in administration during their career in education, as well as in North Carolina. The results indicated the following: the average number of years in teaching for the expert panel was 11 and the mean number of years teaching and/or overseeing a technology education program in North Carolina was 7.26.

Table 1

Title of Current Position, Area Codes for School or Offices, and Grade Levels Taught/Overseen in Technology Education

| Title/Grade | Frequency | Percent |
|---|---|---|
| Technology Teacher | 15 | 78.9 |
| Technology Teacher Educator | 1 | 5.3 |
| Administrator | 3 | 15.8 |
| 704 Area Code | 7 | 36.8 |
| 910 Area Code | 6 | 31.6 |
| 919 Area Code | 6 | 31.6 |
| Middle School Grades | 6 | 36.8 |
| High School Grades | 12 | 68.4 |
| College Level | 1 | 5.3 |

Note: Total percent for each category is 100 percent.

The survey also asked expert panel members the highest degree held and whether or not the degree was in technology education. The majority of expert panel members indicated they had a Baccalaureate degree, with over 30 percent of the panel members having a Masters degree or higher.

### *Delphi rounds*

Round one of the Delphi research study began by developing a questionnaire for soliciting from the expert panel what each felt were quality indicators for a technology education program in North Carolina. With a 100 percent return rate, the majority of the respondents, over 51 percent, suggested keeping categories and indicators used as examples. Those indicators that expert panel members suggested that were alike in meaning, but different in wording, were combined and modified into one indicator once approved by the review panel.

Round two allowed the panel of experts to rate all categories and indicators from round one. The rating process used a Likert Scale of one to five with the following classifications for each rating number. One represented a very poor indicator of quality that was not needed for any technology education program as a quality standard. A rating of two represented a poor indicator of quality that meets 49 percent or less of all state technology programs need as a quality standard. Three represented a fair indicator of quality that was appropriate for 51 percent or more of technology education programs within the state to meet as a quality indicator. Four represented a good indicator of quality that 75 percent or more technology education programs needed to meet as a quality indicator; and, five represented an excellent indicator of quality that 100 percent of all technology education programs in the state needed to meet as a quality standard.

The indicators given by the panel of experts and the example indicators kept from round one were used in round two for the Likert scale rating system. All 19 expert panel members responded to the questionnaire. Once all data was collect, statistical means in addition to standard deviations were calculated for each indicator and category and those categories and indicators with a mean of 3.01 or higher were kept for the next round. The mean of 3.01 represented the Delphi process of starting to reach consensus by keeping only those categories and indicators that had a rating at or above the statistical. This assured the researcher that overall, the indicators kept were appropriate for at least 51 percent of the technology education programs in the state. No new indicators were suggested, but 29 indicators were modified by expert panel members. For those indicators with multiple suggestions for modifications, the researcher combined suggestions made for a particular indicator and made modifications that met the overall requests made by expert panel members for that indicator. Modification's made to indicators in this round by the researcher were approved by the review panel prior to being mailed in round three.

Once round two was completed, indicators were ranked from the highest to the lowest for each category by using the results from mean calculations. This process was conducted to allow comparison of these statistically ranked means of indicators to the actual ranking of indicators conducted in round three to show consensus was being achieved through the Delphi process. Categories were also rated in this round with a mean and standard deviation obtained for each category through the means and standard deviations of indicators within a particular category. This analysis provided a statistical ranking of categories according to their individual mean. The Analysis of Variance (ANOVA) statistical test, with seven degrees of freedom, was used to analyze these categories to see if they differ significantly as a whole ranking at a .05 probability value level. A One Factor Repeated Measure's ANOVA was conducted for the categories considering individual scores and standard deviations. The researcher used this parametric test considering that the distribution of scores was equal, and the information used in the test had multiple categories with rated data at the interval level. The ANOVA test outcome was that categories, and their statistical means, were not statistically different, with an F value of 1.42, and the probability value of .2048. Table 2 indicates this information about each category showing means, standard deviations, and the ANOVA's overall F value with the overall probability value for the categories.

Questionnaire Three of this Delphi study allowed expert panel members to rank order indicators kept from round two within each category. The ranking scale was from most important indicator to least important indicator for a particular category. This process was to assure that consensus was being drawn by comparing ranked indicators' medians to the statistical ranking (from the mean ratings) found in round two.

Table 2

One-Factor Repeated Measures ANOVA Test on Category Names From Round Tow

| Category Name | M | SD | F value | p |
|---|---|---|---|---|
| Philosophy and Mission | 4.26 | .57 | -- | -- |
| Instructional Program | 4.21 | .56 | -- | -- |
| Student Populations | 4.29 | .63 | -- | -- |
| Program Requirements | 4.09 | .69 | -- | -- |
| Safety and Health | 4.11 | .65 | -- | -- |
| Professional Development | 4.42 | .61 | -- | -- |
| Facilities/Equipment/Materials | 4.35 | .70 | -- | -- |
| Public Relations | 4.25 | .76 | -- | -- |
| *Total Scores for Group of Categories | -- | -- | 1.42 | .2048 |

Note: *represents DF 7, ANOVA SS 1.65, M Square .23.

Note: *represents Error= DF 126, ANOVA SS 21.00, M Square .16.

Once the data was collected, the Spearman's nonparametric statistical test was used to show that consensus was being achieved by the Delphi process.

Sixteen expert panel members, or 84.2 percent, responded to the questionnaire for this round. No new indicators were given in this round and six modifications were suggested by the panel members. As with previous rounds, suggested modifications to the same indicators by the expert panel members were combined by the researcher, and approved by the review panel. Once the data was collected for this round, the mean rankings were compiled with medians for each indicator. This information was compared to the ratings that gave statistical rating means from the previous round to indicate consensus was being achieved through the Delphi process.

After determining the mean ratings, mean rankings, and medians for each indicator, the Spearman's nonparametric correlation test was applied to show the correlation between the statistical ranking from round two means, to the actual ranked medians from round three. Consensus was achieved by determining the correlation between the information found in round two and comparing it to the data collected for this round. Since the indicators were rated in round two from one being the lowest to five being the highest rating, and just the reverse in this round from one being the highest ranking and higher numbers representing lower rankings, a high negative correlation was expected from the data. This assumption held true for the majority of indicators grouped by category, as well as for the entire listing of indicators analyzed together.

Next, the Spearman's nonparametric correlation test was used to compare the actual ranking scores' means from this round to each indicator's median. This statistical process revealed the relationship between each indicator's ranked score to the median for that particular indicator to show that no outliers (effects of one or more extreme scores) were influencing the consensus drawing process for the ranking of indicators in this round. Since the ranking of indicators would have a positive mean, so would the median be positive for each indicator, therefore, a high positive correlation was expected from this data used in the statistical test. When comparing the mean rankings to their medians, this assumption held true for the data and a high positive correlation was achieved for indicators in each category, except facilities/equipment/materials and public relations (See table 3). The facilities/ equipment/materials category had a low correlation coefficient of -.176 and the public relations category had a positive correlation coefficient of .441. These two categories, with their indicators, did not indicate consensus through a high negative correlation coefficient correlation of -.395. Suggested modifications from both panels were made to indicators from this round and incorporated into the fourth and final round.

Questionnaire four, the last round in the Delphi study, was to determine final consensus of those indicators kept from round three. The expert panel members could accept or reject each indicator as it was transcribed, with no modifications being made to any indicator. Seventeen expert panel members, or 89.4 percent, sent back the questionnaire. The data from this instrument was analyzed using a Chi Square nonparametric test. Each indicator was placed in a contingency table to indicate the number of responses made to accept and reject the indicator. A probability value (p) was found for each indicator using the Chi Square test (see Table 4). A probability value of .05 or less meant consensus was achieved on the indicator. Therefore, the hypothesis for this round stated consensus for an indicator could be achieved if the probability value is less than .05. The null hypothesis was tested by the Chi Square test. The null hypothesis stated that consensus would not be achieved because an equal agreement would exist between accepting and rejecting an indicator by the expert panel members. Any indicator with a probability value higher than .05 was eliminated from the final list of indicators. Table 4 shows the Chi Square test results for each indicator sent to the expert panel in this round. Twenty-five indicators, or 96.1 percent, were kept from round four. Again, indicators with a probability value of greater than .05 did not indicate consensus was achieved by the expert panel and therefore were eliminated from the final listing of indicators.

Table 3

Categories with Spearman's Rho Nonparametric Test for Correlation Between Mean Rate (Round Two), Mean Rank (Round Three), and Median (Round Three)

| Category | r (M rate/M rank) | r (M rank/Mdn) |
|---|---|---|
| Philosophy and Mission of Program | -.903 | .915 |
| Instructional Program | -.882 | .985 |
| Student Populations | -.974 | 1.00 |
| Program Requirements | -.444 | .932 |
| Safety and Health | -.820 | .974 |
| Professional Development | -.632 | .948 |
| Facilities/Equipment/Materials | -.176 | .985 |
| Public Relations | .441 | .971 |
| Overall Total Scores for Combined Categories | -.395 | .954 |

Note: r represents the Spearman's (Rho) for a category.

Note: r (M rate/M rank) represents the Spearman's correlation coefficient between the mean ratings from round two and the mean ranks from round three.

Note: r (M rank/Mdn) represents the Spearman's correlation coefficient between the mean ranks from round three and their medians.

Twenty-five indicators with a probability value of less than .05 merged in the final listing of categories and indicators to represent a quality technology program in North Carolina. Only one indicator, with a p value of .1 was dropped from the final listing (See table 4). The indicators were considered verifiable because each remained after this fourth round and lasted through the Delphi processes of modifications and elimination. Also, each remaining indicator is shown statistically, or in a quantitative process, as having consensus from the experts to be an indicator of quality. Once the study was completed, both panels had the opportunity to review the final checklist of quality indicators and give feedback about the results as well as the Delphi process used throughout the study. Additional ways of verifying the study were stated and a complete copy of the results were given to the North Carolina State Department of Public Instruction.

Table 4

Indicators Kept or Rejected From Round Four Based on Using a Chi Square Test

| Indicator | N | Acpt.(%) | Reject(%) | X | p< |
|---|---|---|---|---|---|
| Philosophy and Mission of Program Category | | | | | |
| The program objectives address the need to teach the application of technology for the present and future needs of society. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |
| The philosophy and program objectives include teaching students the importance of using knowledge, materials, tools, and machines to solve problems by producing products. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |
| Technology teachers are actively involved in developing the philosophical and/or mission statement for the program. | 17 | 17 (100) | 0 (0) | 17.000 | .001 |

(Table 4 continued)

| | | | | | |
|---|---|---|---|---|---|
| The philosophy and program objectives address the need to continually update and revise the curriculum. | 17 | 16 (94.1) | 1 (5.9) | 13.326 | .001 |
| Instructional Program Category | | | | | |
| Course content is developed from course competencies/enabling objectives and utilizes approved curriculum guides, courses of study and professional resources. | 17 | 15 (88.2) | 2 (11.8) | 9.942 | .01 |
| *Course content is allowed to develop and to experiment with new technologies and areas. | 17 | 15 (88.2) | 2 (11.8) | 9.942 | .01 |
| Course content is affected by the perpetual evolution of technology and society's interaction with that technology. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |
| Student Populations Category | | | | | |
| Technology education activities are provided for all students without bias toward gender, ethnic background, achievement, handicap, or dis-advantagement. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |
| All students are provided guidance about technology education course offerings at their school. | 17 | 17 (100) | 0 (0) | 17.00 | .001 |
| All population types are represented in the technology education program. | 17 | 15 (88.2) | 2 (11.8) | 9.942 | .01 |
| Program Requirements Category | | | | | |
| Sufficient funds are budgeted for equipment and facility improvements to accomplish course objectives. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |
| Administration presents the attitude necessary for growth and development of technology education programs. | 17 | 13 (76.5) | 4 (23.5) | 7.118 | .01 |

(Table 4 continued)

| | | | | | |
|---|---|---|---|---|---|
| The maximum number of students per period is appropriate for class population (special populations, etc.) and appropriate for the type and kind of instructional activity(ies) conducted. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |
| *Administration is knowledgeable of the need to continually update the technology curriculum. | 17 | 15 (88.2) | 2 (11.8) | 9.942 | .01 |
| Safety and Health Category | | | | | |
| Technology teachers prepare and teach appropriate lessons on safety. | 17 | 17 (100) | 0 (0) | 17.000 | .001 |
| Students participating in technology education classes are required to complete a written safety test on applicable equipment with 100% success. | 17 | 14 (82.4) | 3 (17.6) | 7.118 | .01 |
| Technology teachers and/or vocational director prepares a written plan for a comprehensive safety and health program. | 17 | 11 (64.7) | 6 (35.3) | 1.420 | .1** |
| Professional Development Category | | | | | |
| *The technology teacher is provided adequate time and finances to attend at least one state sponsored workshop or function. | 17 | 15 (88.2) | 2 (11.8) | 9.942 | .01 |
| Adequate funding is provided for technology teachers to participate in local, state, and national professional development according to local policy and procedures. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |
| The technology teacher participates in staff development activities that lead to the correlation of technology education with other related academic and vocational disciplines. | 17 | 15 (88.2) | 2 (11.8) | 9.942 | .01 |

(Table 4 continued)

| | | | | | |
|---|---|---|---|---|---|
| Facilities/Equipment/Materials Category | | | | | |
| The technology presented is applicable to the present and future workplace. | 17 | 17 (100) | 0 (0) | 17.000 | .001 |
| The appearance and arrangement of the laboratory reflect the mission and philosophy of the program. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .01 |
| The technology offered in the program is up-to-date with current technological needs. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .01 |
| Public Relations Category | | | | | |
| *Teachers and students maintain a high state of visibility through the promotion of class and student activities as a public relations strategy. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |
| Students promote and support technology education programs through involvement in activities, including NC-TSA or Career Exploration Clubs of North Carolina. | 17 | 15 (88.2) | 2 (11.8) | 9.942 | .01 |
| Business and industry actively communicate with the local schools. | 17 | 16 (94.1) | 1 (5.9) | 13.236 | .001 |

Note: *represents indicators modified and approved by the review committee for use in this round.

Note: **represents indicators that had a p value of greater than .05 and eliminated from the final list of indicators.

## Conclusion

Through the four Delphi rounds conducted within this study, a panel of experts in fields of education and technology education identified and validated quality indicators through a consensus obtaining process. By using stratification measures for locating expert panel members, the indicators and categories represented consensus from across

North Carolina. Also, the above-mentioned statistical tests and procedures validated the Delphi process for this study in conducting a consensus building process.

Three major implications can be drawn from the information collected from this study. The first implication starts with curriculum development and content. The information gathered during the research process can help establish an assessment model for technology education within the state of North Carolina, as well as other states willing to revise and custom the information for their particular curriculum assessment needs. The theoretical base from which the information developed from this study includes the same evaluation model used in other assessment strategies for technology education programs nationwide. This evaluation model is based upon the systems approach of input-process-outcomes, as originally developed by Wenig (1970) from Stufflebeam's assessment model (Madaus, Scriven, & Stufflebeam, 1983) of educational areas and used extensively throughout the state, national standards projects, and technology education curriculum development world-wide.

A second implication for the research study is that it can be used to help support present and future content strategies for such endeavors as the National Standards Project titled "Technology for All Americans Project," currently being conducted by the profession through the International Technology Education Association. The profession is establishing national standards for all technology education programs in the United States to meet and establish benchmarks for the second, fifth, eight, and twelfth grade levels to assess technological literacy through the Technology for All Americans Project (1995). Benchmarks, as defined by the American Society of Training and Development, are areas of reference or established target points for improvement in the organization (Ford, 1993). The information found in this research study not only identifies the use and processes of establishing benchmarks for education, and can be used within the state as benchmarks for technology education programs and a model for other states to incorporate into their benchmarking process. More research and validating procedures need to be developed and preformed before fully integrating this information, and future quality indicators, into any technology education program.

Finally, the research study was conducted to start the process towards determining and identify what constitutes a quality technology education program within North Carolina. The methodology can be duplicated by other states to begin to establish quality for their technology curricula. With more research and validation procedures aimed at establishing quality, schools will have established benchmarks that can be use to improve technology education within every state and start a national quest towards establishing program quality. Only through this process of seeking quality, can the profession begin to show accountability towards the improvement of all technology education programs as we go into the 21st century and prepare students to live in a technical world.

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