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TEACHER EDUCATION RESPONSE TO REINVENTING AGRICULTURAL EDUCATION FOR THE YEAR 2020: USE OF CONCEPT MAPPING TO PLAN FOR CHANGE

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Abstract

Goals for agricultural education outlined in the results of the Reinventing Agricultural Education for the Year 2020 project proposed change at all levels of education including teacher education. For this study, teacher educators and other stakeholders provided input about what changes in preservice programs are needed in order to meet the needs of the future. A web-based statistical program was used to gather, sort, rate, and display the input in the form of a concept map, providing visualization of the concepts through cluster analysis. A group of participants met to examine the results of the project and to determine any desired action based on the results. The group decided to promote the development of national standards for teacher education in agriculture. This decision was adopted by the Program Improvement Committee of the American Association of Agricultural Education as part of its Program of Work and represents a philosophical shift of the organization as it moves toward the next century.

Introduction/Conceptual Framework

In 1996, The National Council for Agricultural Education (The Council) implemented the Kellogg-sponsored *Reinventing Agricultural Education for the Year* 2020 (RAE 2020) project. This initiative focused on visioning the future of agricultural education and involved over 10,000 individuals from across the nation and its territories (RAE 2020 Steering Committee, 1999). Results were directed toward needed change in our profession to include agricultural literacy, teacher supply, lifelong learning, and partnerships. A response from teacher educators to these identified areas of change will help ensure success of the RAE initiative. This article presents results of one research-based activity that has motivated a group of teacher educators to work toward change to meet the needs of future secondary programs.

The conceptual framework for this article is divided into two sections: a) the rationale behind the project to examine teacher education's response to *Reinventing Agricultural Education for the Year* 2020, and b) an examination of concept mapping as a type of structured conceptualization, which can be used to develop a framework to guide planning.

The Rationale for Teacher Education Resnonse to RAE 2020

Agriculture is an applied science that combines principles of the physical, chemical, and biological sciences in the production and processing of food and fiber. As curriculum developed over the years, the vocational skill component of agricultural education became the focus for instruction as opposed to an emphasis on the "why" of production practices (NRC, 1988). According to the National Research Council (NRC) in its 1988 report Understanding Agriculture: New Directions for Agricultural Education, the justification for a focus on production agriculture was that early agricultural

educators were primarily concerned with training students to become practicing farmers (NRC, 1988). As a practice established in the 1920s, this was one of the guiding influences for secondary instruction through the mid-1980s. Changes in the curriculum reflected changes in production agriculture-new and more efficient ways of showing "how" (NRC, 1988).

These traditions of production agriculture coexist with results of RAE 2020 that allude to such notions as emerging biotechnologies, environmental concerns, and other teachers (e.g. science) offering instruction in agriculture in some communities (RAE 2020 Steering Committee, 1999). These tensions are a result of the agriculture industry being so broad as to encompass all areas of academics along with the varying complexities in the skills needed by its workforce. Changes are needed in both the content to be delivered in the secondary agriculture classroom and the manner in which it must be delivered.

Agricultural education has evolved into a hybrid model of vocational-technical-applied science and mathematics education with a relationship to mainstream vocational-technical education as ill-defined as the one it has with the academic disciplines (Conroy, 1999). Recognition and response to this evolution are necessary for improvement of educational and employment opportunities for youth who will face technologies and management systems that demand high-level cognitive skills. Central to meeting these industry needs will be teacher education programs that prepare teachers to plan, deliver, and assess instruction in the technological age. Planning for this type of change in teacher education at the national level would strengthen the profession and provide a timely response to the RAE 2020 initiative.

The first step in planning is the conceptualization of goals and objectives, needs, resources, and capabilities that eventually comprise the elements of a plan or "articulation of thoughts, ideas, or hunches and the representation of these in some objective form" (Trochim, 1989a, p. 1). The following section describes concept mapping as a method that can be used to assist groups in the theory and concept formation stages of planning for change.

Concept Mapping as a Tool for Planning

Social scientists utilize a variety of methods and processes that are helpful in the formulation of a planning or research project-brainstorming, nominal group techniques, focus groups, Delphi techniques, facet theory, and qualitative text analysis (Trochim, 1999). Concept mapping is "a type of structured conceptualization that can be used by groups to develop a conceptual framework to guide evaluation or planning" (Trochim, 1989a, p. 1). Structured conceptualization can be defined as a sequence of concrete operationally defined steps that yield a conceptual representation of the group's ideas for necessary change (Trochim & Linton, 1986). The process is useful when there is a group of individuals interested in developing a conceptual framework for evaluation or planning. The framework is displayed in the form of a concept map which is a pictorial representation of the group's thinking-it displays all of the ideas of the group relative to the topic at hand, shows how these ideas are related to one another, and shows which ideas are more relevant, important, or appropriate (Trochim, 1989a).

The major benefit of the concept mapping process is that it brings order to a task that could be extremely difficult for groups to accomplish. It has several distinct advantages in that it a) encourages the participant group to stay on task, b) expresses the conceptual framework in the language of the participants rather than the program planner, c) results in graphic representation which shows all major ideas and

their relationships, d) is comprehensible to all participants and can be shared with other groups and audiences easily, and e) has been shown to improve group cohesiveness and morale (Trochim, 1989a).

Concept mapping was chosen to develop a framework for the teacher education response to *Reinventing Agricultural Education for the Year* 2020 because of its proven value in involving relevant stakeholder groups in the act of creating the plan (Trochim, 1989a; Trochim, Cook, & Setze, 1994). Multiple planning and evaluation projects in which concept mapping has been utilized have shown its value in helping people think more effectively as a group without losing their individuality. It also is useful in helping groups manage the complexity of their ideas without losing the details, or trivializing one person's notions or ideas (Trochim, 1999).

Statement of the Problem

Agricultural education has been struggling with strategic planning on the national level for many years (Eaton & Bruening, 1996; NRC, 1988; Pope, 1992). Recommendations resulting from national studies such as Understanding Agriculture: New Directions for Agricultural Education (NRC, 1988) have not met with success in terms of mobilizing the teacher educators to develop a response to the recommendations (Conroy, 1997). This paper provides a description of the use of one research tool known as concept mapping as a means to conceptualize the thoughts, ideas, and suggestions of teacher educators and others relative to changes which must occur in teacher education to meet the needs of secondary programming in the future.

Purpose and Objectives

The purposes of this article are to present a new and innovative form of research to the agricultural education community and to describe how this process was undertaken to conceptualize a planning strategy leading toward a desired change. Teacher education response to *Reinventing Agricultural Education for the Year* 2020 will be addressed as the context in which this process was engaged. Specific objectives were to:

a) Describe how the concept mapping process was utilized

b) Discuss in general terms the outcome of the concept mapping process

c) Describe how the preliminary outcomes are being utilized

Methods and Procedure

The authors purchased the license to utilize The Concept System, v1.75, developed by Dr. William Trochim of Cornell University, a specialist in program planning and evaluation. The project, entitled *Agricultural Education in the 21st Century Project*, utilized a website developed for use by project participants and the project administrator. There are six steps in the typical concept mapping case: 1) Preparation (selection of participants and development of focus), 2) Generation of statements by participants, 3) Structuring of statements (sorting and rating), 4) Representation of concepts in the form of a concept map, 5) Interpretation of the concept map, and 6) Utilization of the concept map (Trochim, 1989a). Each step is described in the following sections and follows guidelines established and validated by Trochim (1989a).

Preparation

This step involves two separate activities: selection of participants and development of the focus question. Since conceptualization appears to work best when it includes a variety of relevant people (Trochim, 1989a), those invited included teacher educators and others who subscribe to the

American Association of Agricultural Educators (AAAE) listserv, National FFA staff, presidents of all state/territory agriculture teachers' associations, and selected science teacher educators (N≈407). All were contacted by e-mail sent via the AAAE listserv, by personal letter from the project administrator, or through e-mail not associated with the AAAE listserv, and asked to access the Internet-based project website. Once participants logged onto the project website, they were asked to respond to the following focus question:

> Please list one specific change that must occur in pre-service training in order to better prepare secondary teachers who will be capable of meeting the challenges facing agricultural education in the next century.

Generation of Statements by Participants

The Concept System website was set up so that participants could brainstorm by entering statements in response to the focus question. The system did not record any information about the participants to protect and guarantee anonymity in the process. Participants could enter multiple statements (one at a time), view responses of others, and could also log onto the system on more than one occasion. A specified time frame of approximately two weeks was allotted for this phase of the project to enable as many people as possible to enter the website and provide responses. Two reminders were sent to participants, each of which generated additional responses.

Structuring the Statements

Following completion of the two-week brainstorming phase of the project, the system administrator closed the website to further input of statements. All participants were invited to volunteer to sort and rate the brainstormed statements, also using a website constructed specifically for the project. Fifteen individuals (5 Central Region, 3 Eastern Region, 5 Southern Region, and 2 Western Region of AAAE) volunteered to perform the sorting and rating phase. They consisted of two Ph.D. students, one curriculum developer, one consultant, one department chair, three full professors, three associate professors, three assistant professors, and one extension professional. Each person was contacted by e-mail with a follow-up phone call from the project administrator to provide a walk-through of the system and to answer any questions. Completion of this phase resulted in a ranking of all 170 brainstormed statements using a Likert-scale of 1 (Relatively Unimportant) to 5 (Extremely Important) followed by a sorting activity in which participants grouped like statements into "piles" and named each resulting group.

Representation of Concepts in a Concept Map

The sorting and rating process occurred over a one-month period to provide maximum flexibility to participants. All sorting and rating did not have to occur at one time, which permitted participants to conduct the activities during convenient times. At the end of this phase, the project administrator again closed the website to further input. Twelve of the 15 volunteers completed both the sorting and rating components. Their data were utilized for the major statistical analyses required to map the conceptual domain-multidimensional scaling and cluster analysis.

Multidimensional scaling analysis created a map of points that represented the set of brainstormed statements, resulting in a set of x-y values that were then plotted on a point map. Each plot represented one statement. When coupled with cluster analysis, the two-dimensional solution has been found to be an acceptable graphic representation of results (Kruskal & Wish,

1978). The locations of points on the map resulted from calculations of a similarity matrix, or how many times various statements were grouped together by sorters. The stress value following 19 iterations was 0.309. While this is considered to be a high stress value in more controlled psychometric testing environments-which are not the case in concept mapping-it is within the range of acceptable reliability for concept mapping (Trochim, 1999). Hierarchical cluster analysis was utilized to group individual statements on the point map into clusters of statements that reflected similar concepts. The Concept System analyses used the Ward's hierarchical cluster analysis on the x-y multidimensional scaling coordinate values as the standard procedure. The result of the cluster analysis was a cluster map, showing visually the major areas of the map covered by each concept, and their spatial relationships.

Interpretation and Utilization of the Concept Map

A goal of the project was to involve teacher educators in a process to identify ways in which AAAE could respond to the RAE 2020 project. The preliminary concept map and the 50 most important suggested changes were presented to a group of 27 teacher educators, representatives of USDE and The Council on December 8, 1998. Selection of the group provided geographical diversity. The major goal for the discussion was information sharing-advising participants of progress on the project, receiving feedback on the concepts, and seeking volunteers to participate in further work. Small groups discussed the concept map. Notes were kept of the discussions and are summarized in the following section.

Results

A total of 170 statements were entered into the website, but it is not known how many different individuals participated. As stated earlier, a feature of the System is that it can guarantee and assure anonymity, which is a key component in organizational strategic planning and evaluation. The statements were sorted by mean ratings of importance as determined by the rating process. The 10 areas of most needed change are reported in Table 1.

Table 1. Top 10 Areas Identified as Needed Changes in Preservice Education

Item	Mean rating[a]
Enhance mentoring during the first three years of teaching	*4.64*
Teach students how to design and teach a complete unit	*4.55*
Mentoring program for beginning teachers with experienced teachers	*4.47*
Develop the attitude of developing ag specialists in education, not FFA teachers	*4.45*
Teacher education faculty should have regular professional development	*4.45*
Pre-service ag educators must have knowledge and experience in working with students from diverse backgrounds	*4.40*
Train teachers to teach students problem-solving/critical thinking skills	*4.40*
Foster strong partnerships and linkages with USDA, CES, and ag industry	*4.36*
Focus not just on teaching specific "stuff," but thinking about how to learn	*4.36*
Encourage ag ed students to join state NAAE group and let them interact with ag teachers in the field	*4.36*

"Based on a scale of 1=Relatively Unimportant to 5 = Extremely Important.

Eight clusters were identified and ranked according to their overall means (Table 2). Clusters related to preservice program equirements were rated as the most important, but there is not much difference between means of the various concepts (Due to space limitations, Table 2 presents only the top three statements by cluster). There also may be confusion as to why certain statements are grouped within certain concepts and not another. Figures 1 and 2 show the spatial relationship between the various statements and respective concepts. A statement in the Enhance Professional Development cluster could be very close to the Improve Standards and Structure cluster. The boxes containing the "Xs" (Figure 2) on the Enhance Professional Development and Reform Pre-Service Curriculum clusters show the positions of two actual statements, both dealing with curriculum issues. A discrepancy in placement of statements in what appears to be inappropriate concepts can be attributed to the variability of sorting. This was reflected in the moderately high (but acceptable) stress value calculated as part of the multidimensional scaling procedure. However, the overall effect of this is minimal; the concepts are still very well defined and reflect the majority of the statements placed together as part of the sorting process.

Reactions of Teacher Educators to the Concept Maps

Participants at the December 1998 meeting were informed of the overall purposes of the meeting: a) to review results of the concept mapping project and b) to determine which members of the group were interested in participating in follow up discussions to develop a teacher education response to RAE 2020. As stated earlier, the group received copies of the preliminary concept map, and the top 50 prioritized statements for action as identified through the rating process. Four groups were asked to study the concept maps and the statements to decide if there was agreement on the general concepts that should be addressed as part of a teacher education response to RAE 2020. They were also asked to develop additional concepts, if necessary.

Individual groups reported back to the whole group and enthusiastic discussion occurred around the centrally mapped theme-Reform Pre-service Curriculum. Discussions also focused on interrelationships of other concepts to this central issue. Mathematically, statements identified as part of the cluster "Reform Preservice Curriculum" are related more to the set of all statements than are those in any other cluster, as evidenced by the position of this cluster in the center of the map. One of the groups identified an area in which teacher education in agriculture has not had a key role-setting policy on the federal or state levels.

The consensus of the larger group was that if standards for teacher education were developed, the issues of involvement in policy development would be addressed as well as those conceptualized by the concept mapping. The group believed that standards could be utilized as the basis for reforming preservice curriculum, which would result in enhanced program planning and a structure for staff development at the university level. As for the policy setting issue, it was felt that national standards could be the leverage for setting policy and directing funds to priority areas of agricultural education. The results of the meeting represent an important step in development of a teacher education response to RAE 2020.

It should be noted that the authors sensed the enthusiasm and excitement of the group as they reached consensus. The group decided that national standards for teacher education are needed and that an ad hoc working group within the AAAE structure should oversee the development All participants agreed with these

Table 2. Relative Importance of Clusters

Cluster name	Average rating[a]	Top three statements (mean[a])
Enhance professional development	3.76	Enhance mentoring during first three years (4.64); mentoring program for beginning teachers with experienced teachers (4.47); teacher education faculty should have regular professional development (4.45).
Develop partners and linkages	3.72	Foster stronger linkages with USDA, CES, and industry (4.36); teachers must become part of the total school (4.27); communicate rewards of teaching as a profession (4.27) Provide experiential preservice activities
Provide experiential presetvice activities	3.69	Teach students how to design/teach a complete unit (4.55); Pre service educators must have knowledge/experience in working with students of diverse backgrounds (4.40); Train teachers to teach students problem-solving and critical thinking (4.40)
Improve standards and structure	3.58	Develop attitude of developing ag specialists in education, not FFA teachers (4.45); encourage students to join NAAE state group and have them interact with teachers in the field (4.36); revitalize Ph.D. programs (4.27)
Build collaboration locally	3.53	Closer linkages must be developed/maintained with ag industry (4.27); get industries involved (4.27); train teachers to make better connections to the industry (4.09)
Reform preservice curriculum	3.49	Promote interdisciplinary and collaborative teaching (4.18); innovative curriculum (4.18); enhance teachers' ability to guide students in research and special projects (3.9 1)
Expand youth and leadership programs	3.48	Variety of instructional learning (4.09); ag educators must learn how to integrate ag into core of middle school/other programs (4.00); need to better prepare our teachers to work with culturally diverse students (4.00)
Enhance science and technical requirements	3.35	Recruit students that truly represent our cultural diversity (4.00); evaluate ag science concepts needed to be taught in schools and require (3.9 1); increase biology and chemistry requirements in preservice program (3.82)

[a]Based on a scale of 1=Relatively Unimportant to 5 = Extremely Important

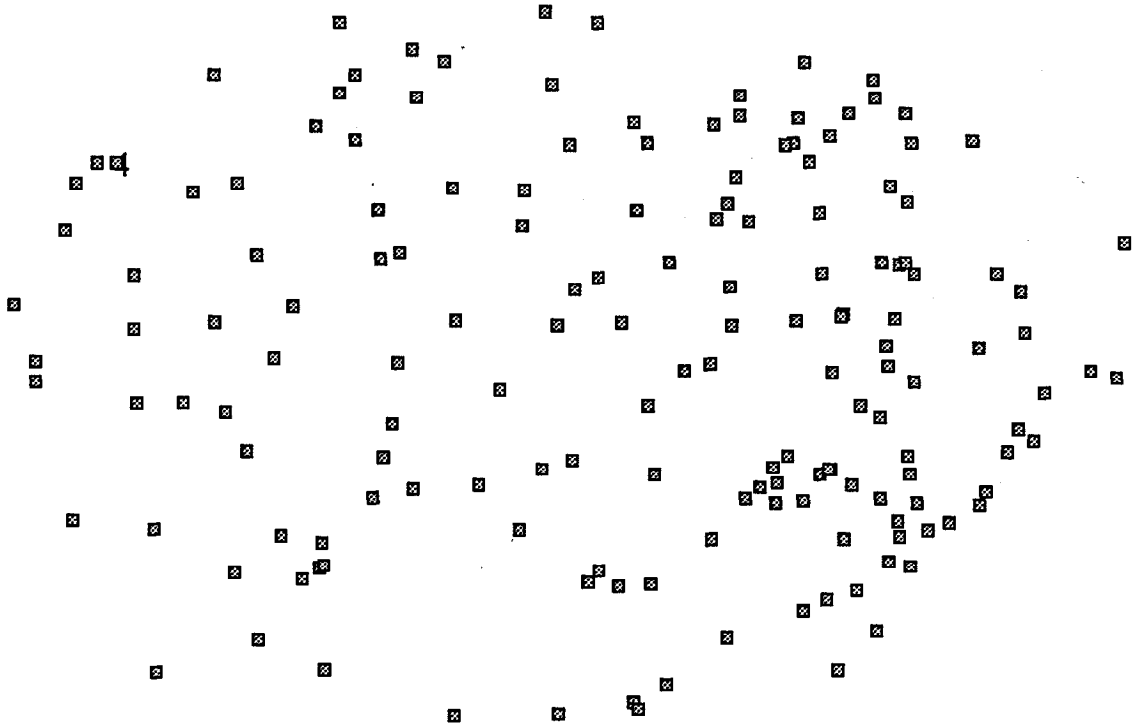

Figure 1. Point Map

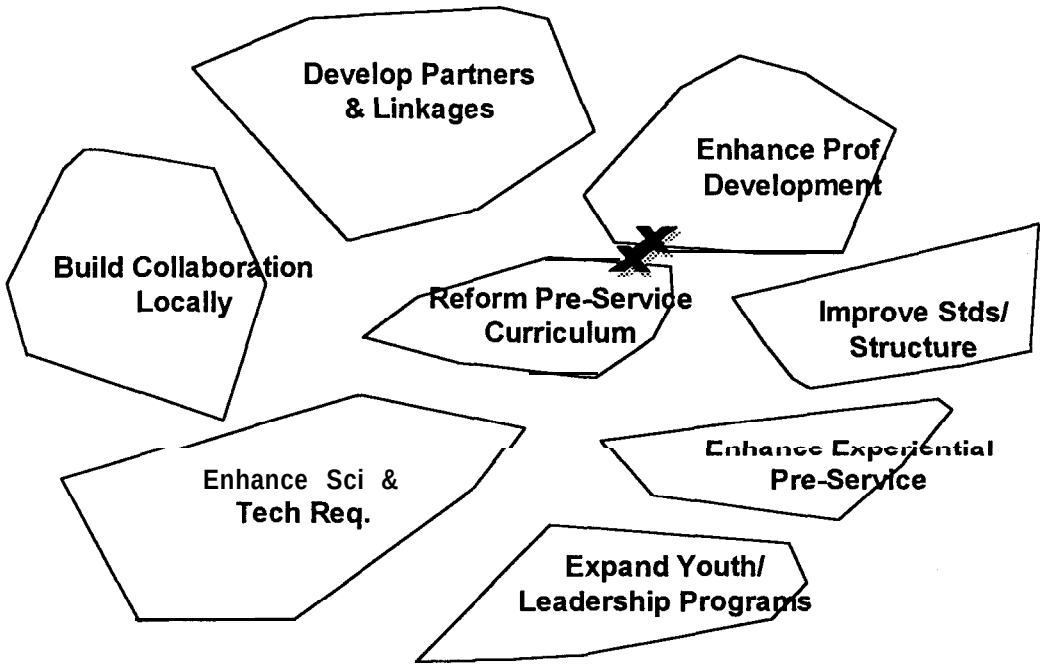

Figure 2. The Eight Identified Clusters

decisions, and it was decided that the information would be presented to the AAAE Program Improvement Committee for action. The Program Improvement Committee met and agreed to promote the initiative.

Conclusions, Discussion, and Recommendations

The significance of the results of the concept mapping project is that they represent a shift in philosophy for AAAE and its membership. Over the past 20 years, various individuals and programs have attempted to organize and mobilize support for national standards.

In most cases, support was highly localized to specific programs or states. Informal interviews with individuals involved in attempts to develop standards in the past revealed that smaller teacher education programs were not in favor of standards because they viewed them as requiring many things (facilities, faculty, and courses) that limited resources would not permit.

Discussions at the concept mapping meeting in December raised this issue again; however, the consensus was that program size cannot be a factor in the development of standards and standards can assist smaller programs to leverage funds and promote change within their respective states and institutions. The concept mapping project resulted in a representation of reality-where participants are in their thinking-, but it also yielded a suggestive device. According to its developer, William Trochim, concept mapping is both a "soft science" and "hard art" in that it has qualities of both. The artistic procedure yields an interpretable, suggestive picture while the scientific procedure, if conducted properly, is valid, reliable, and has theory-enhancing value (Trochim, 1989b). In the way that concept mapping was used for this study, both scientific data analysis techniques and artistic representations were beneficial in helping participants conceptualize what they wanted to do.

It is not possible to say whether the group would have come to the same decision without the concept map, but the visualization certainly provided ease in understanding and interpreting the information that had come in from across the country. It might be said that the process yielded conceptual clarity (Trochim, 1999) to what might have otherwise been data in tables. At the very least, the authors conclude that advantages of concept mapping reported by Trochim in 1989 were observed as part of the process: a) Participants stayed on task; b) The process resulted in a conceptual framework in the language of the participants rather than the project administrator; c) The results were displayed in graphic form that showed the ideas and their relationships; d) Results were easy to share and understand; and e) Participants were enthused about the project and the decision to develop standards. Further studies utilizing concept mapping are warranted to determine if the noticed cohesiveness and conceptual clarity are evident. If so, this technique could prove to be an invaluable tool for program planning, especially for use with large groups of individuals who are not located close together.

Implications

This article presented a unique system for use in program planning and evaluation. The low cost and ease of use permit it to be used within a variety of settings and across geographical boundaries. The authors found that the claims made about the system by its developer were, for the most part, observed to be true. Within a very short period of time, data were collected, analyzed using sophisticated statistical techniques (requiring only a "point and click" of the mouse button) and presented to a representative group of participants for interpretation. The participants appeared to have few problems with their interpretations of the concept map.

The implications for agricultural education go far beyond the data reporting and the concept map. The process brought together a group of people to propose a solution to a problem. The solution was the result of participants' input, and resulted in a decision to move toward change-a change that had met with defeat just a few years ago according to one observer at that time. There is also something worthwhile to the notion of conceptual clarity, as Trochim calls it-the ability to clearly SEE a concept as well as describe it. Concept mapping, by showing the spatial relationships of the various concepts, assists participants to prioritize or, as in the case of this project, identify one preferred outcome-standards for teacher education in agriculture. If this is the contribution and response that we will make, as a profession, to the RAE 2020 initiative, we will have more than met the challenge to move forward in the next century.

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