

Open-ended Feedback on Education Innovation of Food Science, Technology and Engineering

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Abstract

In an era of rapid technological advancement and digitally native generations, education in food science, technology, and engineering must undergo transformative changes to meet modern progress and challenges. The integration of artificial intelligence and digital tools is reshaping curricula, fostering innovation, and equipping future professionals with the skills needed to address increasingly complex responsibilities. Future competencies include open innovation, cross-sector collaboration, creativity, sustainability, social responsibility, interdisciplinary teamwork, and others. To identify gaps in current curricula, key challenges, and opportunities for advancement, a global survey was conducted among students, academics, and industry professionals. Following previous studies utilizing close-ended questions, this study employed an open-ended method to elicit spontaneous insights and minimize possible biases associated with close-ended counterpart approach. Key findings highlighted the importance of practical, hands-on learning and business skills, greater emphasis on sustainability and environmental impact, increasing demand for technology integration and recognition of regional disparities and needs, and drive for globalization while maintaining local relevance. The study's main recommendations included: Higher education reform requires regular curriculum updates that balance global education needs with local relevance and integrating advanced innovation and science; Enhanced resource allocation should support practical training; International collaboration through student exchanges, research partnerships, and knowledge-sharing platforms, along with strong industry integration via internships and applied projects. The use of open-ended question proved to be a highly effective method for capturing respondents' perspectives often overlooked by close-ended approaches.

Keywords: Sustainability, Entrepreneurship, Multidisciplinary, Internships, Soft Skills, Regional Disparities.

Introduction

The rapid advancement of science, technology, and innovation, propelled by the proliferation of computerized capabilities and artificial intelligence (AI), underscores the imperative need to evaluate the landscape of most educational programs including food science, technology, and engineering (FST&E) education. This vital need is accentuated by significant strides in various

technologies including digital technologies and capabilities, AI, smart sensors, robotics, blockchain, and the Internet of Things (IoT) [1, 2]. Critical and significant emerging breakthroughs to be considered are quantum computing and AI, promising to redefine the boundaries of technology and business, and most probably also reshape education programs [3].

FST&E professions are witnessing significant challenges as well as changes imposed by the accelerated rate of change and digital transformation. The expected changes will most probably affect FST&E education as already projected [2, 4-13]. In light of future challenges, education programs for various fields were considered for instance for FST&E [2, 4, 14, 15], as well as for chemical engineering [16-20].

Partnerships between academia and the food industry have been shown to be crucial for aligning educational outcomes with regional job markets. Collaborative programs, internships, and industry-driven projects help bridge the gap between theoretical knowledge and practical skills, with regional industries often shaping the focus of such collaborations [1, 2].

A Food Engineering (FE) education study indicated that Brazil is not properly doing its homework, based on global movement, concerning FE education. The need to rethink Brazilian technical education, without culminating in additional workload, was emphasized, not only regarding new materials and technologies for learning and teaching, but also in terms of bringing a human and market approach. The achievement of this complex goal seems to be provided by the encouragement of student associations, transversal learning processes, and learning experiences outside the classroom as a means of improving undergraduate programs and human resources [21]. The high importance of apprentices in food industry was also reported recently [1, 2].

A student study on blended learning (the use of conventional face-to-face learning experiences in combination with online education resources and practices) highlighted that students had recommended that there should be more lecture designed video screencasts, and they should be offered more opportunities to do oral presentations in this module. The study affirmed the merits of incorporating blended and collaborative learning in food science (FS) and technology (FST) curricula [22].

The utilization of web survey is quite frequently applied to study and identify education and marketing strategies. For instance, an on-line survey by 267 students in over 20 countries using a 5-point Likert scale found that students anticipating a job with high responsibility were more satisfied with 3 specific soft skills (i.e., "Working with others," "Being responsible," and "Thinking & solving problems"). Among technical skills, students were more satisfied with improvement in basic sciences (Microbiology, Chemistry, Processing, and Safety), and those in Northern Europe were more satisfied with overall technical training. These data show variations in perception and/or efficacy of technical and soft skill training in FS programs and underline the need for separate attention to the incorporation of soft skill training into the design of FS&T courses [23]. More recently similar technique was utilized for identifying possible educational gaps and insights on future curricula changes [1, 2].

The overall objective of this study was to employ a global web-based study utilizing an open-ended question to investigate students and professional respondents' insights provided spontaneously avoiding possible bias that may result from suggesting close-ended questions. These insights are important for exploring possible future trajectories of FST&E curricula on a global and local scale.

Methodology

Research design and participants

A structured questionnaire was employed as outlined previously [1, 2, 24]. The questionnaire targeted global professionals, including students, in the fields of FST&E, nutrition, and related disciplines. Qualtrics software XM (Version September 2022, Qualtrics, Provo, UT, USA. <http://www.qualtrics.com/>) was utilized. The questionnaire's web link was distributed to professionals worldwide via email sent directly by various organizations, including the International Union of Food Science and Technology (IUFoST), the Institute of Food Technologists (IFT) and ISEKI Food Association. Additional e-mails were sent by one of the authors. The survey was conducted in English to mitigate language ambiguities and was entirely anonymous.

Open-ended Question

Previous studies focused on closed-ended questions [1, 2]. In this study, data was collected from the open-ended query soliciting free suggestions for future curriculum enhancements. Open-ended question concluded the questionnaire and was utilized to discover the responses that individuals give spontaneously and to avoid the bias that may result from suggesting responses to individuals [22, 25]. Two hundred respondents (out of 688, 29.1%) provided their free format feedback. The text collected from the open-ended question was categorized under similar groups using AI (<https://claude.ai/>) and verified and revised as needed by thorough analysis. Several respondents provided more than one insight. Categories description that included below 10% of the respondents' feedbacks were not included in the analysis. An exception was made for the assessment of nutrition insights.

Results and Discussion

The Panel

Two hundred responders (out of 688; 29.1%) filled out the open-ended question. Detailed suggestions were provided 120 (60%) by respondents. The other 40% offered only general feedbacks such as: "Nothing to add", "Thank you", and were excluded from further analysis.

Curriculum Modernization and Skills Development

The most frequently category addressed by the panel was focused on curriculum modernization and skills development (Fig. 1).

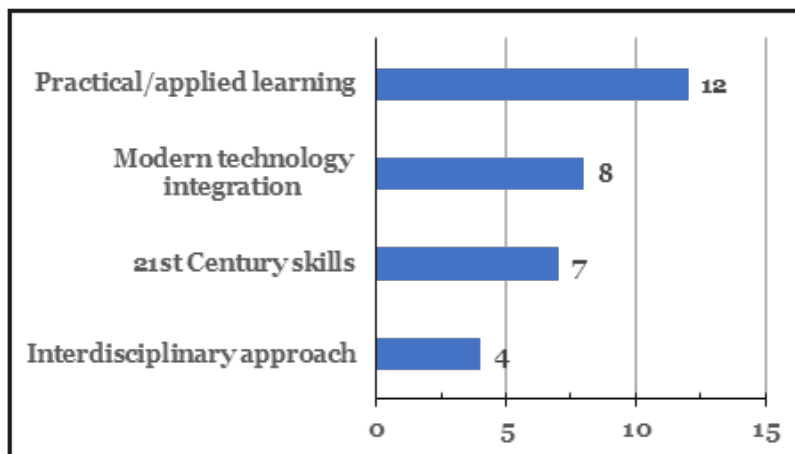


Figure 1: Curriculum modernization and Skills Development (31 Respondents, 25.8%)

Some of the key quotes included: "FST education must adopt 21st century skills," "Team work," "Big data management," "Circular economy," "Interdisciplinary work," "Including real world experiences," "Soft skills," "Project management and innovation to any FST curriculum will advance the future of this space."

Practical and/or applied learning was the most frequently selected category followed by modern technology integration, 21st century skills and interdisciplinary approach. It is not surprising that curriculum development was the most frequently addressed

topic as the preceding close-ended questionnaire addressed future education aspects. Nevertheless, it also highlights that the respondents envision future curricula to include innovative hands-on and practical examples as well as modern 21st century skills and interdisciplinary approaches. It is clear that these insights are merely guidelines, nonetheless they provide a clear direction education programs revision should be considering.

International Collaboration

The second theme the panel has identified was international collaboration and global standards (Fig. 2).

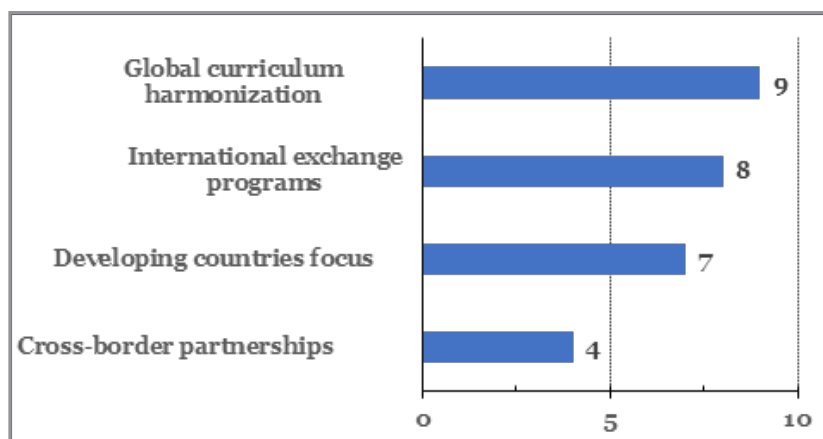


Figure 2: International Collaboration and Global Standards (28 Respondents, 23.3%)

Several representative feedbacks included: "FST/FE curricula should be harmonized as much as possible on the global level," "Student exchange among the FST programs in different Universities located in different continents could be very important these days". These topics highlight that while global curriculum harmonization, international exchange programs and cross-border partnerships, were the most frequent insights, curricula revision should also focus on local needs of developing countries.

The aforementioned insights clearly indicate that a global education harmonization is warranted but considering geographical differences especially developing countries should be carefully considered. The global/local aspects should be sensibly considered in future curricula development.

Sustainability and Food Security

The third category highlighted by the respondents could be described as sustainability and novel foods (Fig. 3).

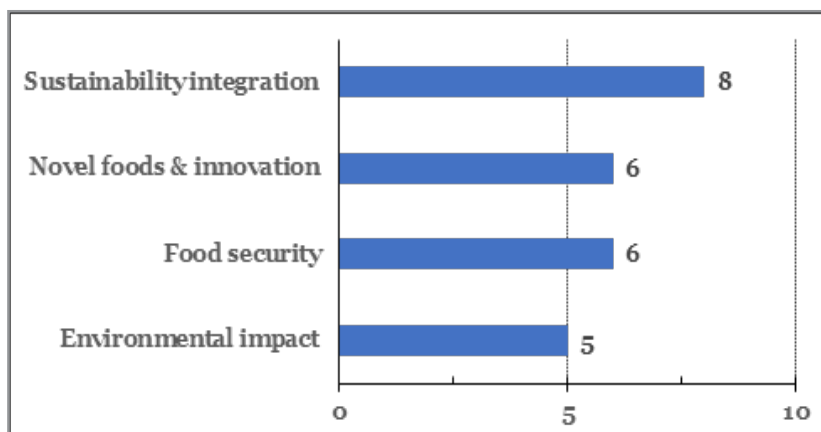


Figure 3: Sustainability and Food Security (25 Respondents; 20.8%)

Some of the key quotes were: “Sustainability programs for food students,” “Have courses on sustainability and reducing negative impact on environments”. These insights project a clear indication of the integration importance of sustainability, food security and environmental impact in future curricula. Also, novel foods and innovation are significant part of any new product development course and should be also contemplated.

The high importance of sustainability as projected by the respondents agree with close-ended questionnaires reported previ-

ously [1, 2]. It also complies with another study that highlighted that sustainability should be promoted among FS students in all its multidimensionality, and actions need to be implemented that bring sustainability closer to students’ social practices, which should be incorporated into all university education and that is taught by professors duly trained in the subject [26].

Industry-academia Connection

The fourth category projected by the respondents could be described as industry-academia connection (Fig. 4).

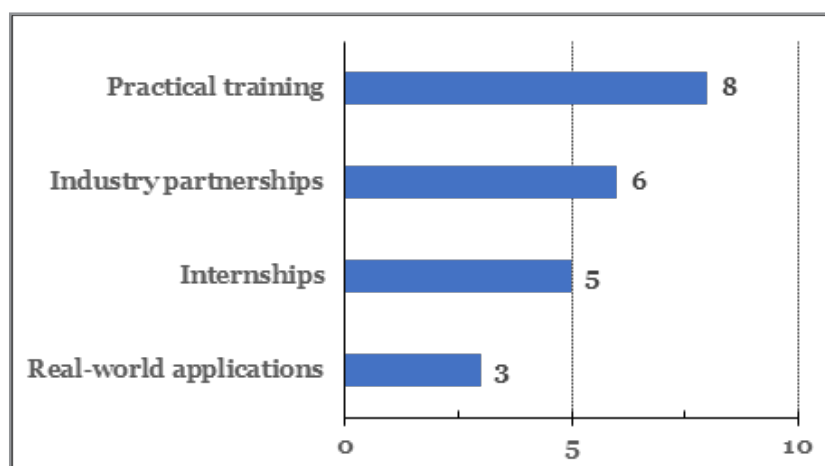


Figure 4: Industry-academia Connection (22 Respondents; 18.3%)

Notable quotes included: “I believe that exposing students to real world situations and problems is critical to food science education,” “There should be pilot plants including laboratories in all university enabling more practical teachings. Industrial attachments and relevant industry should be compulsory.” Figure 4 highlights the importance the respondents allocated to industry-academia collaboration that could be also related to practical training, partnerships, internships and real-world applications. Previous study underscored the importance of adapting FST&E

education to regional differences and evolving industry expectations [1]. The significance of academic partnership and the importance of collaboration between academia and the food industry was also highlighted [2]. Hence, the open-ended insights corroborate the close-ended feedbacks.

African Development

The fifth category highlighted by the respondents could be described by African development (Fig. 5).

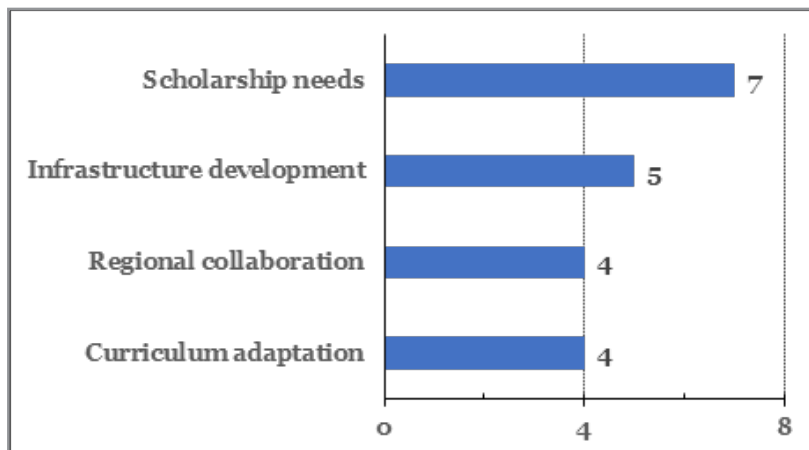


Figure 5: African Development (20 Respondents; 16.7%)

Significant quotes included: "IUFOST must proactively engage with African institutions that are into food science/technology/engineering teaching and research," "I wish there is more post graduate scholarship program for the developing country citizens especially for African students".

It is not surprising that the special education needs for Africa as expressed by the respondents in the open-ended question sup-

port previous data [1, 2]. These insights provide a clear direction for future curricula improvements addressing the unique needs of this region.

Educational Reforms

The sixth theme highlighted by the respondents could be described by educational reforms (Fig. 6).

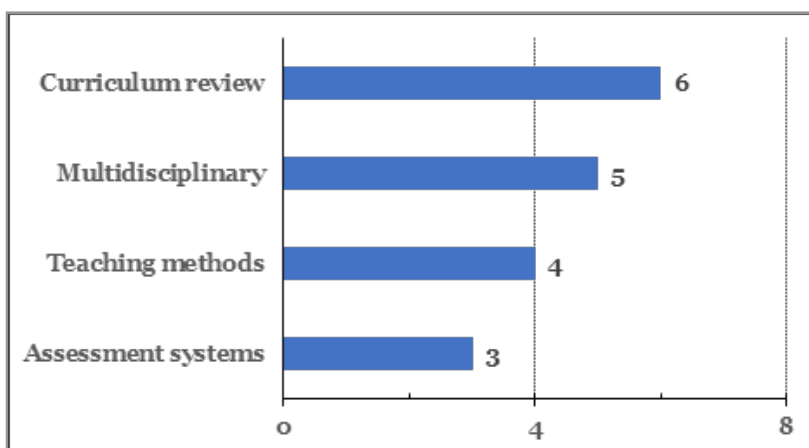


Figure 6: Educational Reforms (18 Respondents; 15.0%)

Selected statements include: "Periodic review of curriculum is important to be relevant to the needs of industry and society," "boosting research collaboration and multidisciplinary of researchers," and "I recognized when teaching students that most important for them is seminar where they can do their own food e.g., bakery product, juice, meat product, quark, etc.".

Reviewing and updating the curricula, including multidisciplinary, revising the teaching methods (e.g., hybrid/frontal, proj-

ect oriented) and assessment system to evaluate both academic and applied tools and needs have been highlighted. These data support the respondents' previous insights based on close-ended questions [1, 2].

Professional Development

The seventh theme highlighted by the respondents could be described by professional development (Fig. 7).

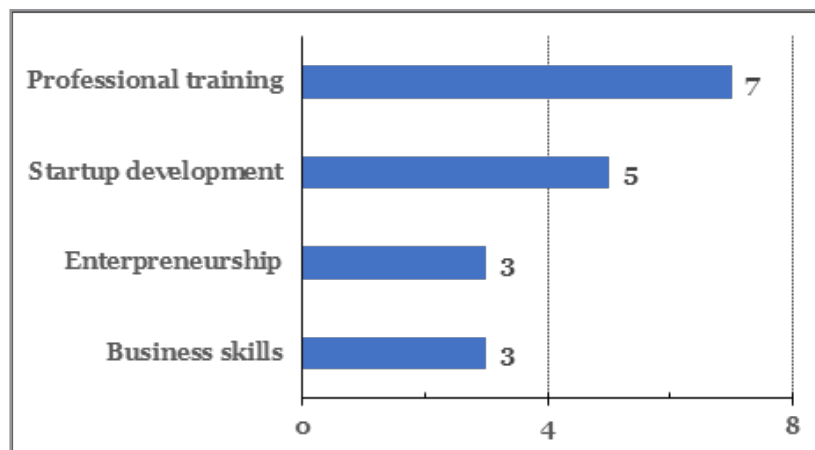


Figure 7: Professional Development (18 Respondents, 15.0%)

Representative quotes included: “This is the time for training/ internships of students with food startups, in my opinion it must be compulsory for all students of different education/professional food degree program particularly with food startups,” “Entrepreneurship is of paramount importance to FS curriculum,” and “More emphasis should be placed on practical, industrial trainings, entrepreneurship, visitation to other countries for more exposures.”

It is clear that professional development is cornerstone of education where new considerations such as startups, entrepreneurship and business skills are paramount. Although the respondents have not defined these skills as soft skills, they clearly project that professional development should be a part of the future curricula. Similar insights were reported previously [1, 2, 11, 23].

Additional Insights

The need for integrating FST&E curricula with nutrition science has been suggested previously [1, 2, 6, 27, 28]. In this study however, only 3 respondents (2.5%) have addressed this topic. The quotes are: “To be included topics about novel foods and clinical nutrition,” “FS is a very applied science, its barely its own science. Transferable fields (Statistics, computer science, nutrition, technician skills, physics) are so much harder to acquire than an understanding than most FS concepts. More math more coding,” and “Nutrition should be core subject in food study.” This apparent discrepancy between the compelling need to full assimilation and its status to date, probably indicates that integration of nutrition in FST&E curricula should be carefully considered and its paramount contributions and strengthen be emphasized.

Conclusions and Recommendations

These key insights and main conclusions could be summarized:

- Strong emphasis on practical, hands-on learning and business skills.
- Growing focus on sustainability and environmental impact.
- Increasing demand for technology integration.
- Recognition of regional disparities and needs, and push for globalization while maintaining local relevance.

In addition, these key recommendations could be drawn:

- Curriculum development – regular review and updates, global standardization while maintaining local relevance, and integration of modern technologies.
- Resource allocation - increased funding for practical training, support for developing countries, scholarship programs
- International collaboration - student exchange programs, research partnerships, and knowledge sharing platforms.
- Industry integration - internship programs, industry-led workshops and real-world project implementation.

It should be emphasized that future curricula changes face many challenges and the above insights and recommendations should be carefully addressed through both global and local lenses.

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