ENGINEERING ASPECTS OF NUTRACEUTICAL AND FUNCTIONAL FOOD SCIENCE CURRICULA IN TRANSFORMATIVE LEARNING AND ITS TEACHING STRATEGY

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ABSTRACT
The current global trend for the last 5 years is food and health. The new terminology issued including "functional foods", "nutraceutical", "health risk foods", etc. Indonesian Society for Functional Foods and Nutraceuticals (ISFFN) is one of organizations concern with the development and contribution of good foods, its technology, and scientific base; even the generalization for wider society is to help them with better living qualities. The organization would be a consultative curriculum related to functional foods and nutraceuticals. In the present study, the syllabi for engineering aspect of nutraceutical or functional foods is developed and treated with different types of teaching methods in the classes for five academic year (2019/2020 to 2023/2024), i.e., (a) students' interest oriented, (b) workshop with two steps peer evaluation @2 peers, (c) lecturing and leading group presentation in each weekly topic, (d) individual and group works, (e) the use of excel application for calculation problem exercise, and (f) field visit along with a worksheet project guidance. The classes were off line and online model using a learning management system Moodle platform. Data from students' feed backs were matched into transformative learning indicators from references. The results indicated that several feed backs for lecturers were positive (encouraging, caring, stimulating deeper thinking, driving interaction among students even though online learning, clear and relating to daily life) but several corrective actions in the future were required (considering students' learning pace, more examples in calculation exercise, and giving the answers before peer evaluation during workshop to help the students able to do peer evaluation). Transformative education found from syllabi set and in combination with class treatments included students reflected themselves among other students' learning progress, interacting with lecturer and students well, but the good relationship lost sometimes in online lecturing. In conclusion, all class treatments could make students achieving transformative learnings, yet the measurement scales of the transformation itself was undefined, thus warranted research on appropriate scaling.

INTRODUCTION

The dynamics of science and technology continuously moves to interdisciplinary educations, even several internet-based companies such as Google practiced the recruitments free from educational background. Regarding foods correlation to health quality for the last decade, trends of enthusiasm of many stake holders indicated that they focused on healthy foods both scientifically and economically. On the other hand, to support the sustainable contributions of foods for health there are needs for education model which prepares visional generations in the future. Hence, curriculum and pedagogy on health science is seen as one of pillars to develop further health quality (public health). On the trading side, terminology of "functional foods", "food for specific health use" (FOSHU), even "food with claims" are stated in Indonesian Regulation issued by Indonesian Food and Drug Agency (PerBPOM RI, no. 13, year 2023 and before 2016). The dynamics of science and technology is continuously taking place, until now. It has identified the fundamental sciences required, i.e., Food Science and Technology, Medical Science and Technology, Analytical Techniques and Instruments, Pharmacology and Pharmaceuticals, and Molecular Biology. Since the wide scope of interdisciplinary science and technology involved, a new paradigm of curriculum and the way to deliver a complex science becomes a real challenge.

Based on the aforementioned educational needs in reaching the better lives and health, several treatments in teaching and structuring the curriculum is documented for the last 5 years. After the needs of global emerging science and technology as well as human resources had been identified and declared by the stake holders, an initiative to set a forum for all stake holders is growing. One of them is the growth of International Society for Nutraceutical and Functional Foods (ISNFF), and also in Indonesia named as Indonesian Society of Functional Foods and Nutraceuticals (ISFFN) in 2015 in Yogyakarta, marked as

Declaration and Kick off period. Further development is the consortium of the societies in continents and countries. Meanwhile, research on millennial perspective about functional foods was also performed in 2018. It found around 95% of respondents were willing to buy functional foods in particular in trusted modern markets more than the conventional one. This informs us that the relevant industries would need appropriate quality of human resources in the future. Finally, the identified stakeholders include government, academics (students, lecturers, and researchers), industries, consumers as general, and the most importantly is human resources to sustain the new sciences and technology emerged for tackling the future.

The initial ground breaking science and technology for food and health relationship which was developed in 2003 named as "omics science and technology". However, until now it still left gaps on what mechanisms of various food components act and communicate with human body, in particular how it involved directly or indirectly in managing health status of individuals. It is partially responsibility of higher education where investigation and construction of a system for holistic approaches can be discovered to fill the gaps in order to be useful for human lives and the whole biosystem involved in the life sciences. More importantly is the conducive environment for bridging the interdisciplinary sciences and technologies, where each field has already been well-established for long time. It needs dialogue at various levels of research and its applications to contribute positive solutions in the society. Moreover, the pandemic Covid 19 also triggered a deeper understanding that genetic levels of cells in the body are capable of communicating with viron (a non-living matter), through the study on advanced epigenetics in term of signaling, silencing (knock out genes), or switching on (knock in genes), even a technology to modify the genes itself in managing the health quality of organism (as a system biology). The good curricula and techniques in cultivating an understanding about the food and health mechanisms will be a great contribution in the living itself for human being and its living environments. There is a scarcity of curriculum at higher education to bridge the important educational program in Indonesia to nurture researchers, producers, and health workers who can tap the opportunity for organizing the public health system better.

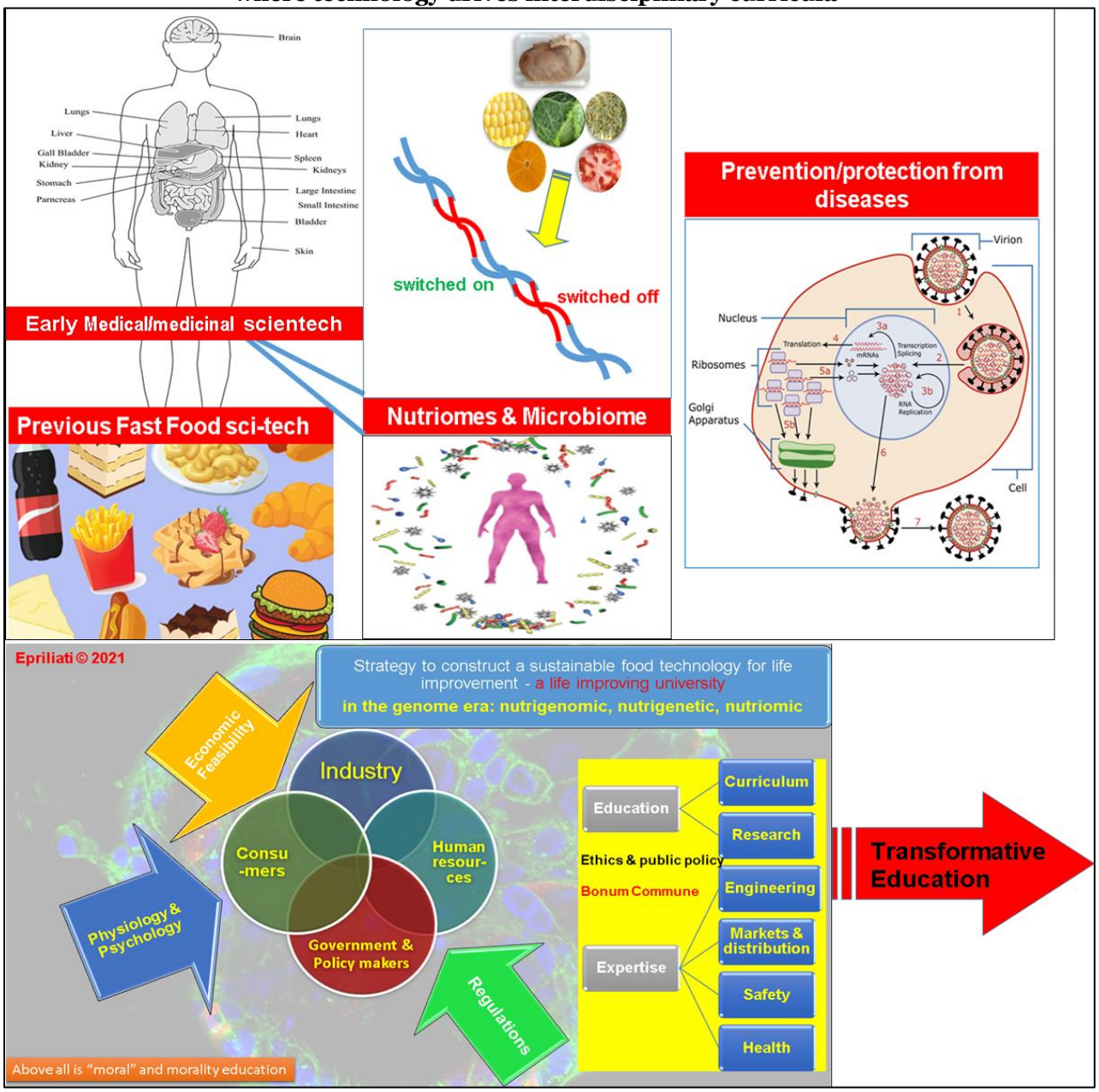
The theoretic and scientific construct of the curriculum is based on the following core publications depicted in Picture 1. The essence of knowledge need to be understood by lay society is that particular compounds in various commodities is capable of communicating at genetic levels thus it switching on or off the genetic materials to do their jobs. When the compounds exist in the raw materials or in food matrices, then extracting them pure prior to consumption is identified as "not always the correct ways" in food preparations or pharmaceutical rules. How can the beneficial compounds in the natural matrices work accessing genetic sensors for signaling their governmental actions in determining health status? Hence, the science of food engineering and processing whose fundamental theoretic is Physical Chemistry, Food Material Sciences, and Food Engineering is required. The applications of those sciences and technology are along the supply chain at level of postharvest period, processing, storing, transporting/distributing, consuming, physiological functions inside the body and their actions in system biology of health status (epigenetics). However, in the term of countries and trading system, there are many regulations involved. Otieno et al. (2023) reported the application of transformative learning that found it helped evaluators in food system in term of coping with its complexity.

Foods are essential for living. The uses of foods by the organisms could generate positive and negative effects. Since it relates closely with life, either the individuals or other sides (e.g. consumers), thus above all aspects of stakeholders is moral to contribute better life for all. Going back to curriculum in education, it plays an important role in generating expertise and experts in the field for health related foods discussed before. Food safety, engineering, health science, and market/distribution expertise are the direct outcomes of education expected from higher education levels. With the pandemic Covid 19 in 2020 – 2022 which recently occurred, the new paradigm in higher education is necessarily related to genetics, therefore, the strategy to construct education involves nutriomics, nutrigenetics, and nutrigenomic to mark that it is genomic era. The actions of food components are illustrated in Picture 1. Foods are acting as sources of the bioactive compounds that communicate with sensors of genetic signaling to switch -on or -off after having access into the nucleus. Therefore, the disease problems in the modern society can be solved through reform the dietary foods with those that still have natural active compounds capable of reaching the genetic materials. Vegetables and various naturally colorful stuff are the important commodities. Similarly, and surprisingly, that the bioactive compounds obtained from food materials are protectors for human from diseases onset! Hence, pathogenesis of virus in pandemic covid 19 clearly proved the actions. Again, it is important to master the fundamental sciences previously mentioned in the curricula. During teaching activities, the detail subjects in the curriculum for functional foods (not necessarily nutrition) and

nutraceutical (nutrient as the bioactive compounds) were treated with particular teaching methods to investigate what the students' responses during their study period. The treatments were observed for 5 years, during even and odd semester, thus the cycles can be related to the performance index obtained by the student in the classes. The courses in the curriculum was directed to achieve the main goals, i.e., students acquired the science and technology of preserving and providing the bioactive compounds either as nutriomes (nutrition for genetic material pathways in the epigenetics mechanisms) or non-nutrition during post harvesting until physiological actions in the body.

Picture 1

Progress in health management from early medical/medicinal science until 21st century where technology drives interdisciplinary curricula



METHOD

Samples of Lectures

There were 3 lectures which was taught in sequences or parallel for even and odd semester, respectively in Department of Food Technology, Faculty of Agricultural Technology, Widya Mandala Surabaya Catholic University, Indonesia. A document of learning plan for each lecture [i.e., Physical Chemistry (**PC 2 credits + 1 Laboratory Practices**), Food Material Sciences (**FMS 2 credits + 1 Laboratory Practices**), and Food Engineering (**FE, 6 credits imbedded exercises**)] which described weekly activities was used as reference guide line of lecturing and evaluation at the end of each semester. Physical Chemistry is a fundamental science for Food Technology, especially for Food Engineering I and II, which then applied in Food Processing Technology in food product development subjects for various food commodities. Hence, Food Material Sciences is a basic knowledge of food characteristics on which Food Processing Technology subjects would laid on. Food Engineering consisted of theory and exercises (problems, interpretation, systematic discussion of the calculation results in the contextual cases). This document was implemented for 5 years (academic year of 2019/2020 – 2023/2024). Physical chemistry was in parallel semester with Food Engineering I, and Food Material Sciences with Food Engineering II in academic year before 2020 whereas in academic year of 2020(+) Physical chemistry, Food Engineering I and Food Material Sciences were run in the same semester. Each class had 45 – 85 students (average 176 students for each academic year), thus totally 880 data entry. Hence, learning outcomes for each lecture were inter-related and because it was managed by lecturer team, yet the specific substances on science and engineering can be drawn as it depicted in Table 1.

Table 1.
Curriculum and syllabi of the core subjects in food and health

PC 2 credits + 1 Laboratory Practices	FMS 2 credits + 1 Laboratory Practices	FE, 6 (3) credits imbedded exercises
Nature of matters: quantum physics, gas law, phase of matters	Physical properties of geometric and visual characteristics	Heat transfer: conductive, radiative, convective; pump, plate heat exchanger
Thermodynamics laws: temperature and kinetics of Molecular theory	Physical properties of thermal characteristics	Mechanical separations: filtration, centrifugation, sedimentation, extraction
Thermodynamics of machinery: Helmholtz – Gibbs equation	Physical properties of mechanical characteristics	Thermal processing for safety and quality aspects
Thermodynamics of separations: Duheim –Gibbs equation	Physical properties of powder/emulsion system	Baking, frying, roasting, mixing technology

Notes: Physical Chemistry (**PC 2 credits + 1 Laboratory Practices**), Food Material Sciences (**FMS 2 credits + 1 Laboratory Practices**), and Food Engineering (**FE, 6 credits imbedded exercises**)

The way to deliver the lecture materials were both offline (before pandemic covid 19and post pandemic covid 19/epidemic covid 19) and online during pandemic covid 19. The learning activities were similar, but slight modifications were used according to the available facilities, especially using Moodle application of learning management system. All were compiled as data of final grades at the end semester of the students, i.e., the values already mixed up with students' grades obtained from other lecturer teammates and feed backs from students for the lecturer in charged who design the study of lecturing methods.

Descriptions of the students included (1) 3rd and 4th semester where they were subsequently taking the aforementioned classes, plus few remedial students from different semesters; (2) mostly they aged between 19 – 22 years old; (3) 55-60% were female, the rest were male. The top 5 state of minds of the students recorded through questionnaires were (a) panics facing the engineering exams 48.04%, (b) hardly direct themselves for thinking 41.18%, (c) having difficulties to stop for a while and thinking clearly about the problem in the exam 43.14%, (d) completely dependent on examples in the class 44.12%, and (e) never trying to raise questions or arrange the exercise 68.63%. Mathematics was the scary subject for the majority, but Food Material Science was seen the subject which encouraging because they understand that various commodities important for their careers in the future. Classes' delivery methods are listed in the Table 2. Impacts of the delivery lectures were recorded and expressed as mean values of performance index and survey on students' feed backs at the end of each semester.

Table 2.
Planning of delivery methods of the subjects for 5 years (odd and even semesters)

Parameters	Methods of delivering lecture and practices		
	PC	**FMS**	**FE**
a.y. 2023-2024 (off line)	Any works according interests of the students (newspaper, comics, 3D visualization, poster, recorded poster presentation, machinery design, etc.) under theme of **traditional or ethnic foods**	Field visited with guidance, Work sheet report template for any commodities according to students' interests	Any works according interests of the students (newspaper, comics, 3D visualization, poster, recorded poster presentation, machinery design, etc.) under theme of **traditional or ethnic foods**
a.y. 2022-2023 (off line)	Poster and recorded poster presentation	Poster and recorded poster presentation	Exercise with problems, involving university values (**natural disaster related food processing**)
a.y. 2021-2022 (online)	Group presentation and individual report based on students' interests	Case study with 2 steps peer reviewed, @ 2 peers	Presentation after 50 minutes lecturing by the lecturer, given topics in line with weekly subject courses, introducing excel application development for calculation of the cases
a.y. 2020-2021 (online)	Group presentation and individual report based on students' interests	Case study with 2 steps peer reviewed, @ 2 peers	Presentation after 50 minutes lecturing by the lecturer excel application development for calculation of the cases
	Recorded - poster presentation; class competition for solving an exercise under a leading group (mentored by the lecturer before)	Recorded - poster presentation; class competition for solving an exercise under a leading group (mentored by the lecturer before)	Group presentation and individual report based on students' interests, under theme of **covid 2019 safety and prevention**
a.y. 2019-2020 (off line)	Group presentation and individual report based on students' interests	Group presentation and individual report based on students' interests	Presentation after 50 minutes lecturing by the lecturer

Notes: Physical Chemistry (**PC 2 credits + 1 Laboratory Practices**), Food Material Sciences (**FMS 2 credits + 1 Laboratory Practices**), and Food Engineering (**FE, 6 credits imbedded exercises**)
a.y. = academic year

DISCUSSION

The role of scientific philosophy

The newly revealed knowledge about relationship of food components and health opened up the needs of interdisciplinary education among food based study programs, medicines, molecular biology, nutrition, and pharmacy. According to philosophy of sciences, at the beginning of new sciences, the philosophy plays a crucial role in thinking and answering activities, thus generating and building a systematic information becoming sciences. A burning logical questions and answers drive researchers and scientists to ask deeply and systematic questions born from critical thinking power. Then, they investigate and synthesize the data into an understanding of the discovery or results. Seeking the truth behind the

phenomena observed from daily life or developing tools or new thinking concepts is the ultimate function of higher education. The students are habituating in an academic environment and a curriculum to nurture their expertise. Meanwhile, the output of learning process is expected to bring solutions for problems in society.

Regarding functional foods and nutraceuticals, the selected course subjects had been treated for 5 years and the delivering method of learning substances to students as listed in Table 1. To fit the solution from research or in depth study with the real problems faced by the society, then science would require engineering mastering skills thus the students familiarize themselves with technology generating activity. It is common problems that engineering is frequently seen as a difficult subject in the class. Science related to engineering in the study were treated to help students to be transformative learners. Engineering Science is strongly laid on Mathematical and Physical Sciences so that the learners capable of creating, modifying, innovating, and exploring forecasts, calculating risks, and shaping the conceptual future. Hence, technology is born from knowledge and engineering in order to be applicable in the real society, bringing a leverage for the better lives in the society. For instance, the technology for empowering immune system in the body through stem cell therapy which is capable of tracking selectively the designated organs through signaling at molecular and genetic signals. In Epigenetic Sciences it is illustrated in Picture 1. The pandemic covid 19 is one of proofs about the essence of interdisciplinary Foods, Medicine, Pharmacy, and Biological Sciences by which a set of golden rules had saved the society through various new tools for safety protection for health workers in the hospitals, like hazmat suit during pandemic covid 19 that had saved many souls from death while helping patients.

In the future, eagerness to investigate on wider and deeper foods and medicines is predicted continuing, therefore, a curriculum for functional foods and nutraceuticals in the Health Science, Life Sciences, and Foods/Medicines becomes relevant for transforming the future alumni into skilled human resources in managing public health enlightened by scientific lights. Physical Chemistry helps the understanding toward biological molecules to reacting properly in a curing/preventing physiological pathways in the body. This is in the field of functional foods and nutraceuticals academic; and at practical levels it is for foods/medicine/nutrition/pharmacy industries. However, in this study the experimental classes were carried out in Food Technology Departments, for the fundamental sciences at 3rd and 4th semester, where in the higher semester the students will choose elective subjects on functional foods or evaluation of nutrition (quality and health effects). The whole concept of nutraceutical and functional foods we discussed before is considered as still relevant in the present study. In addition of the hard skill curriculum, in the teaching methods, university's values were implemented in exams and daily classes discussion, i.e., caring, commit, and enthusiasm as part of human rights consideration.

Curricula implementation for transformative education

Table 1 displays lectures' contents used in the classes as the locus of experiments. Experts required in the higher education, industry and institutional supporting policy into the government need knowledge in the processing, influencing factors for the quality of functional foods, nutraceuticals or medicines. Therefore, various physical parameters like temperature, pressure and any defects that threaten their quality should be mastered and understood on contextual problems in the society. Table 1 includes all key points in the nutraceuticals and functional foods to guarantee the quality along the line of production, distribution, transportation, storage, and consumption.

Table 2 informs us the classes' treatments to reach the goals of education. The different types of treatments were arranged based on students' needs and feedbacks from the previous classes. The more important differences are online and off line classes, i.e., before pandemic, during pandemic, and epidemic covid 19. Every time the semester begins, lecturer gives introductory and learning contract with the students so early students' interest is acknowledged throughout the semester period of curriculum implementation. Finally, the results during experiments of teaching interventions is documented in Table 3. Performance index obtained by students in the classes is considered as a reliable indicator for achieving the learning goals. In combination with descriptive feed backs for the lecturer, then it is expected to grasp what the students found, felt, gained, developed, and experiencing transformations.

It can be seen that general performance indices obtained by students varied and at the level of sufficiently good to almost excellent (ca. 2.5 – 3.5 from 4 scale) including for those with parallel classes. Furthermore, the data were grouped into the characteristics or indicators from references about transformative learning. There are few literatures available on transformative learning in science and technology fields. Hence, based on qualitative feedbacks of the students in each class where the locus of

treatments of delivering subjects (Table 3 the last column and Table 4) were matched with the transformative learning indicators obtained. This is displayed in Table 5.

Table 3.
Results of teaching methods expressed as performance index of students and feed backs for lecturers

Methods of delivering lecture and practices	Learning result parameters (mean values of class performance index)			Student ultimate feed backs at the end of each semester (>40%)
	PC	FMS	FE	
Assignment based on student interests Lecturer guided student field visit project reports	a.y. 2023-24: 2.81 (51 students)	a.y. 2023-24: 3.14 (50 students)	*Ongoing (February – August 2024)*	Lecturer encouraged students to be active. Lecturer was interactive, caring (reminded students to submit assignment), enthusiastic, involving examples from daily life, her explanation was easily understood by students.
Poster and other teaching demonstration tool design Excel application Recorded poster presentation	a.y. 2022-23: 2.54 (47 students)	a.y. 2022-23: 2.81 (49 students)	a.y. 2022-23: 2.91 (47 students)	n.a.
Case study with 2 steps peer evaluations @ 2 peers, finalization by lecturer (a.y. 2020-2021), online during pandemic covid 19	a.y. 2021-2022: 3.12 (58 students) a.y. 2020-2021:[#] 2.75 (46 students), 3.10 (59 students)	a.y. 2021-2022: 3.00 (64 students) a.y. 2020-21: [#] 3.40 (55 students) 2.90 (47 students)	a.y. 2021-2022: 2.98 (54 students) a.y. 2020-21: [#] 3.45 (50 students) 3.61 (51 students)	1. Stimulating interaction among students even though under pandemic covid 19. 2. Broadening students' mind. 3. Useful. 4. Unique and interesting. 5. Confusing at the first case study, after familiar with it, case study was found useful to help students learning wider and deeper. 6. Being sensitive and aware of phenomena in environment where the students lived. 7. Stimulating the students to think more and to develop logical thinking. 8. Understanding the applications of lecture in the daily life. 9. Student needed written material step-by step calculation. 10. Student needed correct answers form lecturer for the exercise. 11. Student could not act as peer examiners of the workshop because had no the correct answers. 12. Students did not understand the terminology.

Methods of delivering lecture and practices	Learning result parameters (mean values of class performance index)			Student ultimate feed backs at the end of each semester (>40%)
	PC	FMS	FE	
Excel application development to tackle mathematics phobias[‡]				13. Lecturer spoke too fast for students in online classes. 14. Reflecting her/his self to other students' thoughts/works/ideas, whether she/he had work better than others
Thematic* assignments with questions as guideline in the learning orders; exercise problems in each lecturing topic.				1. Understanding the materials well. 2. Happy with on cam working together with the class mates and got opportunity to show their works. 3. Taught well. 4. Learning others' thoughts. 5. Got lost in the midst of explanation every time during online learning. 6. Students encountered problems in online lectures.
Combination of lecturer – student leading group delivery	a.y. 2019-2020: [#] 2.32 (64 students) 2.41 (65 students)	a.y. 2019-2020: [#] 2.52 (80 students) 2.20 (65 students)	a.y. 2019-2020: [#] 3.04 (65 students) 3.00 (62 students)	Presentation by leading groups after lecture 50 minutes drove students learnt before classes, positive attitude of student preparation

Notes: Physical Chemistry (**PC 2 credits + 1 Laboratory Practices**), Food Material Sciences (**FMS 2 credits + 1 Laboratory Practices**), and Food Engineering (**FE, 6 credits imbedded exercises**).
a.y. = academic year.
n.a. = not available.
*Food for society to face natural disaster, traditional/ethnic foods, and foods related to Covid 19. The responses were in Table 4.
[#]Parallel classes.
[‡] It was a response for students need for more calculation problem regarding final examination.

Table 4.
The responses of students surveyed using a critical survey during learning in Moodle platform.

Aspects	Major responses (scales)
Relevance:	
1. Focus on interesting issues	Often
2. Important to my practice	Often
3. Improve my practice	Often
4. Connect to my practice	Often
Reflective thinking:	
1. I am critical of my learning	Sometimes
2. I'm critical of my own ideas	Sometimes – often
3. I'm critical of other students	Often

4. I'm critical of readings	Sometimes
Interactivity	
1. I explain my ideas	Sometimes
2. I ask for explanation	Sometimes
3. I'm asked to explain	Sometimes
4. Students respond to me	Sometimes
Tutor support	
1. Tutor stimulates thinking	Sometimes – often
2. Tutor encourages me	Sometimes – often
3. Tutor models discourse	Sometimes – often
4. Tutor models self-reflection	Sometimes – often
Peer support	
1. Student encourage me	Sometimes – often
2. Students praise me	Sometimes – often
3. Students value me	Sometimes – often
4. Student empathize	Sometimes – often
Interpretation	
1. I understand other students	Sometimes – often
2. Students understand me	Sometimes – often
3. I understand the tutor	Sometimes – often
4. Tutor understand me	Sometimes – often

According to Charter et al. (2014) basically a transformative learning is a chance of individual to experience changes, from mind state one to the other after he/she obtains new understanding, new knowledge, and it reaches his/her heart that drives them to take a new attitude in his life. Hence, transformative learning assumes there will be repentance (left the previous attitudes) and it happens continuously. Thus, the concept of a long life learning can be illustrated and achieved. However, there is also a weakness of transformative learning because of the limitation of human being in term of space and time, i.e., when the new knowledge is false or as a post truth phenomenon. Therefore, a concept of religiosity helps individual to accept the reality of human weaknesses; and the time line of being will bring the history of individual human life path. This is considered as applicable in Indonesia because the first educational regulation is envisioned national human building of "akhlak" or "morality", especially Indonesia greatly put the belief to Monolithic God religions as a number one of fundamental national law in Pancasila and written in the UUD 1945 (Fundamental law issued in the early independence day August1 7, 1945). This concept is in line with Carter et al. (2014) and Dirkx et al. (2006) that not only the individuals of the students that is matter, but also the socio-cultural experiences during space and time frames where the students are connecting and interacting with their environments where she/he lives. In the digitalization era of high technology, the transformative learning needs to be filtered for good governance of life in the diverse cultures. Regarding the interaction of nature and nurture, we also did experiments on transformative learning in science education. Similarly, the other data from lecturers' characteristics, psychological states of the students and alumni who were students and now take as lecturer careers are involved. However, this chapter is insufficient to discuss the whole data here.

Several literatures describe the essential indicators of transformative learning and in the present study they are used to identify the relevant findings from the data obtained. Table 4 indicates that there are many aspects still prospective to be treated for transformative learning because students' responses are still at the scale intervals of sometimes - often, meaning that these aspects can be developed in the future. Meanwhile, in Table 5 there are several transformative indicators still empty, thus the classes still have opportunities to explore those indicators with other treatments or teaching strategies to help students, especially at private university, they are eager to study but lost battle in the selection to enroll at state university or because of other nonacademic factors.

Table 5.
Matching the data in the present study with references of transformative learning indicators

Transformative learning indicators	Ref.	Findings in the present study
Principles of transformative education	tef-global.org	
1) Human rights		Student grouping, student interests

2) Sustainability		-
3) The importance of value systems: morality, ethics, and spirit		University values: care, commit, enthusiasm; happy experiencing on cam to share their work in the online classes
4) Diversity		Two steps peer evaluation @ 2 students
5) Economic and social justice/equity		Involving SDGs in the relevant topics
6) Peace education and social conflict resolution		Self-evaluation and group member evaluation, thematic topic of natural disaster, covid 19, and traditional/ethnic foods
7) Holistic education		Field visits with guidance
8) Community based learning and indigenous wisdom		ibid
9) Simulation/experiential learning		-
10) Incorporating new brain neuroscience and skills of critical thinking		Stimulated by the lectures to think logically
11) Use of technology for greater connection not alienation		Two steps peer evaluation @ 2 students
12) Sanctity of human learning and life		-
Pedagogical approaches in teaching explain	Gudaji, 2019	
1) Constructive		Individual workshop Moodle platform, two steps peer evaluation, @ 2 students, leading group presentation, field visits with guidance.
2) Collaborative		Work group assignments.
3) Integrative		Exercises with thematic topics, i.e., natural disaster, covid 19, and traditional/ethnic foods.
4) Reflective		Two steps peer evaluation, @ 2 students, the uses of excel application in calculating and renew with different exercise problems.
5) Inquiry based learning		Workshop, field visits with guidance.
Phases of transformative learning	Nerstrom 2014	
1) Having experiences		Field visits, workshop, excel applications
2) Making assumption		-
3) Challenging perspectives		Thematic topic at special current issues: natural disaster, pandemic covid 19
4) Experiencing transformative learning		Learning others' thoughts, finally accepting workshop
Types of transformative learning	Mezirow's theory	
1) Critical reflection		Workshop-cases of the assignments, field visits, self-motivated trials
2) The centrality of experience		-
3) Rational discourse		Students developed logical thinking
Essential components of transformative learning	Mezirow's theory	
1) Disorientated dilemma or experience		Initial introducing workshop.
2) Dialogue		Mentoring leading group, discussion in the group.
3) Critical reflection		Self-evaluation and group member evaluation.

4)	Holistic of rational and emotional transformation	Finally accepting workshop, found it useful, aware of environment.
5)	Awareness of context	Being sensitive and aware of students' environments/daily life.
6)	Active on revision or exploratory premise	Individual and group assignments; two steps peer evaluation @ 2 students

Transformative learning in food and health for better living quality

Pedagogy is the way that the teacher delivers the content of the curriculum, the teaching style used, and the theories employed. The impacts of pedagogy partially can be seen from performance index. However, there are still other transformational aspects such as the student attitudes after class or further characters in the next semester. This is because the classes Physical Chemistry, Food Material Science and Food Engineering are taught in a sequential curriculum semester thus the lecturer can recognize the individual transformation. Yet, such theoretical concept to draw its underlined characters is unknown at the moment. Therefore, this chapter is expected to be material learning for education expert to develop further non-academic index, especially regarding to human character development in building a human resource important for living together in harmony even though the individual variety or ethnicity/religiosity/culture differences among others. Similar findings were from Natural Sciences researched by Barnett & Botes (2022) that the role of lecturers' preparations played determinant factors because they design the teaching methods and generate conducive environments of the class for students experiencing transformative learning. Moreover, transformative learning is considered by Singer-Brodowski (2023) as suitably prospective related to multi professional networks, interdisciplinary or research cooperation process, individual, and organizational levels/cases; just what needed in the Picture 1, i.e., education of functional foods and nutraceutical complexity.

CONCLUSION

It is an opportunity to match what lecturer tried to do to develop the students in Engineering Science applied for functional foods and nutraceutical, which is a relatively new interdisciplinary field of Foods, Health Science and its requirement for engineering aspect to create a proper technology as one of solutions in modern society problems, i.e., uncommunicable and degenerative diseases in public health problems. Functional food and nutraceutical become a hope to save public health at the best costs. Through the science and technology of genetic based sciences called epigenetic, nutriomics, neturigenomics, nutrigenetics, and biological molecules; a map of prerequisites of future human resources are obtained. Curricula and teaching methods, especially in this case is higher education, guides us to seek solutions for the future generations. The treatments applied on the classes of Physical Chemistry, which become the bottom line of engineering capacity to create technology, together with Food Material Sciences as a core subject at Department of Food Technology, had been investigated for 5 academic years from 2019/2019 to 2023-2024 in Indonesia. Various techniques of the following class managements: (a) students' interest oriented, (b) workshop with two steps peer evaluation @2 peers, (c) lecturing and leading group presentation in each weekly topic, (d) individual and group works, (e) the use of excel application for calculation problem exercise, and (f) field visit accompany with worksheet project guidance; were documented and mapped into the theory developed by Jack Mazirow as transformative learning. The results indicated that either online and offline learning found several indicators of existences of transformative learning; as well as phases and conditions that transformative learnings can be achieved. However, there are still non-academic aspects have not been considered, such as measuring the transformation itself which is expressed in appropriate scales. Therefore, the future opportunity to develop further of transformative learning remains to be elucidated.

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