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Genetically modified food for the future: examining university students' expressions of futures thinking

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ABSTRACT

Futures thinking, or foresight, is increasingly recognised as a key element in science and environmental education. We integrated a futures thinking activity into an undergraduate general science course in Taiwan by using an online thinking and discussion tool that provides scaffolding questions to help students think systematically about future possibilities of the specific topic – genetically modified (GM) food. As a course assignment, the enrolled students were asked to work on and write their responses to this online scaffolding tool over five weeks. The purpose of this study was to examine students' expressions of futures thinking on GM food as elicited through this assignment. We content analysed the written responses of 99 students who completed the online task. A particular emphasis of analysis was placed on examining students' thoughts and ideas about 'preferable' or 'desirable' futures of GM food. Nine themes emerged from the analysis and were found be organised into three categories using factor analysis. These results provided insight into characteristics of students' futures thinking and underlying perspectives, and can serve as a basis for future-focused curricular and instructional innovations.

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Futures thinking; gene technology; genetically modified food; undergraduate general science; higher education

Introduction

The emergence of a futures[1] focus in education, and particularly in science and environmental education, has been well mapped by several scholars (Bell, 2006; Buntting & Jones, 2015; Jones et al., 2012; Slaughter, 2008). One most convincing reason for integrating a futures focus into curricula is that a past-to-present, reactive approach can no longer effectively guide us in this rapidly changing and technological world (Bishop & Hines, 2012; Costanza & Kubiszewski, 2014). We are increasingly confronted with important complex issues, such as global warming and gene technology, which are characterised by substantial uncertainty about the underlying processes and significant, often long-term consequences. In order to be better prepared for a world which will be significantly different from the one today, young people need to develop some understanding of the nature of change, including trends that broadly characterise change and factors and forces that create and drive change, so that they can analyse and anticipate change.

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From this perspective, a forward-looking, proactive approach becomes important. There is a need for young people to develop futures thinking – the ability to think more critically and creatively about the future, seeking out and examining different possible futures, and more importantly, determining among them the desirable direction (Hicks, 1996; Hicks & Holden, 1995). This ability would help students not only focus on solving problems but also on avoiding new problems for the future. Arguably, without explicit development of futures thinking, it could be easy for students to feel helpless and hopeless, and become disinterested in and disassociated from a future which is predetermined, and cannot be affected, as a result of uncertainty (Costanza & Kubiszewski, 2014; Hicks, 2012; Lloyd & Wallace, 2004). As university students are soon to join more fully in public discourse and decision making, they must learn to become competent, effective, and responsible in dealing with futures issues.

Based upon the above arguments, we incorporated a futures perspective in an university-level general science course by providing students opportunities to reflect and create a vision of a desirable future regarding genetically modified (GM) food. Using an online scaffolding tool, students were guided to think systematically about current situations, trends and drivers behind these situations, leading to contemplation of possible and desirable futures of the topic. The purpose of the present study was not to evaluate the effect of the futures-oriented instruction, but rather to examine students' expressions of futures thinking, highlighting the aspect of *preferred* or *desirable* futures, as elicited through the coursework on the topic of GM food.

Futures thinking in science and environmental education

Research has indicated that students often possess undesirable, negative views about environmental futures, such as feeling overwhelmed, out of control, or unable to change (e.g. Fleer, 2002; Strife, 2012). But positive views about the future can also be problematic; Ojala (2012, 2015) found in her studies that optimistic views about the future can be unrealistic and based on denial (such as toward climate change), and in turn become a barrier to taking environmental action. Moreover, 'feeling good' about the future is likely a reflection of trust in experts of science and technology to fix the problems, and still leads to complacency and passivity (Liu & Lin, 2018). On the one hand, feelings of pessimism and powerlessness are counterproductive in science and environmental education as they can easily lead to what Sobel (1996) calls *ecophobia* – a fear of ecological problems and the natural world, and when compounded by feelings of being unable to change the situation, this fear or anxiety can easily turn into apathy or feelings of resignation regarding the environment or environmental issues (Hodson, 2011). On the other hand, feeling optimistic due to denial of the seriousness of environmental problems or over trust in the power of science and technology is also an undesirable attitude for science and environmental education.

It becomes imperative that young people are provided with future-oriented learning opportunities where they can evaluate the role of techno-science in environmental development and connect themselves with possible futures in order to gain a sense that 'their collective contributions can make a difference to either improving or reversing some of the studied environmental issues' (Fleer, 2002, p. 149). Without being explicitly supported, the young generations have difficulty in projecting themselves into the future, and in developing skills and values needed to be responsible and active persons, citizens and future professionals (Sjøberg & Schreiner, 2010). Several curriculum documents have emphasised a future-focused goal. For example, the New Zealand Curriculum has specifically stated that a fundamental curriculum principle is about 'supporting learners to recognise that they have a stake in the future, and a role and responsibility as citizens to take action to help shape the future' (New Zealand Ministry of Education, 2017). In Australia, the Tasmanian Essential Learnings (Tasmania Department of Education, 2002) also requires schools to help students move from a passive, disengaged acceptance of *the future* to an understanding that there are many possible *futures* and the future is not pre-determined (Smith, 2010).

Although researchers have advocated a futures focus in science and environmental education, futures thinking has generally been a missing component in teaching practice (Buntting & Jones, 2015; Jones et al., 2012). It is difficult to find evidence of futures thinking being promoted in schools or universities (Hicks, 2012; Slaughter, 2008). One possible reason for this is the lack of appropriate resources and training for teachers. In the educational context of Taiwan, teaching and learning of futures is limited to futures studies as a discipline for higher education; futures thinking as an integral element in science and environmental education is still under-researched and overlooked.

Although a number of practical workbooks with lesson plans and activities are available from earlier work (e.g. Hicks, 1994), there is relatively little research on instruction and teaching for enhancing students' futures thinking. One exception is the recent study (Jones et al., 2012) carried out in New Zealand, which reported the learning process of integrating a conceptual framework of futures thinking into classroom activities. This study sought to use their conceptual framework – the futures thinking model – in our educational context for the purpose of promoting futures thinking and foresight as well as futures-oriented pedagogy.

Context of the study

The study was undertaken in the context of a large enrolment general science course at a public research-oriented university in southern Taiwan. The university covers a range of disciplines in its six faculties (humanities, sciences, engineering, marine sciences, management, and social sciences) and is highly regarded in Taiwan. This semester-long course entitled 'Everyday Science and Technology' was intended for students of all majors as part of general education. The course content covers several contemporary issues in everyday science and engineering such as laser treatments and cosmetic ingredients in the area of cosmetic science, and food additives and contaminants and GM food in the area of applied food chemistry. The course was taught once a week, each time for three hours, and five weeks were dedicated to the food-related topics. The instructor had been collaborating with the author on developing futures-related curricular or teaching strategies prior to the study. Using the topic of GM food, we incorporated an online futures thinking and discussion tool as an assessment task to replace a typical writing assignment. This tool uses a logical sequence of open-ended questions that guide students to explore and think about future possibilities. This is based on the assumption that futures thinking is not a spontaneous or intuitive process, and students need to be provided with opportunity to develop this ability (Jones et al., 2012). After an introductory lecture into the GM food topic in class, students were asked to participate in the online task outside of class as a course assignment for a duration of five weeks.

Online futures thinking and discussion tool

The computer-mediated thinking and discussion tool was developed based on McKim et al.'s *futures thinking model* (2006) for the purpose of facilitating and exploring students' thinking about specific science and environmental topics and their futures. This model provides a framework for inquiry by prompting and guiding students towards (1) an understanding of the current situation, (2) an analysis of relevant trends, (3) identification of the drivers underpinning relevant trends, (4) identification of possible and probable futures, and (5) selection of preferable futures. With each component including specific questions for supporting students' inquiry thinking, the sequential five components act as scaffolds to help students systematically think about futures in relation to the studied issue. In this study, specific questions related directly to GM food were modified from a case study by Jones et al. (2012) and used for the online tool (see Table 1).

This tool is similar to a discussion forum where students can enter a component and write their responses to the key questions, following a fixed sequence as above. It was integrated into the general science course as an assignment activity, where students were requested to work on, and write their responses to, the key questions of one component per week, and thus were given a total of five weeks to complete the entire activity. This discussion tool divided students into small groups of 3–5 based on their own choice, and allowed students to not only write their responses but also view other responses within the group. The purpose was to support peer discussion and a sharing of ideas, although students were asked to express their own thoughts in their answers, and consensus was not required.

Methods

Participants

There were 109 students enrolled in the targeted science course during the 2016 spring semester. They were informed about the use of their coursework for research purposes and assured of the anonymity and freedom to not participate, or to withdraw their cases. Although the instructor was not directly involved in the research, to avoid any

Table 1. Components and the related key questions about GM food.

Component	Key questions
Existing situation	*What foods have been genetically modified? What GM foods are common here in Taiwan? What are the processes of genetic modification? How does GM in the lab differ from traditional breeding approaches?*
Trends	*What are the purposes of GM foods as mentioned in the previous section? What kinds of changes/ modifications are considered to be useful and desirable?*
Drivers	*What factors influence what gets researched and/or developed as a new food? (Consider these factors from social, ethical, and environmental aspects.)*
Possible and probable futures	*What are we likely to see as future developments? Why?*
Preferable futures	*What do we value in the types and forms of food we eat? What would you prefer GM foods to be like in the future?*

conflict of interest, data analysis occurred only after the submission of grades. Of these students, 99 completed the futures thinking assignment and agreed to participate in the study. They included 35 female and 64 male students from their first to final study year, representing a wide range of disciplines in the science, engineering, humanity, and management domains. They were divided into 20 small groups based on their own choice to work on this assignment.

Data analysis

Response data were collected from two futures components of the online assignment, and content analysed for the purpose of finding characteristics and patterns of their expressions. Our initial analysis revealed that many student responses to the component of 'possible and probable futures' ('What are we likely to see as future developments?') were similar to those to 'preferable futures' ('What do you prefer GM foods to be like in the future?'). Therefore, we analysed the both components with the focus to identify key characteristics or features of desirable GM food's futures as expressed by these students.

Three coders (the author and two experienced graduate students) were involved in the recursive review of student responses. They generated an initial set of 22 codes (e.g. *easy to grow*, *lowering costs*, and *preventing human diseases*) after looking independently at 30 randomly selected student cases. They discussed these in a consensus meeting. Two coders then used this coding scheme to independently code the remaining student cases in two stages, each with follow-up consensus meetings which involved all three coders to revise the coding scheme, categorise codes, and ensure the agreement on all the coding. Nine themes that cover a final set of 24 codes emerged in the analysis (Table 2). With this analysis, a student's response often included more than one theme. Also, not all codes could be described as being exclusive to particular themes. The code, for example, of 'easy to grow' denotes an aspect of *higher yield and quality*, but is related to *higher economic value*, such as lowering production costs. Some student quotes were selected and translated into English for the purpose of clarifying and illustrating the themes. These themes were not only examined qualitatively but also quantitatively in terms of the percentage of students expressing particular themes and, counting the number of themes expressed by each student, distribution of students by the numbers. In order to identify underlying relationships between these themes, we performed exploratory factor analysis which allows natural groupings to emerge through the analysis.

Results

The analysis of students' responses to futures-related questions resulted in 9 themes that represent the characteristics of GM food's future directions that are desirable according to the students. More specifically, they included notions about what future GM food should be like, and what to be considered and done for its development. It is worth noting that students mentioned nearly exclusively about crops and vegetables, although animals were included in their responses to preceding questions regarding the existing situations and trends of GM food. Figure 1 shows the distribution of student responses across these themes.

Table 2. Coding categories of students' ideas regarding preferred futures of GM food.

Theme	Code
1. Higher yield and quality	- having more desired features (generally) - easy to grow - more nutritional - more tasty - easy to eat or digest (e.g. easy-to-peel, seedless) - easy to preserve or transport - looking better or different
2. Tolerance to environmental stress	- adaptive to climate change - grown in barren areas - anti-radiation - grown in outer space
3. Minimal impact to the general environment	- with minimal impact to the general environment (e.g. preventing cross-breeding in the wild)
4. Minimal impact to human health	- with minimal impact to human health (e.g. careful testing and monitoring of GM foods)
5. Higher economic value	- higher economic value (e.g. lowering production costs)
6. Advanced medicine	- general medical use - preventing human diseases - catering for specialised health needs - increasing human life span or body function - aesthetic medicine
7. Providing solutions to environmental problems	- providing solutions to environmental problems (e.g. removing pollutants)
8. More consideration needed	- appropriate regulations - more research and more considerations
9. Stopping GM food	- strict regulations - no GM food

The majority of the students (89%) focused their ideas on *higher yield and quality*. This theme included several features, among which 'easy to grow' (67%) and 'more nutritious' (65%) were most frequently mentioned, as shown in Figure 2. Several students specifically linked these features to the need of feeding the growing population and/or to the concern of decreasing agricultural areas. Examples of their comments include:

> Lots of arable land is disappearing due to urbanisation and industrial pollution. […] We must provide enough food for the world population with limited arable land, and GM food can help solve this problem. (S08);

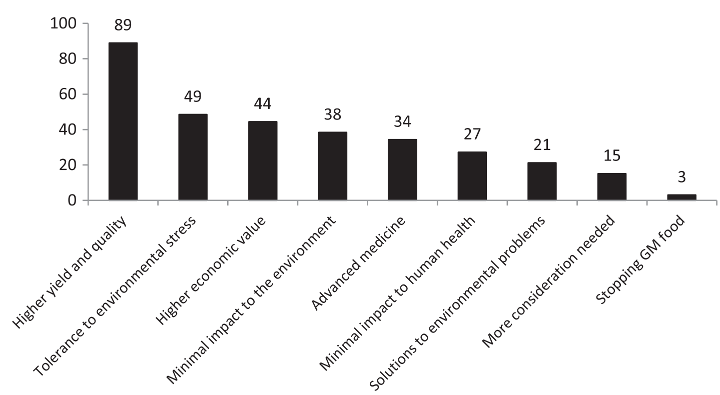

Figure 1. Student distribution (%) of themes of preferred futures regarding GM food ($N = 99$).

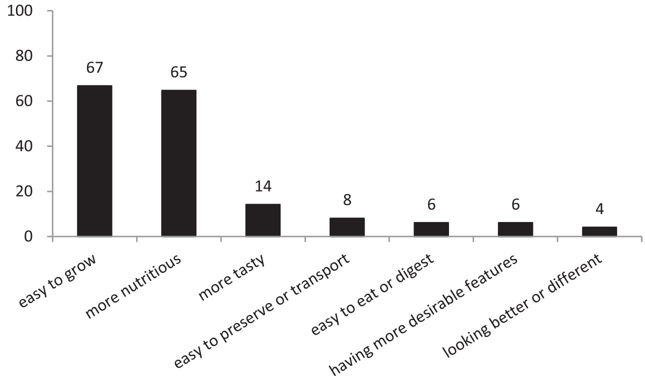

Figure 2. Student distribution (%) of characteristics related to 'higher yield and quality' ($N = 99$).

> [It] can be produced fast and in large amounts in order to meet the needs of a huge human population. (S61)

A smaller number of students looked at taste ('more tasty') (14%), shelf life ('easy to preserve or transport') (8%), teeth- or stomach-friendliness ('easy to eat or digest') (6%) and appearance ('looking better or different') (4%), while several students mentioned generally the need of 'having more desirable features' (6%).

Nearly half of the students (49%) gave responses that fall under the theme of *tolerance to environmental stress*. For these students, being able to grow in the harsh environment is a desirable characteristic of future GM food. They especially referred to the adaptiveness to climate change (47%) as such a characteristic (Figure 3). The following is one example response:

> The future food needs to be very adaptive to the environmental and climate change. They need to be able to grow in extreme weather conditions […]. (S39)

Some students mentioned more generally about the capability of surviving barren areas (8%) including drought, cold, heat, and soil problems, and even in outer space (2%). One student stressed the potential of having anti-radiation properties in response to public concern about food imports from Fukushima, stating:

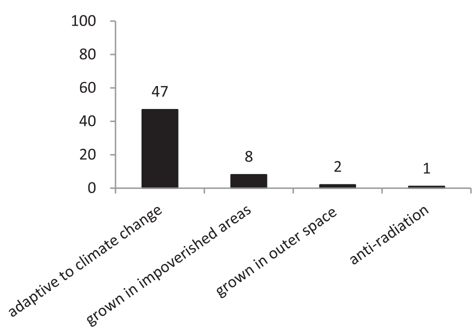

Figure 3. Student distribution (%) of characteristics related to 'tolerance to environmental stress' ($N = 99$).

> If we can develop anti-radiation crops, […] they can grow in radiation affected environments. Despite the concern of eating such foods, the polluted places can be still fully utilised at least for ornamental crops. (S19)

Some students expected GM food to exhibit *higher economic value* (44%), such as lower production costs (e.g. by using less chemicals) and more stable incomes for the farmers (e.g. by having desirable features compared to traditional crops). Meanwhile, many students were concerned about GM food's environmental as well as human health risks. They wanted future GM food to be produced with the assurance of minimal impacts to the environment and to human beings. Within the theme of *minimal impact to the environment* (38%), several students considered GM plants that require little or no pesticides as a desirable characteristic, as opposed to those engineered to be more resistant to pesticides or even to produce pesticides themselves. There were also responses related to the threats imposed by new species on other wild ones. The following is one example of such responses:

> For future sustainable development, [GM food] should reduce the risk of [new] genes leaking out, minimise the threat to other, non-targeted species, and the possibility of dangerous mutations in GM organisms or viruses. (S05)

Within the theme of *minimal impact to human health* (27%), the students were focused on the idea that food should 'bring benefits, […] not damage, to human health' (S69). Therefore, GM food was expected to help avoid the use of chemicals for crop growth, preservation, colour, etc. Also, careful testing and monitoring of GM food was considered to be important for protecting human health.

Another frequently noted theme was *advanced medicine* (34%), which included responses addressing the medical potentials of GM food. Figure 4 shows the distribution of characteristics within this theme. More than 1 in 4 students (25%) advocated engineering of foods towards the goal of catering for specialised health needs; for example, to contain certain nutrients that 'help detox the human body' (S07) or hormones that 'automatically control and balance the blood glucose level in our body' (S42). There were also responses such as 'removing the allergens from particular foods' or 'adding to rice and flour the property of onions so they can lower blood sugar' (S28), so that people with specific health issues can still enjoy these foods. Preventing human diseases were also

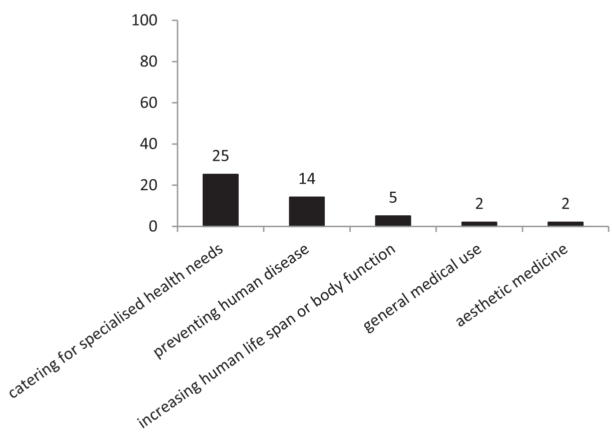

Figure 4. Student distribution (%) of characteristics related to 'advanced medicine' ($N = 99$).

considered by some students (14%) as a desirable feature of future GM food; this referred to the kind of food that can vaccinate people or strengthen immune systems. To develop GM food with the purpose of increasing the human life span or enhancing body functions (5%) was also mentioned within the same theme. Two students believed that GM food can be developed for human aesthetic enhancement or weight loss, while another two only mentioned general medical use without detail.

More than 1 in 5 students (21%) gave responses that fall under the theme of *solutions to environmental problems*. These responses focused on the idea that genetic modification can help to address serious environmental problems including climate change, resource scarcity and pollution. For example, one student commented:

> GM crops and vegetables can contain a diversity of nutrients, and even those found in meat, and they will help to restore the balance of carbon cycle [as meat is less needed]. (S10)

Another student suggested the development of GM plants that can be used to clean up contaminated land by 'removing toxic heavy metals from soil' (S15). This theme is separate from another theme *tolerance to environmental stress*, despite both containing responses that specially addressed environmental problems. The former is focused on improving or solving problems, while the latter emphasises adaptation.

In thinking about desirable futures, some students were more cautious despite believing in the potential advantages of GM food, and gave responses that were categorised as *more consideration needed* (15%). These responses pointed to the importance of having more research or regulations for GM food for the future development. The following is one example:

> GM food is still very controversial, and we still don't have enough evidence to know for sure whether it is bad for us. Although they all try to say 'our GM food is harmless,' it's hard to believe. On top of that, GM food violates natural laws, […] so there is still much to investigate for the future. (S74)

Of the 99 students, 4 students gave responses categorised as *stopping GM food* that showed clear disagreement with further development. They believed that food should be 'simply from nature' (S02), and severe restrictions are needed for GM food in order to 'keep the world from irreversible catastrophe' (S36).

In order to have a better understanding of how these 9 themes were distributed, we counted the number of themes expressed by each student. As shown in Figure 5, there were responses that covered as many as 7 themes (3%), while most of the students (77%) mentioned 2–4 themes in their responses.

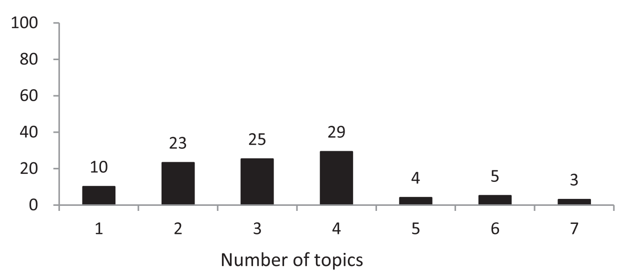

Figure 5. Student distribution (%) of the number of themes mentioned in the response ($N = 99$).

Table 3. Factor loadings and communalities for 9 themes of students' futures thinking regarding GM food ($N = 99$).

Themes	1	2	3	Communalities
1. Higher yield and quality		.688		.668
2. Advanced medicine	.430		−.523	.472
3. Tolerance to environmental stress			.577	.410
4. Minimal impact to the environment	.516			.307
5. Minimal impact to human health	.758			.597
6. More consideration needed	.707			.512
7. Stopping GM food		−.634		.457
8. Higher economic value		.723		.589
9. Solutions to environmental problems			.726	.554

Notes: Factor loadings <0.4 are suppressed. Negative factor loading indicates that a particular theme is highly unlikely to be present within a person's responses belonging to a factor group.

Before conducting exploratory factor analysis to investigate underlying patterns within these themes expressed by the students, we investigated the factorability of these 9 themes. The data contained a sample size of 99 and 9 themes, resulting in 11 cases per theme, and thus met the minimum conditions necessary for factor analysis. Also, the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.55, which is considered acceptable for factor analysis. Finally, Bartlett's test of sphericity was significant, ($X^2(36) = 74.5$, $p < 0.001$). Given these data, exploratory factor analysis was performed on all 9 themes and uncovered three factors based on eigenvalues ≥1.0. As shown in Table 3, all three factors contained at least three items with absolute value of loadings >0.4. The first factor explained 20% of the data variance, the second factor 17.1%, and the third 13.6%. The total variance explained by this 3-factor solution for the 9 themes is 50.7%.

Factor 1 seems to indicate a more *cautious* perspective on future GM food. Although medical applications are seen as advantages, emphasis is placed on minimal impact to the environment as well as human health, and more consideration needed prior to further development. In contrast, factor 2 is more focused on *socio-economic* benefits of GM food. It is unlikely that the theme of 'stopping GM food' is present within a student response in this group. Factor 3 can be seen as *environment-centred*, with themes that address genetic modification as a means to adapt to or to even mitigate environmental change. A student response which aligns strongly with this group is unlikely to suggest human medical applications.

Discussion

This study described ideas and thoughts about desirable futures of GM food as expressed by a number of university students through an online thinking activity. This activity used a structured scaffold to support students in thinking about futures based on considerations of existing situations, developmental trends, and possible drivers behind such trends. By doing so, students could go beyond mere guesswork or speculations when expressing their visions of GM food futures. Although this online activity provided students the opportunity to discuss with other group members, they were explicitly told to articulate their thinking without having to reach any consensus within their groups. As a result, the students were more focused on explaining their own views than responding to others.

During our analysis, we found that most of the students did not distinguish between the two questions regarding 'likely futures' and 'desirable futures.' Several students specifically commented that they wondered why similar questions were posted. This might imply that students generally held optimistic views towards the future of GM food; when they think about what is likely to be as its future development, it's what they generally consider as good and positive. To identify possible reasons for this finding, we looked into student responses to the preceding questions. One possible reason is that students simply viewed genetic engineering as a faster and more precise approach than the traditional breeding as revealed in their responses to the preceding question of comparing the difference of the two approaches. Their accounts were focused on simple, factual information, without demonstrating a conceptual understanding of genetic engineering or articulating their social, ethical or moral grounds. Such results indicate that it is important to help students see the critical differences between genetic engineering and traditional crossbreeding. Also, we found that students exclusively mentioned crops and vegetables in the futures-related responses despite animals being included in their responses in preceding components. This might indicate that engineered animals are still too controversial for the students to consider when thinking about desirable futures.

Through content analysis of student responses, we identified 9 themes, which are particularly helpful in understanding characteristics and directions of students' visions of preferable GM food futures. Most students described 2–4 themes, and many themes were associated with minimising, improving or even solving environmental and human health problems. Using factor analytic approach, three natural groupings were found across the 9 futures themes. They represent three perspectives that can be described as *cautious*, *socio-economic*, and *environment-centred*. The *socio-economic* perspective seems to be more dominant than others. We believe that understanding these perspectives underlying the variation of students' ideas is more important than recognising the existence of these ideas themselves because they provide insight into the ways in which individual ideas were held within a specific perspective and serve as an valuable basis for instruction (Hicks, 2002; Paige & Lloyd, 2016).

As information and communication technologies are widely available, university students, like other adults (including teachers), use the internet as a major source of information. Looking into a number of GM food-related online articles, we found repeating ideas and arguments that are aligned with students' futures themes, especially *higher yield and quality*. In this respect, students' expressions of futures thinking about GM food are similar to what Inayatullah (2008) described as *the used future* and *the disowned future*, which respectively mean to follow the same pattern of thoughts about development as other people, and to focus on pursuing a specific vision or goal (e.g. to be faster and better) without reflecting on other aspects that are important for ourselves (e.g. the meaning of moving genes among species). Only a few students within the *cautious* perspective questioned whether we *should* alter or even generate living organisms. Moreover, some familiar concerns were not voiced out in students' responses, nor in the located articles – for example, that genetic alterations could cross with other species and upset ecosystems or that they could cause farmers to become more dependent on corporations for their seed stock.

Implications for instruction

Based on the above findings, although the scaffolding activity in the study helps students to think more systematically about futures, we felt that more critical questions should be added to facilitate students' scientific, ethical, social and ecological reasoning in order to consider more thoroughly the possible and desirable future scenarios. For example, instead of asking generally 'What factors influence what gets researched and/or developed as a new (GM) food?' we should ask questions that require students to think more specifically about factors related to different reasons *for* and *against* research and/or development of particular GM foods. Also, including futures thinking regarding other food topics such as food additives and organic foods and reinforcement with whole class discussion would likely help students expand their thinking and ideas about different aspects of food, and seek and develop a broader picture of future food.

Implications for research

Scholars and policymakers have been interested in people's attitudes toward genetic technology and its application since its emergence in the mid-1990s (e.g. Arvanitoyannis & Krystallis, 2005; Bal, Samancı, & Bozkurt, 2007; Christoph, Bruhn, & Roosen, 2008; Magnusson & Hursti, 2002). Within this body of literature, there is a rich source of data from different cultures, yet, according to Gardner and Troelstrup's (2015) recent review analysis, they mostly came out of the English speaking countries of the USA, the UK or Australia (55.25%) and an additional 13.16% from Turkey. Further investigations on students' ideas and attitudes toward gene technology embedded in cultural contexts or within particular educational contexts are needed in order to examine cross-cultural comparisons. Moreover, few studies have looked at students' thoughts or attitudes of gene technology in the context of a higher education curricular innovation. Our study contributes to fill in the knowledge gap by taking a unique angle – a futures focus – to explore Taiwanese university students' thinking about GM foods during coursework. Facilitating students' understanding of such issues presents a significant challenge due to their complexity. The accelerated development of science and technology also means that more innovations will open up new spheres of inquiries, creating unknown and unpredictable situations. How could we help students to take the long view in a world of uncertainty and change? As the incorporation of futures thinking in science and environmental education remains relatively un-researched (Buntting & Jones, 2015), more research along this line is needed as important basis for curricular and instructional development.

Notes

1. The plural term 'futures' is used to emphasise the characteristic of multiple possibilities, and also to avoid confusion such that a future topic means a topic in the future, whereas a futures topic denotes a topic of the future.

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